提昇香港塑膠工程師的環保製造技術及管理知識

講義匯集

主辦機構：

香港塑膠工程師學會

資助機構：

香港特別行政區政府

執行機構：

Hong Kong Productivity Council
香港生產力促進局

此講義匯集是為「提昇香港塑膠工程師的環保製造技術及管理知識」項目而編制的一本刊物。

塑膠工程師學會

塑膠工程師學會(Society of Plastics Engineers)在世界各地70多個國家共有近2萬位塑膠專業人士為會員，並向業界提供塑膠技術資訊。

香港塑膠工程師學會的目標是推廣涉及塑膠的科學與工程知識。學會於2011年獲得香港特區政府的「專業服務發展資助計劃」資助，推行了一個名為「提昇香港塑膠工程師的環保製造技術及管理知識」的計劃，而香港生產力促進局負責執行。

項目簡介

香港生產力促進局與香港塑膠工程師學會推行了「提昇香港塑膠工程師的環保製造技術及管理知識」計劃。此計劃是獲得香港特區政府的「專業服務發展資助計劃」資助，並由香港生產力促進局負責執行。此計劃內將舉行六項專題工作坊，目的是協助本地塑膠工程師獲得使環境可持續發展的最新製造技術和環境管理知識。工作坊除了授課外，還提供案例分享。

此計劃舉辦了六項專題工作坊，內容包括：

- 綠色材料
- 先進電腦輔助工程(CAE)技術-產品結構及模流分析
- 綠色製造
- 環保生產與工廠管理系統
- 環球環保標籤
- RoHS 2及其他環保法規

為了使業界內更多工程師得到有關環境可持續發展的最新製造技術和環境管理知識，我們選了六個工作坊內的一些講議，編制了這本講議匯集。

目錄

目錄

工作坊 1

「綠色材料」工作坊

可降解塑膠複合材料
由美國塑膠工程師學會(香港分會)會長羅世平先生主講

可完全生物降解PHA的簡介與應用
由意可曼生物科技有限公司譚觀嶽先生主講

生物降解材料的種類及共混應用
由意可曼生物科技有限公司譚觀嶽先生主講

生物降解高分子材料
由香港城市大學物理與材料科學系李國耀教授主講

生物降解塑膠
由毅興環保塑膠有限公司項目主管陸萍小姐主講

可降解塑膠複合材料

由美國塑膠工程師學會(香港分會)會長羅世平先生主講

可降解塑膠複合材料

PAM

Plastique Avec Maize Limited
鵬馬環保塑料有限公司

Plastique Avec Maize Limited

PAM

Introduction 公司簡介

Plastique Avec Maize (PAM) Limited registered in 2007, with a head office in Hong Kong, R&D & application development center in Changping, Dongguan,

which provides the effective services to customers near the Pearl River Delta, and mass production facility in Tengzhou, Shandong that has 1700 acre and taps into the biomass residues available in that region.

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About Pamalin™ Resin

- **Pamalin™ is an injection and extrusion moldable eco-composite resin compounded by using proprietary formulations to replace some engineering plastics with comparable performance and cost less to improve bottom line of plastic processors.**
- **Sustainability can be defined as after 'Brundland Commission' of the United Nation on March 20, 1987.**
- **Sustainable development is defined as**

balancing of the fulfillment of human needs with the protection of the 'natural environment" so that these needs can be met not only in the present but in the indefinite future.

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Sustainable Resins

- **Pamalin™ is generated by**

1. **using renewable materials converted from plants such as corn, bamboo etc.**
2. **into engineering composite, and**
3. **Proprietary additives**

which results in consuming fewer fossil fuels compared to petrochemical plastics.

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Sustainable Resins

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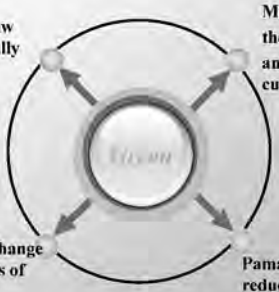
Why Pamalin is Green?

Every up-stream raw materials are carefully screened



Minimal impact on the environment and hazard free to customers

Prevent the climate change by reducing emissions of greenhouse gases.

Pamalin™ can help to reduce Carbon Footprint.

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Carbon footprint counting

1 MT bio-mass
- Burning them produces ⟶ 1.47t CO_2
- Using them as fillers produces⟶2.25t Pamalin resin

1MT Pamalin™ resin uses 400kg bio-mass reduces⟶0.58t CO_2 emissions

1MT CO_2 transaction price is ⟶ 7-15$

Therefore, by producing 1 MT of Pamalin™ resin will SAVE 4.06---8.7$

(The prices of carbon allowances and credits are normally heavily influenced by energy markets, particularly the relative prices of gas and coal and price of electricity.)

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• Pamalin™ Categories

The General Purpose (GP Grade):

Compounding biomass with commodity PP specifically for material handing and packaging applications. They are designed for injection molding household related products.

Special Grades

Including flame retardant grade, electrically conductive grade and anti-bacterial children toy grade to meet electric, toy and furniture industrial specific requirements.

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• Why choose Pamalin™

Green& Enviromentally friendly.

Low Melt Temperature hence less energy input.

Fibre provided better thermal conduction, hence reduce molding cycle time.

High Heat Distortion Temperature.

High Flexural Strength contributed by high content of fibre.

Less expensive

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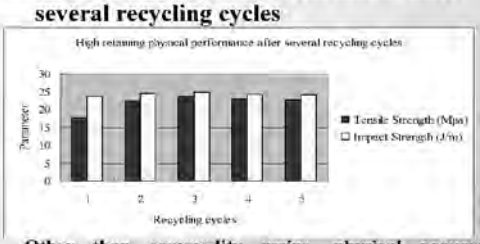
High retaining physical performance after several recycling cycles



Other than commodity resins, physical properties of Pamalin™ resin will be increased slightly during the first recycling processing. With continuing recycling, the decaying of tensile property of Pamalin™ resin is almost negligible, as the charts shown below. The main reason is that the interfacial bonding between the polymer binder and the cellulose fibers improves after each molding (mixing).

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Properties	Test Method	Unit	Eco-resin	PP Homopolymer
Mechanical :				
Flexural Modulus	ASTM D 638	Mpa	1000-4000	380
Tensile Strength.	ASTM D638	Mpa	18.5-34	22.6
Elongation @br	ASTM D638	%	4-10	120
Impact Strength.	ASTM D4812	J/M	18-35	80
Physical :				
MFI	ASTM D1238	g/10min	4-6	8
Density	ASTM D792	g/c.c.	1.03-1.05	0.90
Hardness		R Scale	120	82
Shrinkage	ASTM D955	mm/mm	0.011- 0.015	0.015-0.02
Heat distortion Temp	ASTM D648	° C	105-120	90-98
Processing Conditions :				
Melt Temp		° C	175-195	190-200
Mold Temp.		° C	60-70	10-80
Moisture Adsorption		%	0.5	n/a
Drying Conditions		C/h	Needed	n/a

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Properties	Test Method	Unit	Eco-resin	ABS 757
Mechanical :				
Flexural Modulus	ASTM D 638	Mpa	1000-4000	2480
Tensile Strength	ASTM D638	Mpa	18.5-34	46.9
Elongation @br	ASTM D638	%	4-10	20
Impact Strength.	ASTM D4812	J/M	18-35	20
Physical :				
MFI	ASTM D1238	g/10min	4-6	4
Density	ASTM D792	g/c.c.	1.03-1.1	1.04
Hardness		R Scale	120	116
Shrinkage	ASTM D955	mm/mm	0.011- 0.015	0.008
Heat distortion Temp	ASTM D648	° C	105-108	78-82
Processing Conditions :				
Melt Temp		° C	175-195	190-210
Mold Temp.		C	60-70	10-80
Moisture Adsorption		%	0.5	yes
Drying Conditions		C/h	Needed	Needed

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可降解塑膠複合材料

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- i-Phone Case “INCASE” Obtained Canadian Green Label

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- Pallet for resin loading 3MT injection

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Applications

•Electrical/ Electronic related product-I

Name : Switch / Receptacle plate

Product characteristics: U/L VO,VI and VII available with various bright colors，It also contains good mechanical properties.

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•Electrical/ Electronic related product-II

Name: speaker Box

Product characteristics: Pamalin resin embraces high modulus, Acoustic effect similar to hard wood, it is injection moldable that allows design flexibility.

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•Household related product-I

Name : Flower Pot

Product characteristics: This economic household grade of Pamalin composite has very high flexural modulus due to its high fibre content. It also contains good mechanical properties when approved to sun light &rugged weather.

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•Household related product-II

Name : Multifunctional pail

Product characteristics: Load pail with 3kg objects, drop at 3 different angles for 3 times each .No significant change cosmetically, distortion. Pamalin TMcomposite embraces high impact strength to replace ABS & PP copolymer resin

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•Household related product-III

Name : coat hanger

Product characteristics: This grade of Pamalin composite has very high modulus of elasticity. It also contains good mechanical properties when approved to sun light &rugged weather.

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•Household related product-IIII

- Name: Picture Frame
- Product Characteristics:

Environmentally-Friendly; Elegant

Feels like Wood; Looks like Wood; and smells like Wood.....

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• Industrial product-I

• Construction Lamp used in Hongkong

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•Industrial product-II

Name: Seat Back / Handle

Product characteristics: Special formulated Pamalin TMcomposite can resist U/V light & weathering chemicals. it also has exceptional physical & mechanical resistance while performed other engineering resin.

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•Industrial product-II

Name : Bobbin

Product characteristics: Toughness and rigid to prevent from drop and bulge under wiring tension. It also contains good mechanical properties.

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• Toys

Name: McDonald Toys

Product characteristics: Compliance with the EN71 & RoHS. This grade of Pamalin TMComposite is tough, not easily chip out to create sharp point, and has high modulus, it also can be easily decorated with both solvent and water based paints.

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- **Specilities-I**

- **Name : Sport/carnal foamed shoe sole**

Product characteristics: Absorb moisture / odor and retains high hysteresis; therefore alleviate foot stresses.

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- **Certificates-I**

ITEMS	TESTS	STANDARD
1	Hong Kong Green Label	GL-002-005
2	REACH	RSTS-EE-SVHC-002
3	RoHS	IEC62321/2nd CDV
4	EN71	EN71 part 3:1994+A1: 2000/AC:2002 ICP-OES
5	6 Phthalates Test	EN14372 : 2004 · GC-MS
6	Packaging Requirement Test	GB9693-1988
7	Agricultural chemical Test	GB/T 5009.184-2003/SN/T 1902-2007 NY/T 761-2008/SN/T 1973-2007
8	Fluorescent Substance Test	GB 3561-89
9	Halogen Free	IEC62321 · 1.0 : 2008

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- **Certificates-II**

ITEMS	TESTS	STANDARD
10	Anti-fungal Assessment of Fungal resistance Test	ASTM G21-96 （2002）
11	Bacteria Activity	GB/T 190305-2003
12	SGS-UL/ Flammability Requirements Ratings	UL941996REV.9:200 6,8 V-0/V-1/V-2
13	Hot wire 650oC Test	GB/T 5169.11-2006
14	Hot wire 850oC Test	IEC 60695-2-10 : 2000
15	ISO Degradability Test	GB/T 19277-2003 IDT ISO 14855:1999
16	UV Test	ASTM G154-2006

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Our Services

PAM can offer complimentary advice on followings to its prospects:

1] If Pamalin TM can be used as alternative

2] Choice of Pamalin TM processing parameters

3] Recommended surface finishing method to meet customer's operational requirements

4] Provide Pamalin TM related technical support training

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Contact Us

- ***Head Office***: **Unit 6&7,BLK A,3/F, Wing Cheung Industrial Bldg, 58-70 Kwai Cheong Road, Kwai Chung,N.T. Hong Kong**

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  ***Tel*: +86-769-82831908 *Fax:* 86-769-82831917**
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  ***Tel*: +86-632-5990161 *Fax*:86-632-5990161**

  E-mail: sales@pan-plastics.com

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We believe it is important to co-operate with YOU to bring about positive development!

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可完全生物降解PHA的簡介與應用

由意可曼生物科技有限公司譚觀嶽先生主講

可完全生物降解PHA的簡介與應用

可完全生物降解PHA的简介与应用

The Introduction and Application of Fully Biodegradable PHA

谭 观 岳

深圳市意可曼生物科技有限公司

Shenzhen Ecomann Biotechnology CO.,Ltd

Ecomann & PHA
意可曼与PHA

Applications and Technology Developments
应用与技术发展

Prospect
展望

Ecomann Introduction
意可曼介绍

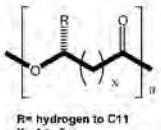
- Fully Biodegradable PHA Manufacture Established 2008
  全降解材料PHA生产山东工厂 建于2008年
- Shenzhen Headquarter: Sales, R&D
  深圳总部：研发与销售团队

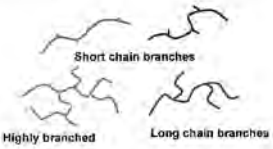
Ecomann Introduction

Plant : Zoucheng city, Shandong Province
生产工厂：山东邹城

annual capacity 5000 MT
目前年产能 5000吨

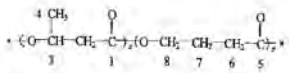
PHA Introduction PHA简介

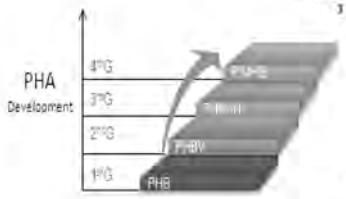




- ✓ A highly versatile polymer family
- ✓ Broad range of structure economically accessible
  --homopolymers, copolymers, terpolymers, blocks
- ✓ Broad range of physical properties

PHA Development

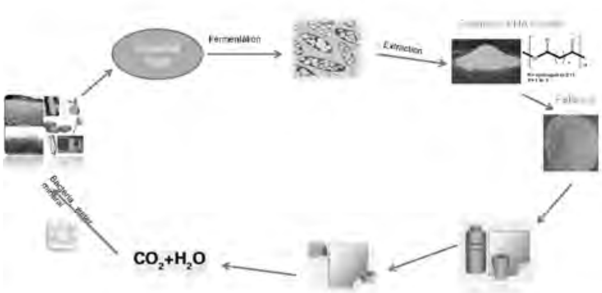




Ecomann produced P34HB
意可曼PHA（P34HB）

可完全生物降解PHA的簡介與應用

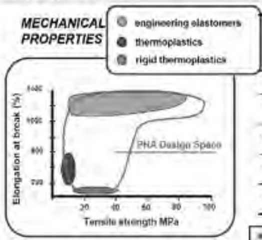
PHA life cycle analysis & production flow



PHA Properties PHA特性

- Molecular weight: 1,000-1,000,000 分子量
- Glass transition temperature: -60 ℃ to +60 ℃ 玻璃化温度
- Melting point: +40 ℃ to +190 ℃ 熔点
- Crystalinity: 10% to 60% 结晶度
- Elongation at break: 5% to 1000% 断裂伸长率
- Barrier property of air and water: similar to PET
  水气阻隔性：类似PET
- Properties of print : similar to PET
  印刷性能：类似PET

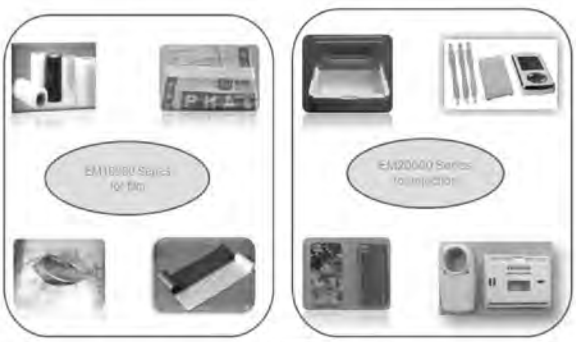
PHA Mechanical Properties
PHA加工性能



PHA 共聚物	熔点/℃	拉伸强度MPa	断裂伸长率%	缺口冲击J/m
PHB	179	40	5	50
P34HB(3%4HB)	166	28	45	80
P34HB(6%4HB)	150	24	242	120
P34HB(9%4HB)	120	18	600	NB
P34HB(12%4HB)	90	23	1000	NB

Qualifications & Certificates
资质和认证

Applications of Ecomann PHA
意可曼PHA应用



Applications of Ecomann PHA
意可曼PHA应用

可完全生物降解PHA的簡介與應用

New Developments
新品研发（热熔胶，生物弹性体，纺丝，发泡）

Hot Melt Adhesive

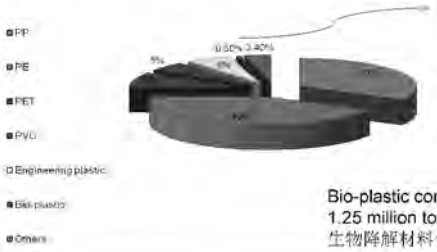
Bio-elastomer

Spinning

Foam

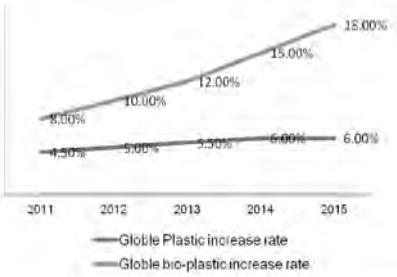
Prospect

2011 Global Plastic Consumption 230million tons
2011年全球塑胶料消耗量2.3亿吨



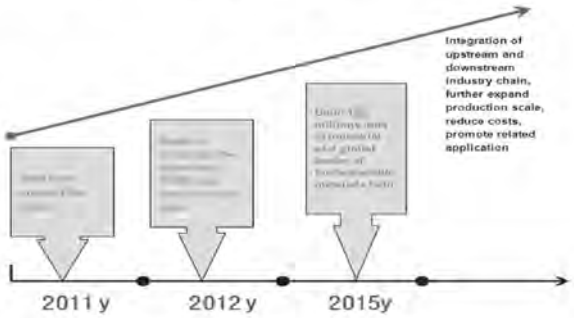
Bio-plastic consumption:
1.25 million tons
生物降解材料使用量：125万吨

Prospect 展望



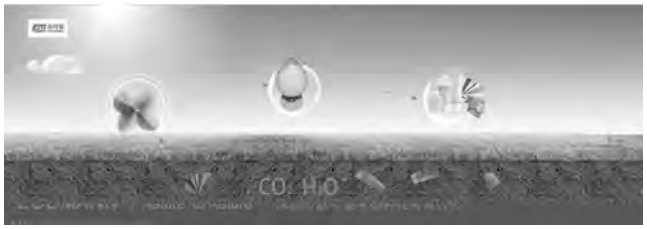
Bio-plastics are increasing sharply

Ecomann Expansion 意可曼发展



We together make the world and our future more sustainable!

Thank you!



生物降解材料的種類及共混應用

由意可曼生物科技有限公司譚觀嶽先生主講

生物降解材料的種類及共混應用

生物降解材料的种类及共混应用

The Classification and Compounding of Biodegradable material

谭 观 岳

深圳市意可曼生物科技有限公司

Shenzhen Ecomann Biotechnology CO.,Ltd

- Conceptions
  降解概念
- Classification of Biodegradable Material
  降解材料分类
- Compounding Application
  共混应用

Conceptions

Item	Oil-Based Material 石油基材料	Bio-Based Material 生物基材料
Durable Material 非降解材料	PVC、PE、PP、PS ect.	Bio-PE、Bio-PA、Bio-TPU ect.
Degradable Material 降解材料	PBS、PBSA、PBAT	Starch、PLA、PHA

Compost 降解

Industrial compost: 工业堆肥降解

Fully compostable in industrial compost plant (60℃, water,bio-organisms)
工业堆肥完全降解（60℃，水份，微生物）

Starch, PLA, PBS,PCL,PBAT,PBSA,PHA
如：淀粉，PLA, PBS,PCL,PBAT,PBSA,PHA

US Compost Certificate: ASTM D6400
美国降解认证：ASTM D6400

EU Compost Certificate: EN 13432
欧洲降解认证：EN13432

Home Compost: 家庭降解（常温降解）

Fully compostable in home temperature condition (water, bio-organisms, minerals)
在常温条件下的完全降解（常温，水，微生物，矿物质）

Starch, PHA
如：淀粉，PHA

EU Home Compost Certificate: OK Compost Home
欧洲家庭降解认证：OK Compost Home

EN 13432 Standard

EN13432降解标准

EN 13432 – Volatile content, Heavy metal content
Heavy metal limits set on country by country basis (PPM)
挥发量，重金属含量
以国家标准限制重金属含量 (PPM)

⇩

ISO 16929 Disintegration of plastic in commercial compost.
商业堆肥中塑料材料的分解度

12 week composting test
12周堆肥测试

- 90% of plastic must be smaller than < 2 mm
  90% 的塑料分解为 < 2 mm的碎片

⇩

ISO 14855 Aerobic Biodegradability and Disintegration in composting conditions
在可控堆肥条件下的需氧生物降解能力和分解度

- 6 months test,
- 90% of the plastic must completely mineralize to CO^2 and water.
  6个月测试，
  90% 的塑料完全分解成 CO^2 和水。

⇩

OECD208A OECD Final Compost Quality Testing using plant seedlings
使用植物种子进行
- Minimum 80% seedling emergence
  最少 80% 的种子发芽。

Commercial Composting tests

商业堆肥测试

1. Plastic specimen for testing were cut from the film
2. The test hole were dug in a fresh Commercial compost heap
3. The bags were filled with a mixture of plastic and immature compost
4. The plastic films were placed inside wiremesh shade cloth bags
5. The test bags were placed in the hole
6. Plastic film samples after 1month of composting
7. Close up of samples after 1month composting show microbial attack & fungal staining
8. Plastic film samples after 2 months composting
9. Plastic film samples after 3 months composting

生物降解材料的種類及共混應用

Classification of Biodegradable Material
全生物降解材料分类

- TPS
- PLA
- PBS
- PHA
- PPC
- PCL.....

TPS (starch) Pros and Cons
淀粉的优点和不足

Pros: 优点
- Fully Biodegradable,
  全生物降解
- Abundance & Renewable & Low cost
  原料来源丰富，可再生，价格低

Cons: 不足点
- Absorb water & Hard to store
  易吸水，存储困难
- Compounding with PE/PP & Partial Compostable
  与PE/PP的共混物料只能部分降解

PLA Pros and Cons
PLA的优点和不足点

Pros：优点	
Good Stiffness 80MPa	硬度良好 80MPa
Transparency 90%	透明度良好 90%
Low Cost & Bio-based	价格相对低，生物质来源
Cons:不足点	
Brittle	偏脆
Vicat soft point 60℃	维卡软化温度 60℃
Sensitivity to Water: 250 PPM Pre-dry	对水气敏感：250PPM 提前干燥

PBS Pros and Cons
PBS的优点和不足

PBS Family: PBS,PBSA,PBAT ect.	PBS家族：PBPBS,PBSA,PBAT等
Pros:	优点：
Easy to Process	容易加工
Higher Vicat Soft Point	维卡软化温度高
Widely Used in Film	广泛应用于膜类产品
Cons:	不足点：
Low MW, easy to hydrolysis	分子量较低，容易水解
Uneasy to Heat Seal	热封性能不佳
Succinic Acid comes from oil	单体来源于石油

PHA Pros PHA 优点

- **Flexibility: Elongation at break　柔韧性：断裂伸长率**
  PHA：20-1000%，PBS：40-450%，PLA：5%；
- **Heat Resistance: Vicat soft point　耐热性：维卡软化温度**
  PHA：80-120 ℃，PBS：100-105 ℃，PLA：60℃；
- **Anti-hydrolysis: 50 ℃, RH:90%;　水气阻隔性：50 ℃, RH:90%;**
  PHA：1000h，PBS：400h，PLA：150h；

PHA Pros PHA优点

- Heat seal property of film:
  膜的热封性能
  PHA >PBS,
- Barrier property of air and water:
  水气阻隔性能：

  PHA is similar to PET>PBS,PLA
  PHA类似PET＞PBS,PLA

生物降解材料的種類及共混應用

PHA Cons PHA不足点

◆ Cost: PHA>PLA 成本：PHA＞PLA
Solutions: Compounding, filling
解决方案：共混，填充

◆ Stiffness: Flexural strength 强度：弯曲强度
PHA:20-50MPa,PBS:37 MPa,PLA:80MPa
Solutions: Compounding, filling
解决方案：共混，填充

◆ Cooling rate: 冷却效率： PHA<PBS<PLA
Solutions: Nucleating, increase heat conductive
解决方法：成核剂，增加热传导性能

Application Comparison 应用对比

Item	Film 膜类	Injection Moulding 注塑类	Sheet/thermoforming 片材吸塑类	Container 容器类	Elastomer 弹性体	Hot Melt Adhesive 热熔胶
PHA	●	●	●	●	●	●
PLA	◎	●	●	◎	○	◎
PBS	●	●	●	●	◎	○
TPS	◎	◎	○	○	○	○

●Suitable,适合 ◎Suitable Through Compounding,共混后适合 ○Not Suitable不适合

PHA Compatible With Other Material 与
与PHA相容的材料

Degradable Material: 降解材料：
PLA, PBS, PBSA, PBAT, TPS ect.

Traditional Material: 传统材料
TPU, PVAc, PVC, POM, PMMA, ABS, NBR ect.

PHA/PLA Compounding
PHA与PLA共混

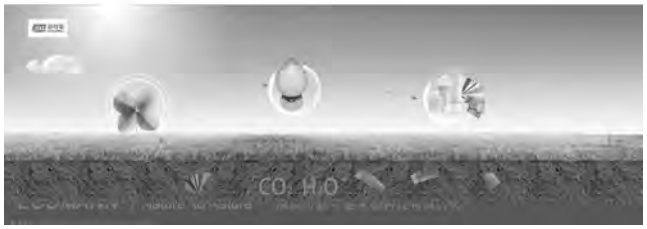
P34HB/PLA	Tensile strength 拉伸强度(MPa)	Elongation at break断裂伸长率(%)	Flexural strength 弯曲强度(MPa)	Notched impact strength 缺口冲击强度(KJ/m2)
0/100	65	5	78	2
30/70	45	25	68	4
50/50	30	68	50	5
60/40	28	120	40	9.8
70/30	25	180	30	12
90/10	23	210	25	NB
100/0	16	850	22	NB

PHA/PBS Compounding
PHA与PBS共混

P34HB/PBS	Tensile strength 拉伸强度(MPa)	Elongation at break断裂伸长率(%)	Notched impact strength缺口冲击强度 (KJ/m2)
0/100	34.3	42	6.3
20/80	25.8	55	7.4
40/60	23.3	62	7.9
60/40	18.9	75	8.7
80/20	16.4	187	12.3
100/0	16.0	850	NB

We together make the world and our future more sustainable!

Thank you!



生物降解高分子材料

由香港城市大學物理與材料科學系李國耀教授主講

生物降解高分子材料

生物降解高分子材料

Prof. Robert K. Y. Li

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目 录

引言

资源与环境是人类可持续发展的重大问题，生物技术将是解决这一问题的关键技术。在造成环境污染的诸多因素中，塑料废弃物造成的的公害很大，按体积计算已居世界首位。我国目前各种塑料制品的年产量正以惊人的速度增加，严重污染着环境和危害着我们的健康。由于其难以降解，废弃塑料所造成的“白色污染”已成为世界性的公害。意大利、德国、美国等国家已率先以法律形式，规定了必须使用可降解塑料产品的范围。开发生物降解高分子材料，寻找新的环境友好高分子材料已是当务之急。

1. 生物可降解高分子概念

依据美国材料和测试协会(ASTM)的定义：生物降解高分子材料是在菌，真菌和藻类等自然界存在的微生物作用下发生化学，生物或物理作用而降解成分解的材料。

真正的生物降解高分子在有水存在的环境下，能被酶或微生物水解降解，从而高分子主链断裂，相对分子量逐渐变小，以致最终成为单体或代谢成CO_2和H_2O。

目前，国内外生物降解高分子材料的研究开发已取得不小的的进展，但在发展中也存在不少问题。生物降解是一个自然分解过程，在自然环境中通过微生物作用、有机物材化为简单的化合物，矿物质，重新参与自然循环。生物降解过程复杂、试验评价困难

2. 生物可降解高分子材料的类型

按来源，生物可降解高分子材料可分为天然高分子型、微生物合成型、化学合成型和掺混型四大类。

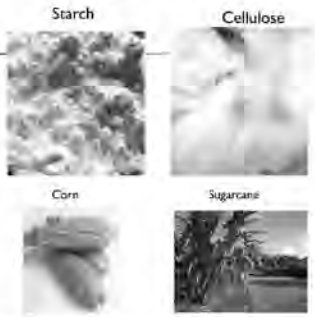
(1) 天然高分子型：利用淀粉、纤维素和木质素等可再生的天然资源制备而成。

(2) 微生物合成型：微生物通过生命活动合成的高分子物质。

(3) 化学合成型：在分子结构中引入酯及结构的脂肪族酯而成。

(4) 掺混型：将两种以上的高分子复合而成，其中至少有一种组分是生物降解的。应用的组分以淀粉居多。

2.1 天然高分子型



2.1 天然高分子型

自然界中存在的纤维素，甲壳素和木质素等均属可降解天然高分子，这些高分子可被微生物完全降解，但因纤维素等存在物理性能上的不足，由其单独制成的薄膜的耐水性、强度均达不到求，因此，它大多与其它高分子，如由甲壳质制得的脱乙酰基多糖等共混制得。

2.1 天然高分子型

表1 主要天然有机高分子[1]

生物降解高分子材料

2.1 天然高分子型

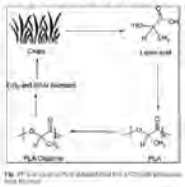
纤维素能采用接枝共聚、物理共混的改性方法，还可以通过缩聚作用接枝。如纤维素与木质素聚氨酯缩聚，制得的棉织物不仅耐压，而且抗伸强度、耐磨性及尺寸稳定性都明显改善。通过溶液共混也能改善纤维素材料的性能和功能。以N, O- 羧甲基壳聚糖为增溶剂制得的纤维素/ 壳聚糖抗菌纤维,力学性能各项指标均达到了国家规定的优等品标准。

甲壳素是一类重要的海洋生物资源，主要来源于虾壳、蟹壳、昆虫壳等，产量仅次于纤维素。美国、日本开发出了一系列壳聚糖可生物降解制品，如絮凝剂、外科缝线、人造皮肤、缓释药膜材料、固定酶载体、分离膜材料等。如N- 乙酰化六壳聚糖和六聚壳聚糖,表现出对恶性肿瘤良好的抑制作用，日本 Kanakumchikurin 医药公司利用壳聚糖较原复合材料制成的人工皮肤对外伤和烧伤的愈合有促进作用。

生物可降解高分子材料[J]，化学与粘合, 2008, 5: 66-69.

2.2.1 聚乳酸（PLA）

聚乳酸合成过程：玉米在加工过程中，通常最先被粉碎成典型的物质，然后对淀粉进行加工，产生粗的葡萄糖，接着进行发酵，将葡萄糖转换为乳酸。乳酸进行浓缩，产生一种可循环的中间体二聚物丙交酯，他可以用于生物聚合物的合成单体。丙交酯通过真空蒸馏进行纯化，然后使用无溶剂熔融处理打开环结构进行定向聚合，从而产生聚乳酸。



2.2 微生物合成型

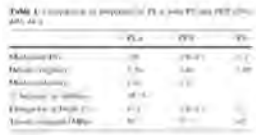
通过微生物合成的高分子物质，这类高分子主要有微生物聚酯和微生物多糖，具有生物可降解性，可用于制造不污染环境的生物可降解塑料。

聚乳酸
（Polylacticacid，PLA）

聚羟基脂肪酸酯
（Polyhydroxyalkanoates，PHA）

2.2.1 聚乳酸（PLA）

聚乳酸性能：



J Polym Environ (2011) 19:637–676

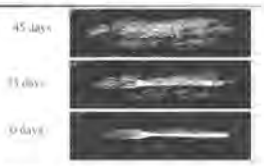
（1）PLA，无毒、无刺激性，可经生物分解为CO_2和H_2O，不造成环境污染。在过去几十年作为替代包装材料获得了极大的关注，甚至于真正的可生物降解材料。

（2）PLA膜具有比低密度聚乙烯（LDPE）更好的紫外光阻隔抗性能，稍微弱于玻璃，聚苯乙烯（PS）和聚对苯二甲酸乙二醇酯（PET）材料；

（3）相比PS和PET，PLA具有较好的力学性能，更低的沸点和玻璃化转变温度。

聚乳酸 (PLA)产品

PLA叉子降解过程



- Biodegradable polymers　　6 months to 2 years
- Conventional plastics (PE & PS)　：500 – 1000 year

Adv. Mater., 1996, 8, 305

2.2.1 聚乳酸（PLA）

聚乳酸降解机理：

PLA降解主要依靠水解，是完全降解。PLA的水解始于水的吸收，小分子的水渗至PLA的表面，扩散进入酯键或聚合基团的周围，在介质中酸、碱的作用下，酯键发生自由水解断裂，导致分子量降低，当分子量降低到一定程度，样品开始溶解，生成可溶的降解产物。有些研究认为降解时不仅发生酯键的自由水解断裂，末端基也起着重要的作用，降解生成的羧基末端基对水解起自催化作用。人们普遍认为PLA在降解的初期阶段，酶解不可能起作用、但是会参与后期降解，尤其是当可溶性副产品降低时。

2.2.1 聚乳酸（PLA）

聚乳酸降解方式：

化学角度主要有三种方式：

（1）主链降解生成低聚体和单体；

（2）侧链水解生成可溶性主链高分子；

（3）交链点裂解生成可溶性线性高分子。

2.2.1 聚乳酸（PLA）

聚乳酸改性：

（1）采用聚己内酯（PCL）和非晶PLA共混，同时利用纳米粘土进行复合，通过微观形态发现PLA和纳米粘土具有很好的相互协同作用。

（2）通过共聚物改性制备PCL-PLA多嵌段共聚物，其机械性能得到了提高，最大拉伸强度32MPa左右，弹性模量低到30 MPa，断裂伸长率高达600%。

（3）淀粉填充等化学和物理改性主要目的是希望提高PLA耐热性，改善耐久性，改善降解性能从而降低生产成本，改善加工性能等。

2.2.2 聚羟基脂肪酸酯（PHA）

✓ PHA结构多元化，通过改变菌种、给料、发酵过程可以很方便地改变PHA的组成，而组成结构多样性带来的性能多样化使其在应用中具有明显的优势。

✓ 与传统化工塑料产品的生产过程相比较，PHA的生产是一种低能耗和低二氧化碳排放的生产，因此从生产过程到产品对于环境保护都是很有利的。

2.2.2 聚羟基脂肪酸酯（PHA）

聚羟基脂肪酸酯（PHA）性能和聚乙烯，聚丙烯或者聚酯（聚对苯二甲酸乙二醇酯）性能接近，但他们和土壤接触具有生物降解性，抗水性，传统工业塑料厂容易加工，其性能可由羟基戊酸（HV）和羟基丁酸酯（HB）之间比例控制，其中：

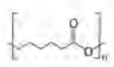
聚3-羟基丁酸酯（PHB）提供硬度材料；
聚羟基戊酸　　（PHV）提供灵活性和韧性。

聚-3-羟基丁酸酯(PHB)：从世界范围看，PHB是公认的最有希望的生物降解塑料之一，也是正在开发的新产品。尤其是技术方的生产工艺简单和设备简易，便于推广并进行大规模生产。

2.3 化学合成高分子型

化学合成并发挥生物降解材料主要有各种脂肪族聚酯，主要品种包括聚己内酯（PCL）、聚丁二酸丁二醇酯（PBS）以及脂肪-芳香族共聚酯（CPEs）。

聚己内酯
Polycaprolactone (PCL)



聚丁二酸丁二醇酯
Poly (butylene succinate) (PBS)

2.3.1 聚己内酯（PCL）

这种塑料具有良好的生物降解性，分解它的微生物广泛地分布在喜气或厌气条件下。作为可生物降解材料可把它与淀粉、纤维素类的材料混合在一起，或与乳酸聚合使用。

PCL的性能：是一种半晶型的热塑性树脂。其力学性能与中密度聚烯烃相似，断裂伸长率和弹性模量介于LDPE和HDPE之间，其柔软程度、拉伸强度与尼龙类似。玻璃化温度为-60 OC，熔点约63 OC，分解温度约250 OC，由于PCL熔点低，限制了其应用范围。PCL分子内酯基的存在，使它具有较好的生物降解性和生理相容性。

2.3.2 聚丁二酸丁二醇酯 (PBS)

PBS塑料属于热塑性全生物降解塑料，是一种新型的塑料，它是用丁二醇和丁二酸合成的聚酯加工而成，其合成原料来源既可以是石油资源，也可以通过生物资源发酵得到，PBS是生物降解塑料材料中的佼佼者，这种塑料做成的袋子埋进土壤后，经过3个月就能够完全生物降解。

PBS特性：

（1）PBS力学性能十分优异，接近聚丙烯（PP）和丙烯腈-苯乙烯-丁二烯共聚物（ABS）塑料；

（2）耐热性能好，热变形温度接近100℃，改性后使用温度接近100℃，克服了其它生物降解塑料耐热温度低的缺点；

（3）加工性能良好，可在现有塑料加工通用设备上进行各类成型加工，是目前降解塑料加工性能最好的；

（4）PBS只有在堆肥、水体等接触特定微生物条件下才发生降解，在正常储存和使用过程中性能非常稳定。

2.3.1 聚己内酯（PCL）

PCL的应用：

1. 医疗材料：

与药物制成药物微球或药物胶囊，可作成恒速释放体系，充分发挥效。另外，PCL片材用做骨折用固定夹板。由于熔点较低，稍加热可软化，方便拆卸。在欧洲，PCL已在临床用作可降解的U型钉。

2. 包装材料：

向PCL中加入滑石粉等无机物进行共混，研制的包装容器、托盘等，改进了刚性和耐冲击性，进一步降低了成本。意大利Novamont公司研发了PCL生物降解塑料（Mater-Bi）一次性餐具。

2.3.2 聚丁二酸丁二醇酯 (PBS)

应用范围：

PBS可以用做垃圾袋、包装袋、化妆品瓶、各种塑料卡片、婴儿尿布、农用材料及药物缓释载体基质等，还有其它涉及到环境保护的各种塑料制品，如土木绿化用网、膜等。

成型加工方法：

PBS属热塑性树脂，加工性能良好，可以在普通加工成型设备上进行成型加工，加工温度范围140-260℃，物料加工前须进行干燥，含水率须在0.02%以下。

PBS是具有良好可生物降解性能的聚合物，与聚乳酸、聚羟基烷酸酯、聚己内酯等可生物降解塑料相比，PBS价格相对较低，力学性能优异，耐热性能好，热变形温度接近100℃，是[illegible]

生物降解高分子材料

2.3.3 脂肪-芳香族共聚聚酯（CPEs）

脂肪族聚酯具有较好的生物可降解性，但其熔点低，强度及耐热性差，无法应用。

芳香族聚酯的熔点较高，强度好，是应用价值很高的工程塑料，但没有生物可降解性。

将脂肪族和芳香族聚酯(或聚酰胺)制成一定结构的共聚物，这种共聚物具有良好的性能，又有一定的生物可降解性。因此，合成脂肪-芳香族共聚聚酯（CPEs），使其完美结合脂肪族聚酯和芳香族聚酯各自的优点。

2.3.3 脂肪-芳香族共聚聚酯（CPEs）

CPEs的性能

(1)CPEs的力学性能和热性能：控制CPEs中脂、芳族比例和平均序列长度，并恰当引入适当含量的第三组分，便能有效控制其力学性能和热性能。

(2)CPEs的生物降解性：CPEs生物降解存在两种机理，即酯键的水解和醚键的氧化降解。影响CPEs生物降解能力的因素有内部因素和外部因素，内部因素包括聚酯的化学结构、结晶度、分子量等;外部因素包括环境温度，酶的种类、pH值等。

(3)CPEs的生物相容性：生物相容性是生物医用材料与人体间相互作用产生的各种复杂的生物、物理、化学反应的性质。目前，CPEs中用做生物医用材料的主要有PEO/PET、PEO/PBT(Polyactive)和PPE(Politerefone)等。但这类材料是否具有长期毒副作用还处于进一步研究之中。

2.3.3 脂肪-芳香族共聚聚酯（CPEs）

合成CPEs常用的方法:

①PET等芳香组分与聚乙二醇（PEG）、聚乙交酯（PGA）、PLA、PCL等聚合物直接在高温、高真空度下进行酯交换反应;

②将二元醇、二元酸等一起投入反应釜中，先在相对较低的温度下进行酯交换反应然后再升高温度，提高真空度，进行熔融缩聚反应;

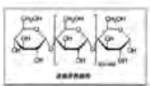
③将对苯二甲酸乙(丁)二醇酯或其衍生物与二羧酸酰氯等溶解在有机溶剂中，在适宜的温度下进行溶液缩聚。

2.4 掺合型

在没有生物可降解的高分子材料中，掺混一定量的生物可降解的高分子化合物，使所得产品具有相当程度的生物可降解性，这就制成了掺合型生物可降解高分子材料，但这种材料不能完全生物可降解。

淀粉基体降解型通用高分子材料

采与淀粉共混的合成树脂有：高密度聚乙烯(HDPE)、低密度聚乙烯(LDPE)、线性低密度聚乙烯(LLDPE)、聚丙烯(PP)、聚乙烯醇(PVA)、聚氯乙烯(PVC)、聚苯乙烯(PS)、聚酯(Polyester)等，其中低密度聚乙烯、线性低密度聚乙烯、聚乙烯醇和淀粉的降解塑料为主要的研究对象，常用的食品包装材料有聚乙烯和聚丙烯。



2.4.1 淀粉改性聚乙烯（PE）

近来十几年寻找合适的增容技术提高聚乙烯和淀粉的相容性：

（1）一般采用接枝共聚物的添加增加相容性：

聚乙烯接枝马来酸酐增容淀粉/聚乙烯的热塑性增强纤维复合材料，结果表明提高了共混物的相容性，拉伸强度和断裂伸长率得到了提高，水分吸收表明聚乙烯接枝马来酸酐的添加降低了体系的吸水性。

（2）也有对淀粉进行处理增加增容性，玉米淀粉采用环氧氯乙烷和增塑剂甘油作为交联剂改性，淀粉的酯化和醚化、偶联剂处理淀粉都能很好的解决相容性的问题。

3. 生物可降解高分子材料降解机理

高分子材料的生物降解可分为完全生物降解和光-生物降解机理。完全生物降解高分子材料降解机理有三种方式：

（1）生物的物理作用，由生物细胞的生长而致使物质发生机械性毁灭；

（2）生物的化学作用，微生物对聚合物的作用而产生新的物质；

（3）酶的直接作用，微生物侵蚀高聚物从而导致裂解。

生物可降解并非单一机理，而是一个复杂的生物物理、生物化学协同作用、相互促进的物理化学过程。

2.4.2 淀粉改性聚丙烯（PP）

在引发剂过氧化二异丙苯(DCP)作用下，以甲基丙烯酸缩水甘油酯(GMA)为相容剂，通过双螺杆挤出"一步法"实现了淀粉(ST)的增塑化及其与聚丙烯(PP)共混增容，制备了PP/ST共混材料。

利用土壤包埋测试聚丙烯和淀粉生物降解材料的降解性，利用热重分析包埋前后PP基材和其混和物的热稳定性，这些分析得出了相关的降解速度理论公式，为实际生产可控生物降解包装材料提供依据。

高分子结构与降解性的关系

易降解高分子结构	难降解高分子结构
直链	侧链、支链、交联
柔软	晶态
脂肪族	芳香族
低相对分子量	高相对分子量
亲水性	疏水性
表面粗糙	表面光滑

生物降解高分子材料

4. 生物降解过程三个阶段

（1）高分子材料的表面被微生物黏附，微生物黏附表面的方式受高分子表面张力、表面结构、多孔性、温度和湿度等环境的影响。

（2）微生物向体外分泌水解酶和材料表面结合，通过水解切断高分子链，生成分子量小于500 的小分子量的化合物；

（3）降解的生成物被微生物摄入人体内，经过种种的代谢路线，合成为微生物体物或转化为微生物活动的能量，最终都转化为水和二氧化碳。

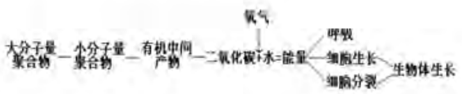
5. 生物可降解高分子材料的应用

（1）利用其生物可降解性，解决环境污染问题，以保证人类生存环境的可持续发展。

（2）利用其可降解性，用作生物医用材料。

4. 生物降解过程三个阶段

高分子材料的降解流程图：



5.1 农用及工业用生物降解高分子材料

这类生物降解高分子材料被称为环境友好高分子材料，通常利用土壤掩埋法使其降解，被广泛应用于农用薄膜、包装材料、工业用易磨损材料等。

（1）农用薄膜：采用生物降解材料制成的塑料薄膜不仅可以保持水分，提高土温，而且使用后能在一定时间内自动降解。完全生物降解高分子左旋聚乳酸（PLLA）农用薄膜已被使用，在土壤掩埋条件下易被微生物降解。

（2）包装材料：将本身可降解高分子加入医药中或直接与原生材料共混而成。其有良好生物相容性和能被体内完全吸收的羟基丁酸-羟基戊酸共聚物（PHBV，商品名Biopol）是很好的包装材料。

（3）易磨损材料：合成脂肪族芳香族共聚酯，聚丁二酸丁二醇-对苯二甲酸乙二醇酯共聚物（PBS-PET）的力学性能与PBS相比得到明显改善。

5.2 医用生物降解高分子材料

对医用材料而言，不仅要求有医疗功能，还要求其无毒，对人体安全，具有优良的生物相容性，即良好的血液相容性和组织相容性。近年来发展的生物降解可吸收高分子材料是指材料完成医疗功能后，在一定时间内能被水解或酶解成小分子，参与正常的代谢循环。

（1）外科手术缝合线：目前被采用的生物吸收缝合线是聚乙交酯（PGA），左旋聚乳酸（PLLA）。另外，研究发现用甲壳素制成的手术缝合线不但力学性能良好，打结不易打滑，而且无毒性。

（2）药物控制系统：降解高分子聚乳酸（PLA）和聚磷酸酯可用于药物控制。

（3）骨折固定材料：PGA和PLLA可用于骨折固定材料。

（4）组织工程支架材料：作为支架材料的聚合物应当是无毒的、具有合适的生物降解性和良好的生物相容性。

6.2 生物可降解高分子材料开发的新方法

6.2.1 生物可降解高分子材料开发的新方法——酶促合成

用酶促法合成生物可降解高分子材料，得益于非水酶学的发展，酶在有机介质中表现出了与其在水溶液中不同的性质，并拥有了催化一些特殊反应的能力，从而显示出了许多水相中所没有的特点。

6.2.2 酶促合成法与化学合成法结合使用

酶促合成法具有高的位置及立体选择性，而化学聚合则能有效的提高聚合物的分子量，因此，为了提高聚合效率，许多研究者已开始用酶促法与化学法联合使用来合成生物可降解高分子材料。

6. 生物可降解高分子材料的开发

6.1 生物可降解高分子材料开发的传统方法

天然高分子的改造法：通过化学修饰和共混等方法，对自然界中存在大量的多糖类高分子，如淀粉、纤维素、甲壳素等能被生物可降解的天然高分子进行改性，可以合成生物可降解高分子材料。此法虽然原料充足，但一般不易成型加工，而且产量小，限制了它们的应用。

微生物发酵法：许多生物能以某些有机物为碳源，通过代谢分泌出聚酯或聚糖类高分子。但利用微生物发酵法合成产物的分离有一定困难，且仍有一些副产品。

化学合成法：模拟天然高分子的化学结构，从简单的小分子出发制备分子链上含有酯基、酰胺基、肽基的聚合物，这些高分子化合物结构单元中含有易被生物可降解的化学结构或是在高分子链中嵌入易生物可降解的链段。

6.3 生物可降解高分子材料当前使用状况

- 传统的食品包装材料存在回收困难和白色污染等问题，淀粉来源丰富可降解，常常应用于填充改性PE、PP等传统包装用高分子材料，存在一定的效果，但会导致PE、PP等材料透明度、结晶度、力学性能、耐热性能的变化，同时也不能完全降解，同时成品使用在食品包装材料中存在一定局限性。

- 天然来源可完全降解聚乳酸（Polylacticacid，PLA）和聚羟基脂肪酸酯（Polyhydroxyalkanoates，PHA）可以通过改变聚合方式等物理和化学改性达到食品包装用材料的要求，不断研究透彻了解其性能、合成方法、改性手段降低其成本，从而完全替代目前不降解包装材料，减少环境污染。

生物降解高分子材料

6.3 生物可降解高分子材料当前使用状况

存在的问题：

（1）性能有不足：很多生物塑料高温性能不佳，在50~55 ℃就会变形，其应用领域和适用范围受到限制。而且，生物塑料的抗冲击性不好，难以在汽车零部件等对抗性要求较高的领域使用。改善生物降解塑料产品性能，才能大规模推广到电子产品，甚至是汽车材料领域。

（2）制造成本高：目前的降解塑料，不管是玉米塑料、淀粉塑料或其他性质的生物降解塑料，都存在这个问题。价格高是生物塑料市场接受度低的主要原因。

7.1 生物降解复合聚合材料发展现状简介

近年来"绿色聚合物材料"的研究已越来越受重视，如可生物降解性脂肪族聚酯(BAP)，聚乳酸(PLA)，聚β2羟基丁酸酯(PHB)，聚己内酯(PCL)，聚乙交酯(PGA)，主链淀粉醚，甲壳素衍生物等，这些聚合物已被用来合成各种各样的材料。但在实际应用中，这类材料还有一些缺陷，如生产费用较高，较难制备以及冲击强度较低等。

（a）与淀粉、纤维素等可再生植物填料复合，在不降低生物降解性的情况下，可降低材料的成本；

（b）与羟基磷灰石复合可制备骨折固定材料；

（c）与蒙脱土、碳纳米管、SiO2纳米颗粒等纳米填料复合可提高其力学性能；

（d）与玻璃纤维、碳纤维等强填料复合可改善力学性能和热性能。

7. 生物降解复合聚合材料

复合聚合材料是指将具有一定特殊形貌（如纤维、片状、微球或颗粒）的无机或者有机添加物加入到聚合物中。纳米复合材料在结构稳定性、气体阻隔性等方面要优于传统材料。

以生物降解聚合物为模板合成的纳米复合材料，不仅能够提高材料的各项性能指标，而且能够提高性价比。将纳米粒子分散在生物降解聚合物中是解决目前生物降解高分子材料研发中所遇到困难的有效手段，包括提高机械性能、耐热性及各项物化性质。

7.2 常用的无机纳米填料

层状硅酸盐，层状钛酸盐，碳纳米管，金属纳米粒子，磁赤铁矿，磁铁矿纳米粒子和氟云母。

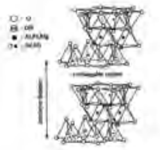


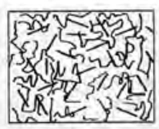
图 1 蒙脱土结构示意图

图 2 碳纳米管示意图

(a) PLA复合材料

蒙脱土复合材料中的两种常见结构：

(a) 插层型结构



(b) 剥离型结构

7.3 生物降解复合聚合材料类型

- 可生物降解的脂肪族聚酯纳米复合材料；
  - (a) PLA复合材料；(b) PCL复合材料；
  - (c) PBS复合材料；(d) PHA复合材料。
- 天然可再生资源型纳米复合材料。
  - (e) 淀粉复合材料；(f) 纤维素复合材料；
  - (g)壳聚糖复合材料；(h) 植物油复合材料。

(a) PLA复合材料

蒙脱土(MMT)是最常见的粘土，在PLA中使用力学性能的改善明显，通常使用有机修饰的MMT(OMMT)来做复合填料。OMMT的含量对材料的性能有很大的影响。

OMMT 和 PLA 复合材料，缩写为**PLACNs**
不同"s"值代表插入层的不同。

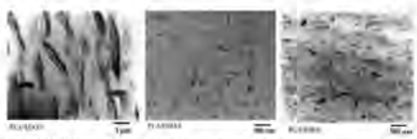
Table 1. Materials Properties of Neat PLA and Various PLACNs

Materials properties	PLA	PLACN4	PLACN7	PLACN7
Modulus (GPa)	4.8	5.5	5.6	5.8
Strength (MPa)	86	134	122	105
Distortion at break (%)	3.9	3.1	2.6	2
P_{PLACN}/P_{PLA}	1	0.88	0.85	0.81

Polymer 44 (2003) 857–866

(a) PLA复合材料

层状硅酸盐的类型是另一个关键的影响材料的性能。不同的硅酸盐分散程度不同，从而影响了材料的性能，和生物降解性和结晶行为。

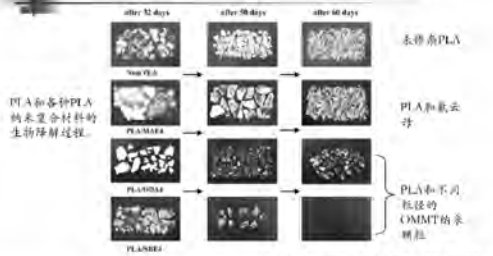


Macromol. Mater. Eng., 288, 203 (2003).

生物降解高分子材料

(a) PLA复合材料

通过选择恰当的层状硅酸盐，我们能得到降解速度可控的PLA。



Macromol. Mater. Eng., 288, 203 (2003).

(a) PCL复合材料

大多数的PCL纳米改性的研究集中在层状硅酸盐

PCL/氨基盐处理的MMT复合材料比PCL/MMT复合材料具有更好的力学强度和模量。

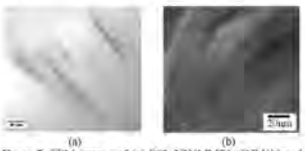


Figure 7. TEM images of (a) PCL-NH4MMT1 (1NM1b) and (b) PCL-NH4MMT2 (2NM3) composites.

Macromolecules 2006, 39, 747-754

(a) PLA复合材料

PLLA接枝到多壁碳纳米管得到PLLA-g-MWCNTs，再与PLLA共混制得PLLA/PLLA-g-MWCNTs复合材料，碳纳米管在PLLA中分散良好，比PLLA/MWCNTs具有更好的力学性能和热稳定性。

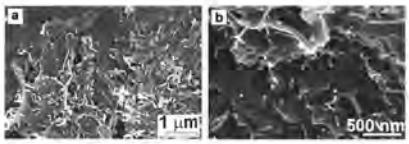


Fig. 2. SEM images of (a) PLLA/MWCNT and (b) PLLA/PLLA-g-MWCNT composites at an MWCNT content of 2 wt%.

European Polymer Journal 43 (2007) 1729–1735

(c) 淀粉复合材料

TPS(热塑淀粉) /Cellulose(纤维素) 复合材料：

均匀分散在TPS中的纤维素改变了支链淀粉的结晶能力，从而优化了复合材料的力学性能。

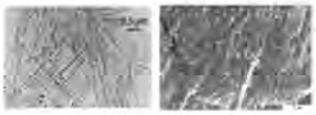


Figure 12. (a) Transmission electron micrograph from a dilute suspension of tunicin whiskers. (b) Scanning electron micrograph from the fractured surface of a composite filled with 6.2 wt% tunicin whiskers.

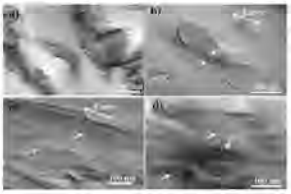
Macromolecules 2000, 33, 8344-8353

(f) 纤维素复合材料

CA(醋酸纤维素)/TEC(塑化剂)/OMMT复合材料：

研究表明具有5 wt%纳米粘土的复合材料具有更好的剥离结构。

由于OMMT更好的剥离和分散在CA中使得复合材料的力学性能改善。



(a) 和(b) 未添加增溶剂

(c) 和(d) 添加增溶剂：

和丁烯二酸酐接枝乙酸丁酸纤维素 (CAB-g-MA)

Figure 6. TEM of the plasticized CA/compatibilizer/organoclay hybrids with or without compatibilizer: (a) without compatibilizer; cross section, 100 kV; (b) intercalated part of without compatibilizer; cross section, 200 kV; (c) exfoliated part of with compatibilizer; cross section, 200 kV; (d) exfoliated part of with compatibilizer; plane section, 100 kV.

Macromolecules 2004, 37, 9076-9082

谢谢！

7. 小结：生物降解复合聚合材料

- 为了增强生物降解高分子的性质，引入纳米粒子到生物降解高分子中是非常有效的办法。
- 不同的纳米粒子可以实现各种不同高分子改性需求。
- 一般来说，生物降解纳米复合材料可实现在机械性能，阻隔性能，热稳定，结晶速率和降解率显等方面的改性。

生物降解塑膠

由毅興環保塑膠有限公司項目主管陸萍小姐主講

生物降解塑膠

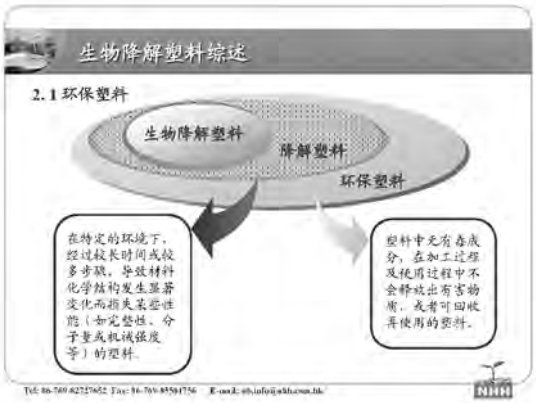

NHH
生 物 降 解 塑 料
NHH Biodegradable Plastics
毅兴环保塑料
www.nhh.com.hk
WELCOME


目 录
1 毅兴环保塑料有限公司
2 生物降解塑料綜述
3 生物降解塑料的改性研究
NHH


毅兴环保塑料有限公司
1.1 毅兴行集团
成立于1970年，总公司位于香港火炭
1994年4月 成为首间在香港上市同类型公司
四大业务：降解塑料，工程塑料，塑料着色，塑料贸易
在全国设有16家公司，并与全球顶色专家联盟
www.nhh.com.hk
ExxonMobil Chemical
DUPONT
TORAY
Polyplastics
Chevron Phillips
NHH


毅兴环保塑料有限公司
1.2 毅兴环保塑料有限公司
成立于2007年
主营：生物降解改性塑料
生物降解塑料：PLA, PBS, PBAT, PPC, PHBV, etc.
降解标准：EN 13432, ASTM D 6400
Modified PLA
conforms to
DIN EN 13432:2000-12
ASTM D 6400:2004
NOTIFICATION OF REGISTRATION
NHH


毅兴环保塑料有限公司
1.3 技术支持
中山大学能源与环境材料研究所
技术总监：孟跃中教授
在国外高水平的英文期刊上发表研究论文200余篇，申请专利30多项
国家重点基金项目：二氧化碳-环氧丙烷共聚物（PPC）合成及应用
www.mengyz.org
NHH


生物降解塑料綜述
2.1 环保塑料
生物降解塑料
降解塑料
环保塑料
在特定的环境下，经过较长时间或较多步骤，导致材料化学结构发生显著变化而损失某些性能（如完整性、分子量或机械强度等）的塑料。
塑料中无有毒成分，在加工过程及使用过程中不会释放出有害物质，或者可回收再使用的塑料。
NHH

生物降解塑膠

生物降解塑料综述

2.2 生物降解塑料

在自然环境（如土壤，城市垃圾堆等)或者特定条件（如生物堆肥等）下，于较短的时间内，有机组分被微生物所分解或代谢，生成二氧化碳和水，及新生物质的塑料。

堆肥

酶解

3-12个月

水+二氧化碳+新生物质

Tel: 86-769-82727652 Fax: 86-769-85581750 E-mail: nh_info@nhhby.com.hk

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生物降解塑料综述

2.3 其它降解塑料

2.3.1 淀粉塑料—PSM类,多用于吹膜，吸塑等产品

利弊：降低成本、减少通用塑料的使用量与我国塑料无法回收再利用，造成大量白色污染。

2.3.2 氧化生物降解塑料—降解添加剂类，适用于PE, PP, PET, PS等

此类塑料保留了原塑料的机械性能，但无法直接堆肥降解，需要先热氧化裂解后，再进行生物堆肥，才能达到彻底降解的效果，此类塑料多用于农膜类产品。

2.3.3 PLA合金塑料

PLA/PC为代表，多用于注塑类产品，如小家电外壳等，其意义与淀粉塑料相仿。

2.3.4 光降解塑料

通过添加光敏剂，加速通用塑料老化裂解，但无法进行生物堆肥。

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生物降解塑料综述

2.4 PLA 聚乳酸循环示图

Tel: 86-769-82727652 Fax: 86-769-85581750 E-mail: nh_info@nhhby.com.hk

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生物降解塑料综述

2.5 生物基塑料（bio-base）和生物降解塑料（biodegradable）

- 生物基塑料是指其原材料是来源于自然界中生物的塑料。
- 生物基不等于生物降解，如经过交联的天然橡胶。
- 生物降解不一定是生物基，例如聚丁二酸丁二醇酯PBS等
- 既是生物降解也属于生物基塑料，例如聚乳酸PLA等。

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生物降解塑料综述

2.6 相关生物降解标准及标记

- **EN 13432** 利用堆肥和生物分解类时设的包装物试验和最终评价的要求，红外分析、重金属含量测试，崩解，堆肥环境下生物降解率测试；要求180天内90%有机组分降解为H_2O和CO_2。种植测试（在堆肥降解后的土壤上行植蔬菜，再检测蔬菜是否对人畜无害）
- **ASTM D 6400** 可堆肥塑料的标准规范。红外分析、重金属含量测试，崩解，堆肥环境下生物降解率测试；单个聚合物的要求是180天内60%降解为H_2O和CO_2。混合物的要求是180天内90%有机物降解为H_2O和CO_2，对水生物及土壤的毒性测试

Tel: 86-769-82727652 Fax: 86-769-85581750 E-mail: nh_info@nhhby.com.hk

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生物降解塑料综述

- **ISO 14855** 可控堆肥条件下塑料最终需氧生物分解能力和崩裂的测定—通过分析释放的二氧化碳的方法
- **ISO 14851、14852，JIS K 6953（日本），GB/T 19277（中国），DIN V54900（德国）**

Tel: 86-769-82727652 Fax: 86-769-85581750 E-mail: nh_info@nhhby.com.hk

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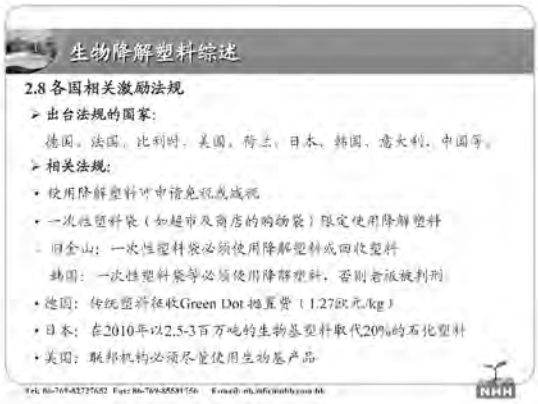
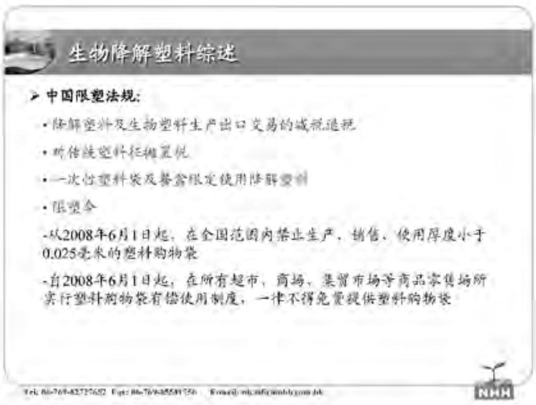
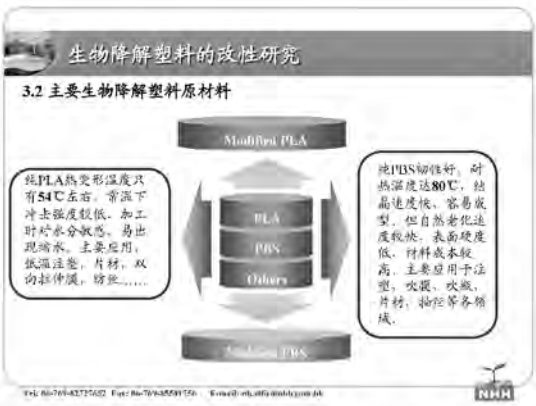
生物降解塑膠


生物降解塑料综述
2.7 氧化生物降解标准 (oxo-biodegradation)
• ASTM D6954 - 04
Standard Guide for Exposing and Testing Plastics that Degrade in the Environment by a Combination of Oxidation and Biodegradation.
• BS 8472 - 2011
Methods for the assessment of the oxo-biodegradation of plastics and of the phyto-toxicity of the residues in controlled laboratory conditions.


生物降解塑料综述
2.8 各国相关激励法规
➢ 出台法规的国家:
德国、法国、比利时、美国、荷兰、日本、韩国、意大利、中国等。
➢ 相关法规:
• 使用降解塑料可申请免税或减税
• 一次性塑料袋（如超市及商店的购物袋）限定使用降解塑料
- 旧金山：一次性塑料袋必须使用降解塑料或回收塑料
韩国：一次性塑料袋等必须使用降解塑料，否则者被判刑
• 德国：传统塑料征收Green Dot 抛置费（1.27欧元/kg）
• 日本：在2010年以2.5-3百万吨的生物基塑料取代20%的石化塑料
• 美国：联邦机构必须尽量使用生物基产品


生物降解塑料综述
➢ 中国限塑法规:
• 降解塑料及生物塑料生产出口交易的减税退税
• 对传统塑料征抛置税
• 一次性塑料袋及餐盒限定使用降解塑料
• 限塑令
-从2008年6月1日起，在全国范围内禁止生产、销售、使用厚度小于0.025毫米的塑料购物袋
-自2008年6月1日起，在所有超市、商场、集贸市场等商品零售场所实行塑料购物袋有偿使用制度，一律不得免费提供塑料购物袋


生物降解塑料的改性研究
3.1 合成生物降解塑料分类
PBAT
PBS
PPC
合成生物降解塑料分类
PLA
PHBV
PHA
石油基
生物基
PBAT - 聚对苯二甲酸己二酸丁二醇酯
PBS - 聚丁二酸丁二醇酯
PPC - 聚甲基乙撑碳酸酯
PLA - 聚乳酸
PHBV - 聚羟基丁酸-戊酸酯
PHA - 聚羟基脂肪酸酯


生物降解塑料的改性研究
3.2 主要生物降解塑料原材料
Modified PLA
纯PLA热变形温度只有54℃左右，常温下冲击强度较低，加工时对水分敏感，易出现缩水。主要应用：低温注塑，片材，双向拉伸膜，纺丝……
PLA
PBS
Others
纯PBS韧性好，耐热温度达80℃，结晶速度快，容易成型，但自热老化速度较快，表面硬度低，材料成本较高，主要应用于注塑，吹膜，吹瓶，片材，抽丝等各领域。


生物降解塑料的改性研究
3.3 NHH BIO 改性材料
● 目的：为改善原材料的某些物理化学性能或加工性能，以全生物降解为基本原则，进行针对性的改性，以满足不同客户要求。

生物降解塑膠

生物降解塑料的改性研究
3.4 NHH BIO 改性应用
耐热
注塑料
挤出
片材料
NHH

生物降解塑料的改性研究
3.5 我们的实验室
DSC / TGA
示扫描量热仪 / 热重分析仪
Heat-Deflection-Temperature
耐热测试仪（HDT）
Universal Testing Machine
拉伸测试仪
Impact Tester
冲击强度测试仪
NHH

生物降解塑料的改性研究
3.6 相关链接
•NHH Biodegradable Plastics Company Limited
•DIN Certco
•Japan Biodegradable Plastics Society (BPS)
•European Union Biodegradable Plastics Association
•US Biodegradable Products Institute
•China Biodegradable Material Group
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Thank You !
www.nhh.com.hk

工作坊 2

「先進電腦輔助工程(CAE)技術 - 產品結構及模流分析」工作坊

Moldex3D 模流分析技術

由科盛科技股份有限公司(台北辦公室)區域經理吳逸群博士主講

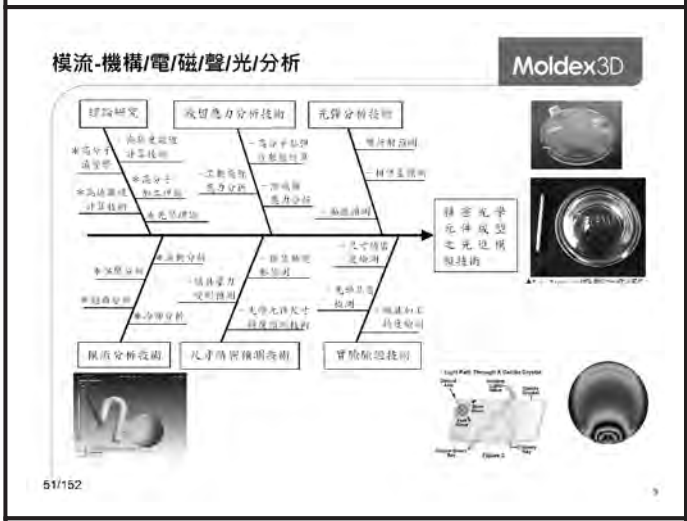
ANSYS 在塑膠產品設計中的應用

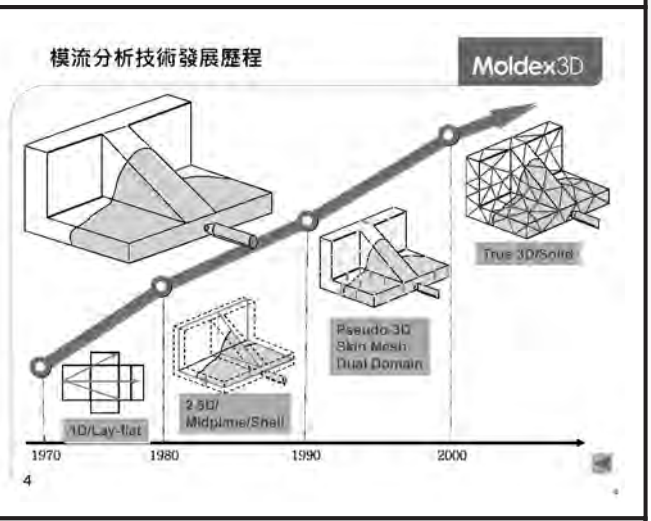
由安世亞太科技股份有限公司結構應用工程師李保木先生主講

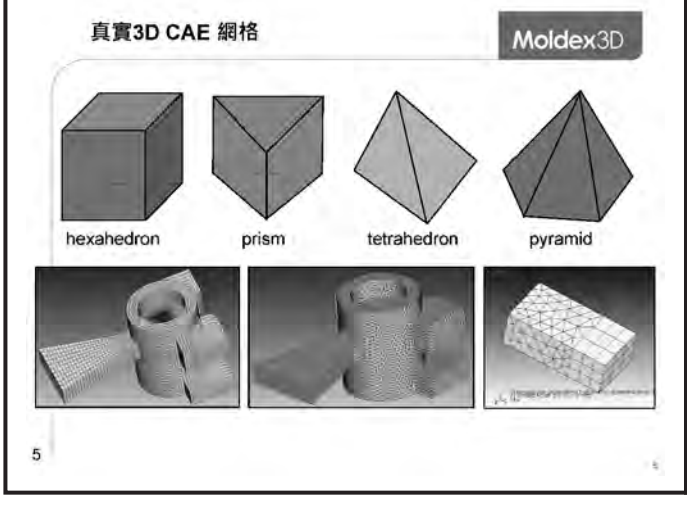
Moldex3D 模流分析技術

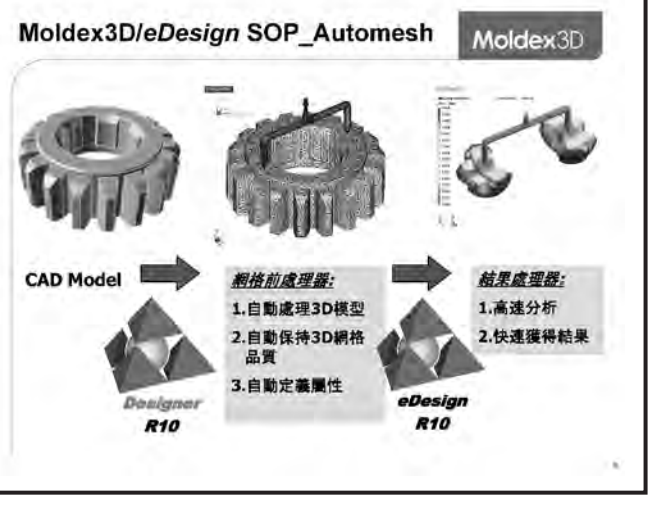
由科盛科技股份有限公司(台北辦公室)區域經理吳逸群博士主講

Moldex3D 模流分析技術









Moldex3D 模流分析技術

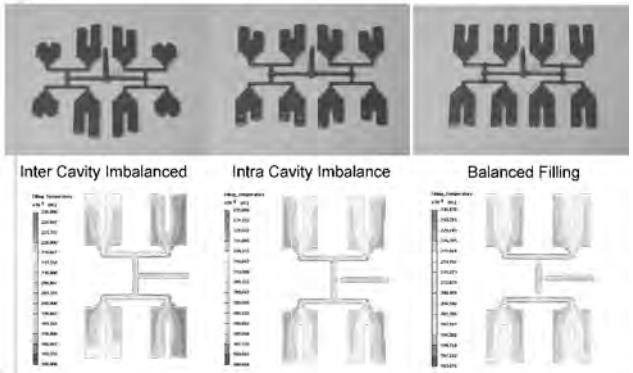
Moldex3D

精選案例分享

Moldex3D User:
BTI

Beaumont
BEAUMONT TECHNOLOGIES, INC.

Moldex3D



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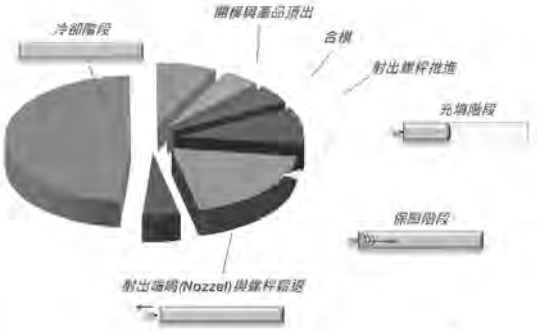
注塑成型製程

Moldex3D



9

客戶成功案例 - 聯合利華 (Unilever)

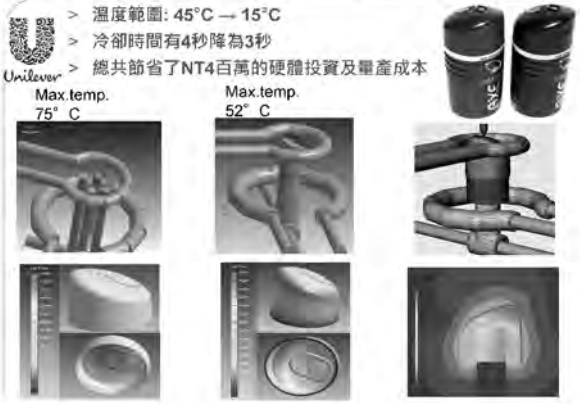
Moldex3D

- 溫度範圍: 45°C → 15°C
- 冷卻時間有4秒降為3秒
- 總共節省了NT4百萬的硬體投資及量產成本

Unilever

Max.temp.
75° C

Max.temp.
52° C



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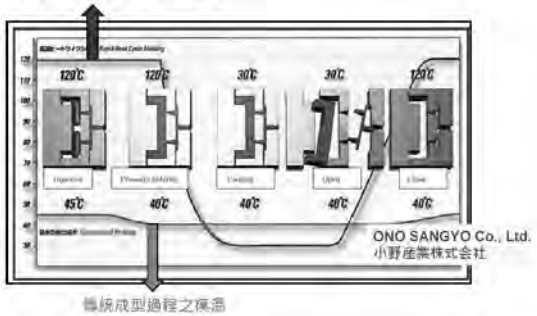
可變模溫製程的特色

Moldex3D

RHCM成型過程之模溫變化



11

為何使用可變模溫製程

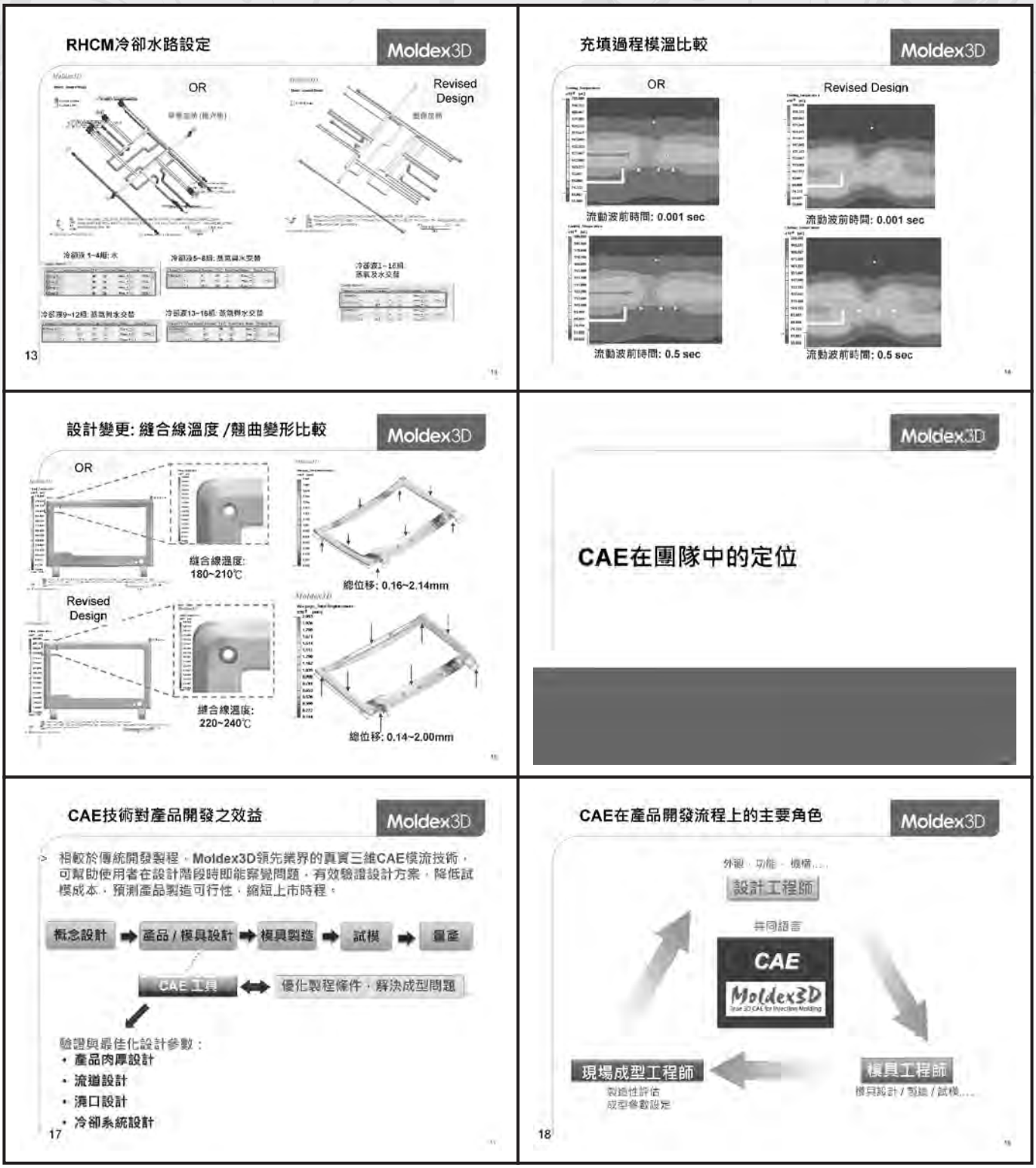
Moldex3D

- 傳統射出成型之問題
  - 縫合線
  - 流痕
  - 凹痕
  - 表面粗糙
  - 表面轉寫性差
  - 表面浮纖現象
- 可變模溫 成型過程
  - 改善產品表面品質
  - 去除縫合線
  - 微結構複寫精確
  - 減低殘餘應力,鎖模力,成型壓力....

ONO SANGYO Co., Ltd.
小野産業株式会社 /台灣中原大學

12

Moldex3D 模流分析技術



Moldex3D 模流分析技術

模具設計品管小組的任務

Moldex3D

> 建立" 高效率的溝通平台"
- 提供設計理念的表達平台,量化問題解析推演的過程
- 提供虛擬的電腦試模平台,尋求問題解決方案的共識

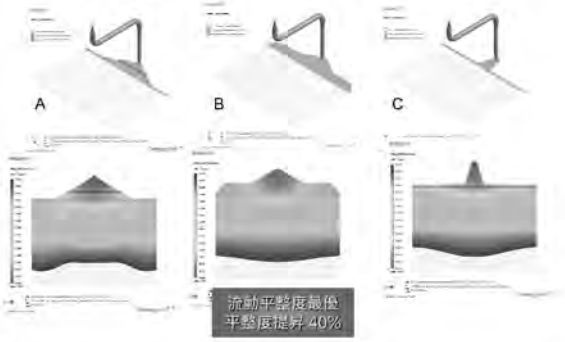
> 建立" 有系統的設計品管"
- 過濾明顯不當的模具設計,可降低現場修模試模次數
- 提供模具的設計品管流程,量化品質管理的關鍵指標

> 建立" 模具開發經驗知識庫"
- 有系統的知識建立,累積試模經驗能量
- 有系統的經驗傳承,提昇模具開發效率

導光板流道設計評估應用

Moldex3D

> 最佳化流道澆口設計，降低變形，提昇品質。



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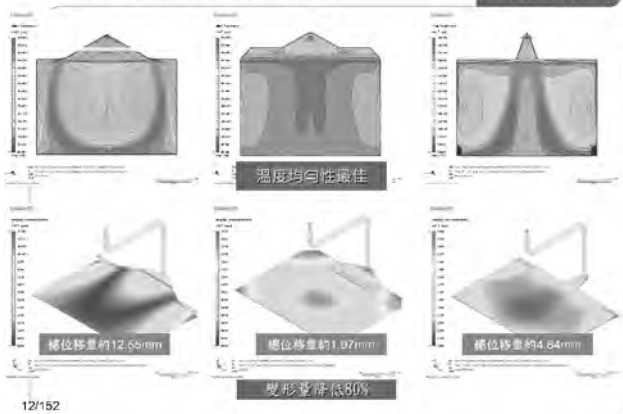
導光板流道設計評估應用

Moldex3D



12/152

Moldex3D 的產業應用與分析方案

Moldex3D

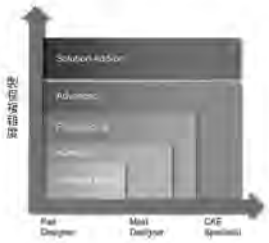
- 流場分析
  Basic Flow Simulation
- 精密成型
  Precision Molding
- 微射出成型
  Micromolding
- 熱流道優化與順序澆口
  Hot Runner Optimization / Sequential Valve Gate
- 變模溫成型
  Rapid Heating Cooling Molding (RHCM)
- 多射與嵌件射出
  Multi-Shot, Insert, Overmolding (MCM)
- 模內裝飾成型
  In-mold Decoration (IMD)
- 射出壓縮成型
  Injection Compression Molding
- 光學成型
  Optical Molding
- 氣輔成型
  Gas-assisted Injection Molding
- 水輔成型
  Water-assisted Injection Molding
- 金屬/陶瓷射出成型
  Metal / Ceramic Powder Injection Molding (MIM / CIM)
- 模面設計成型
  RIM Professional Simulation (RIM-Master)
- IC封裝成型
  IC Packaging

Moldex3D R11產品線

Moldex3D

> 依不同產業需求，Moldex3D提供一系列的模擬套裝組合，針對製程，有效幫助用戶評估成型行為，驗證設計問題，改善產品品質。
- eDesign Basic
- eDesign
- Professional (eDesign + Shell)
- Advanced (Dimetsim + Shell + 3Fill)

> Solution Add-on更提供一系列進階模組，給予用戶最全面的解決方案，深入模擬進階製程，優化設計條件。



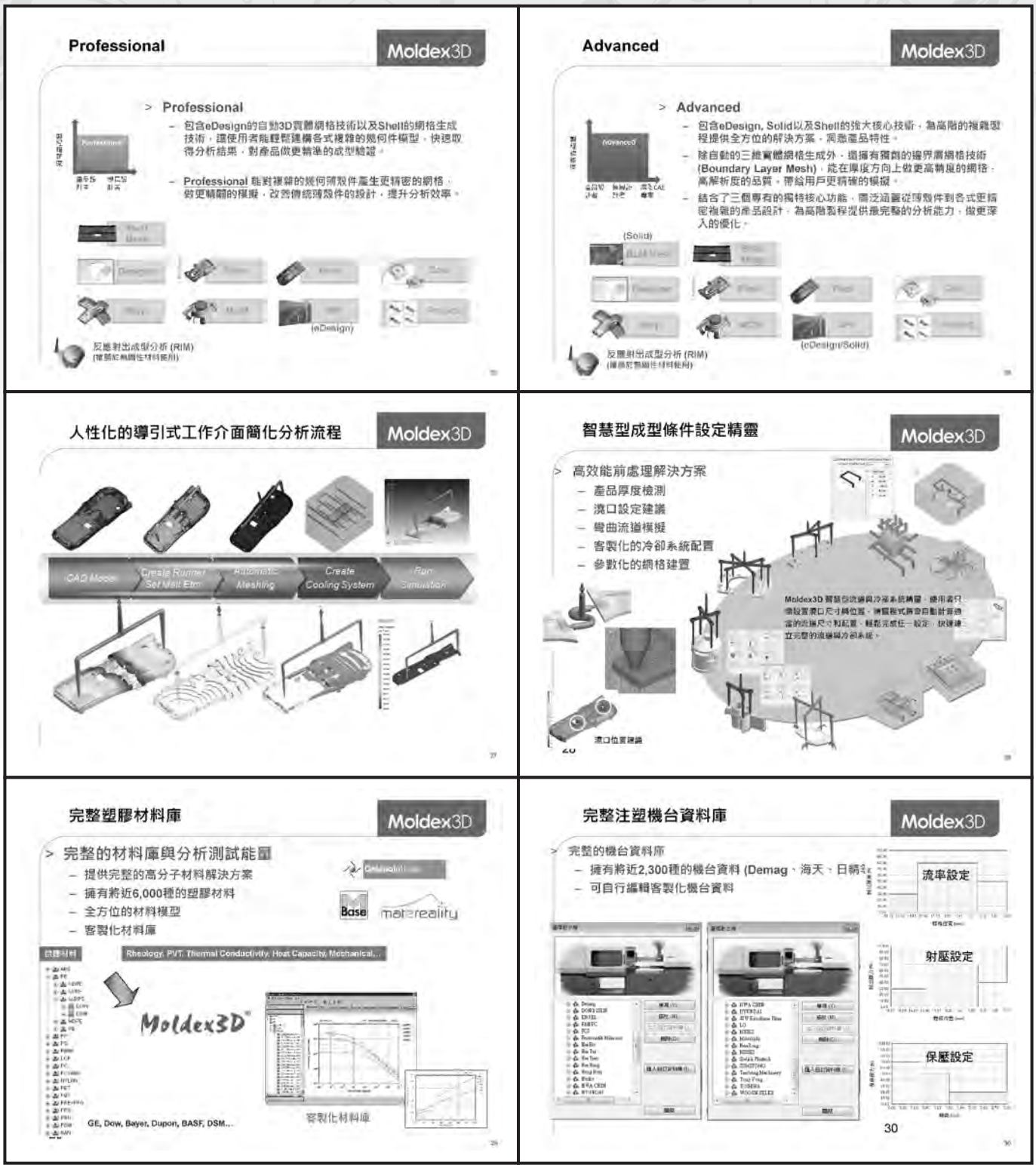
eDesign

Moldex3D

> eDesign
- 擁有Moldex3D eDesign專有的全自動三維網格生成技術，讓CAD模型建構不再是繁瑣的準備工作，並快速進入CAE模擬分析，將製程化繁為簡，輕鬆完成設計驗證。
- 提供精準的分析結果，3D立體的顯示技術，能深入解析產品效能，快速檢視產品與模具設計問題，優化設計。

反應射出成型分析 (RIM)
(增韌於熱固性材料應用)

Moldex3D 模流分析技術



Moldex3D 模流分析技術

高效能多核心平行計算

Moldex3D

> Moldex3D 高效能平行運算搭配遠端計算功能，是領先業界率先推出的雲端計算概念功能。

> 使用者可充分利用多核心、多CPU或多PC的電腦叢集，有效提升高達十數倍以上的運算效能，大幅縮短運算時間，創造更高的工作效能。

高效能平行計算，讓您享受超越十倍速的快感！

31

進階熱澆道模組

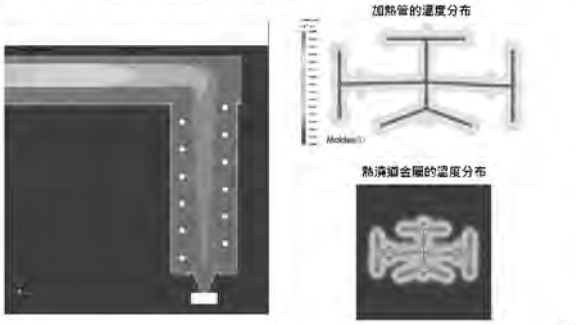
Moldex3D

> 特色
- 支援熱澆道全零件分析
  - 加熱管
  - 加熱線圈
  - 熱噴嘴
  - 熱噴嘴套管

進階熱澆道模組

Moldex3D

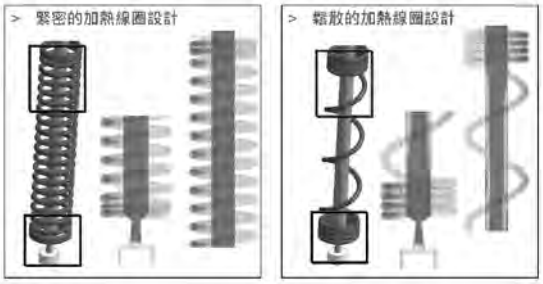
> 特色
- 顯示熱澆道系統的溫度分布與變化



進階熱澆道模組

Moldex3D

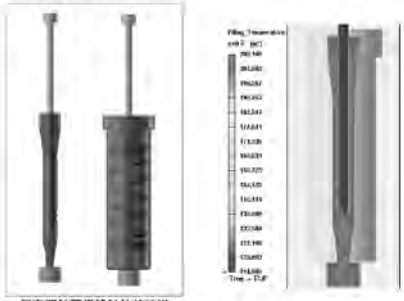
> 特色
- 熔澆道熔化溫度由加熱線圈控制



進階熱澆道模組

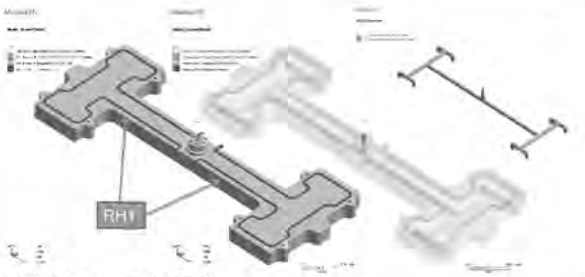
Moldex3D

> 特色
- 支援任何複雜的熱澆道幾何設計



分流板加熱線圈原始設計幾何模型

Moldex3D

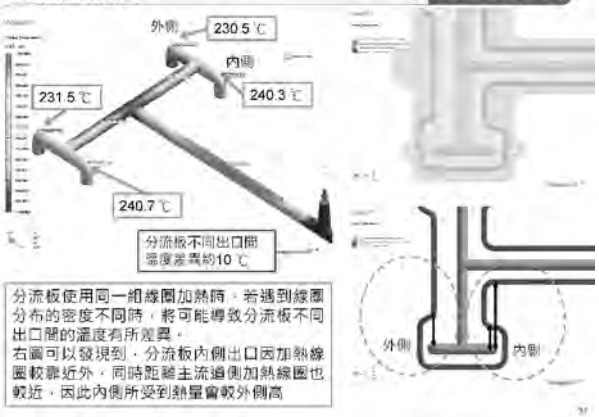


模穴擺設方式：一模8穴H型分布
加熱線圈擺設方式：單迴圈單層分布
加熱線圈功率：
- RH1：8500 W

Moldex3D 模流分析技術

分流板加熱線圈原始設計 流道溫度分布

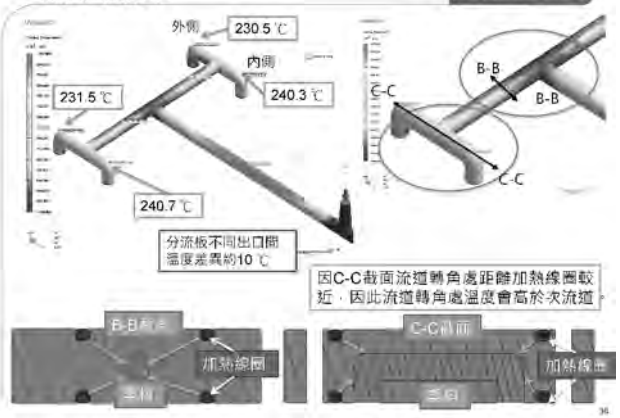
Moldex3D



分流板使用同一組線圈加熱時，若遇到線圈分布的密度不同時，將可能導致分流板不同出口間的溫度有所差異。
右圖可以發現到，分流板內側出口因加熱線圈較靠近外，同時距離主流道側加熱線圈也較近，因此內側所受到熱量會較外側高

分流板加熱線圈原始設計 流道溫度分布

Moldex3D



共射出模組

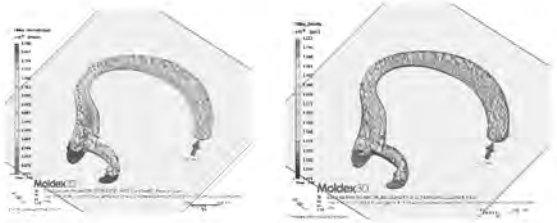
Moldex3D

> 特色
- 適用於Solid專案
- 模擬依序共射出成型製程
- 芯層材料與表層材料可由射速設定來控制
- 支援完整的充填、保壓、冷卻、翹曲的共射出製程模擬
- 支援平行運算

共射出模組

Moldex3D

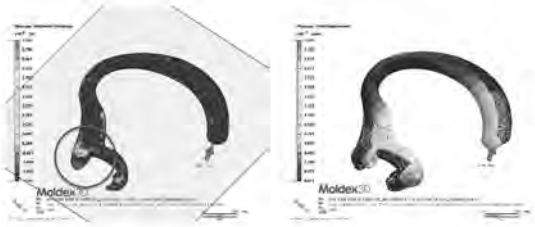
> 效益
- 模擬表層材料與芯層材料的實際特性分布



共射出模組

Moldex3D

> 效益
- 準確標示因設計而可能產生高溫與高壓的位置
- 預估因表層材料與芯層材料交互作用而影響的體積收縮與翹曲



微細發泡射出成型模組

Moldex3D

> 特色
- 適用於Solid專案
- 模擬MuCell®熱塑性材料的微細發泡射出成型製程

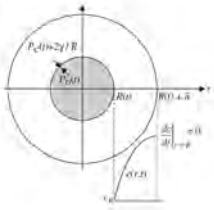
http://www.autoevolution.com

Moldex3D 模流分析技術

微細發泡射出成型模組

Moldex3D

- 特色
  - 控制發泡塑件成型時的氣體使用
  - 考慮成核率與氣泡成長的行為
  - 模擬製程中超臨界流體(SCF)的濃度變化



微細發泡射出成型模組

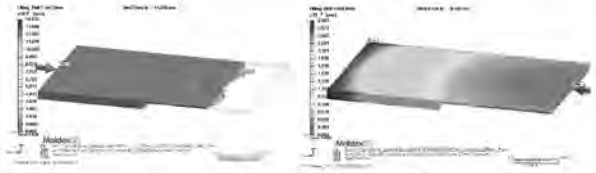
Moldex3D

- 特色
  - 顯示發泡過程中或其後的氣泡濃度與尺寸分布

微細發泡射出成型模組

Moldex3D

- 效益
  - 同時考量氣泡的核率與成長，以預測氣泡密度與尺寸
  - 獲得微細發泡射出成型的設計建議與製程資訊

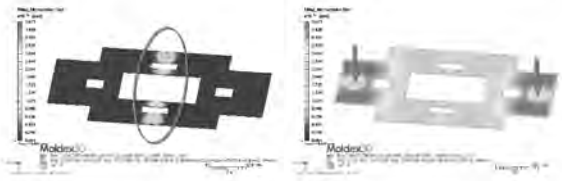


建議將澆口設置於薄壁

微細發泡射出成型模組

Moldex3D

- 顯現模具充填時氣泡成長
- 預測氣泡半徑與數量分布
  - 穿越厚度
  - 在縫合線與澆口區域



專家分析模組（實驗設計法）

Moldex3D

- 特色
  - 適用於Shell、eDesign、Solid專案
  - 使用分析結果作為原始資料來評估最佳結果
  - 取代傳統的試誤法，讓設計者可輕鬆完成分析優化設定
  - 提供控制因素優化後的表面顯示
  - 目前暫只支援單項目標優化
- 效益
  - 協助更有系統、更有效優化成型製程
  - 可獲得更佳的塑件品質

專家分析模組的設定流程

Moldex3D

- 步驟1：定義品質要素
- 步驟2：設定控制要素
- 步驟3：選擇實驗設計法的直交表

Moldex3D 模流分析技術

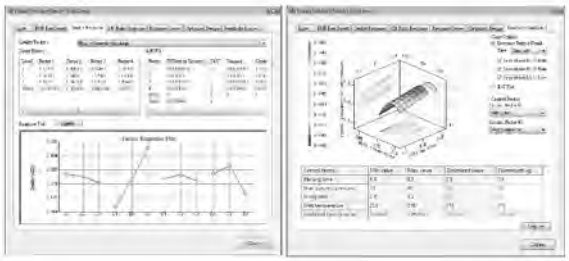
Moldex3D-DOE for Shell/Solid/eDesign Taguchi Orthogonal Array

Moldex3D

實驗設計法的分析結果

Moldex3D

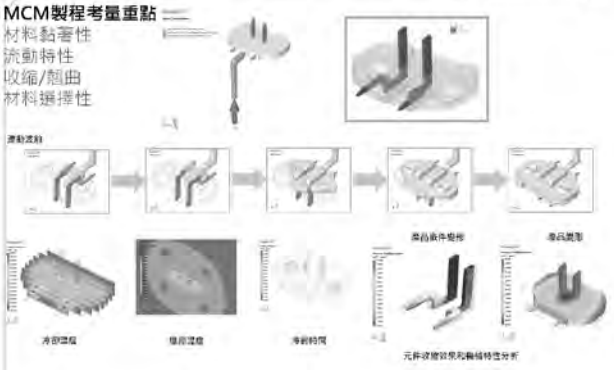
- 品質結果與S/N比率結果
- 優化設計
- 曲線結果與表面結果
- 敏感性分析



Moldex3D-MCM 多材質射出成型模組

Moldex3D

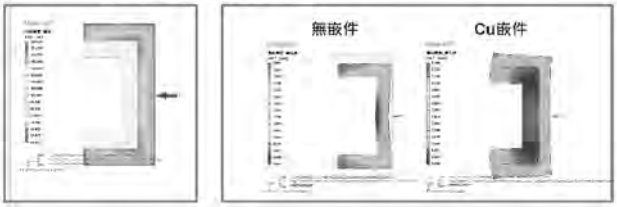
MCM製程考量重點
材料黏著性
流動特性
收縮/翹曲
材料選擇性



常見現象

Moldex3D

- 嵌件或前一射元件對於產品會有顯著影響
  - 不良熱傳導性: 塑膠材質嵌件將會導致不良的冷卻效率
  - 拘束效應: 將影響最終產品翹曲



52

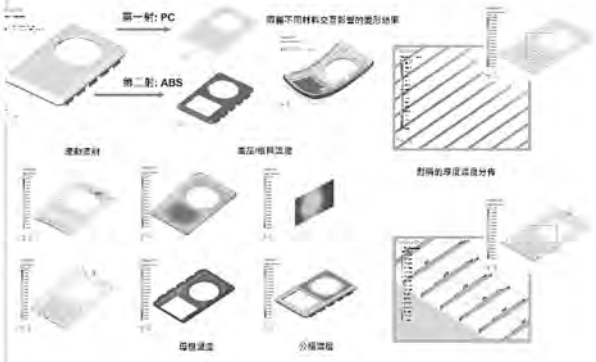
定義塑件/模具嵌入件的顏色

Moldex3D

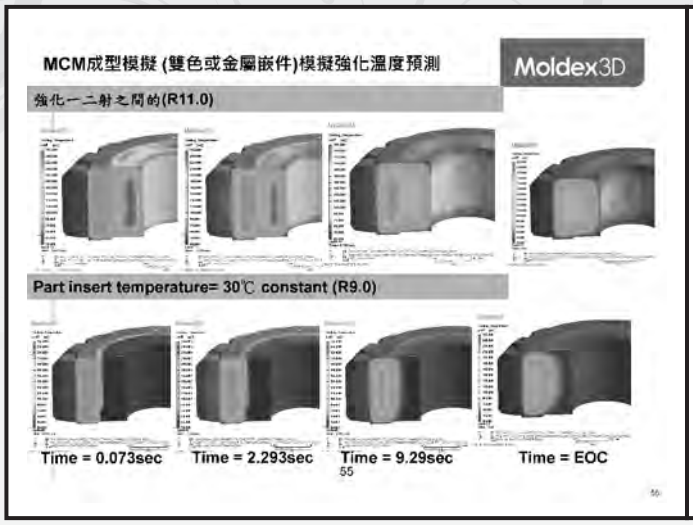
- 特色
  - 允許在Designer或Mesh定義塑件/模具嵌入件的群組顏色
  - 被定義的顏色將成為Moldex3D Project預設顯示顏色
- 效益
  - 更容易根據使用者的需求定義顏色
  - 更容易辨識群組差異，特別是有多個嵌入件的模型

Moldex3D-MCM 多材質射出成型模組

Moldex3D



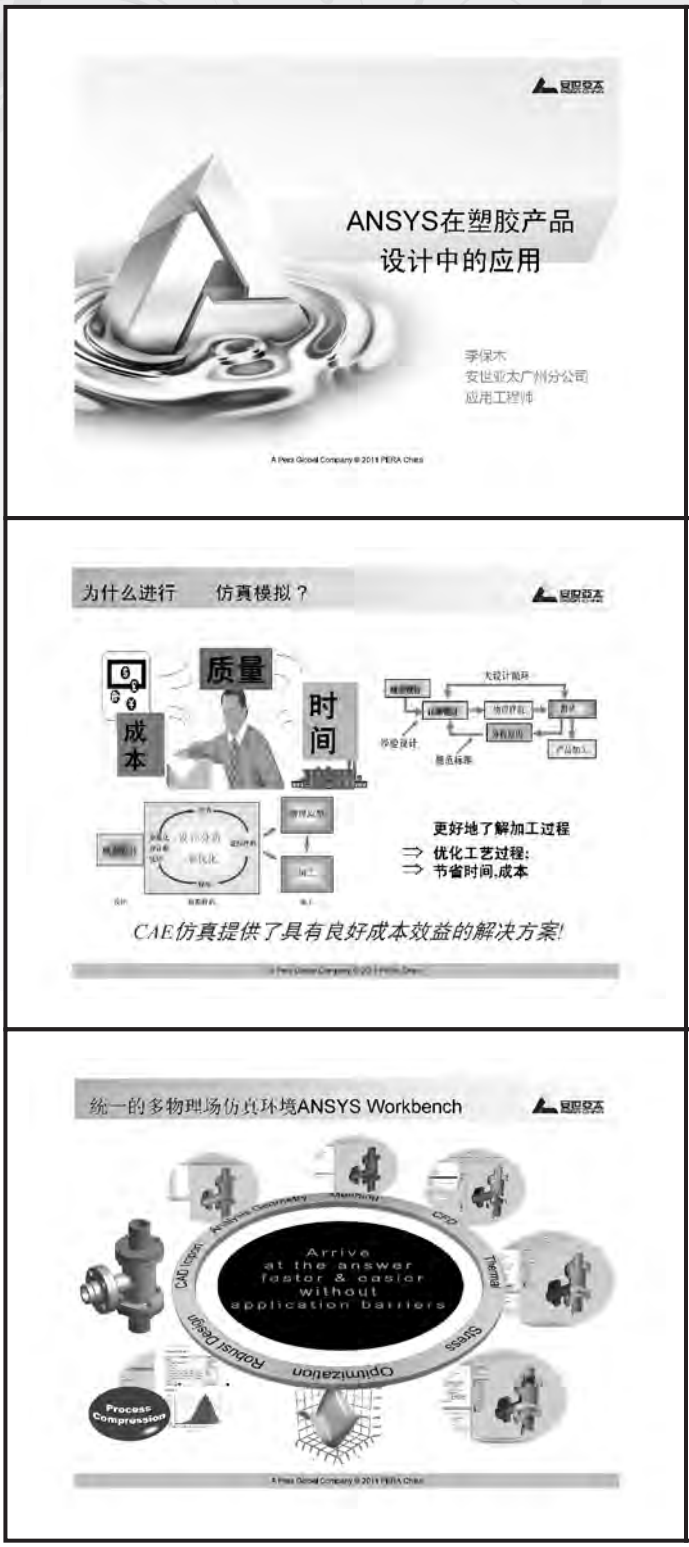
Moldex3D 模流分析技術



ANSYS 在塑膠產品設計中的應用

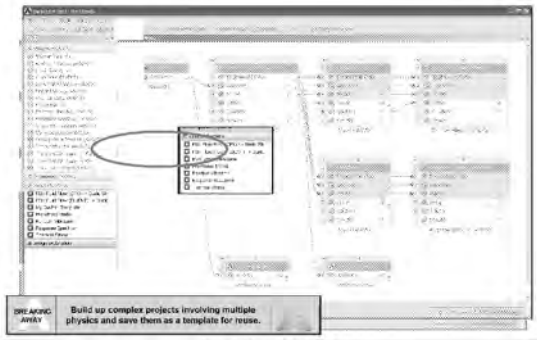
由安世亞太科技股份有限公司結構應用工程師李保木先生主講

ANSYS 在塑膠產品設計中的應用



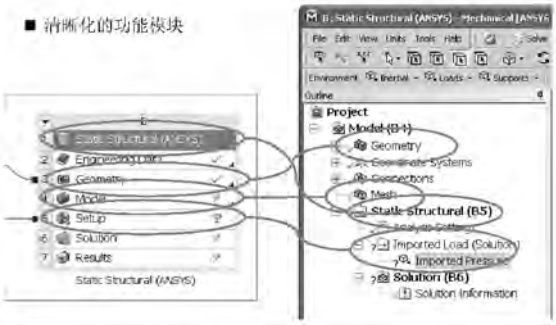
ANSYS 在塑膠產品設計中的應用

复杂项目实施



Workbench应用

- 清晰化的功能模块

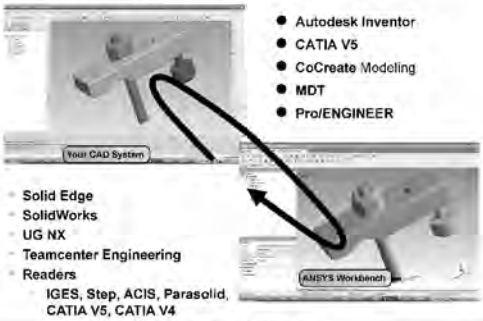


高效的前后处理技术

- CAD-CAE双向参数化模型共享
- 基于特征的几何参数化建模功能
- 几何模型修改能力/编辑能力
- 网格划分能力
- 装配模型自动探测与定义
- 网格模型解读与参数化
- 黏合工程的加载方式
- 强大的后处理能力
- 快捷的方案对比能力
- 快速报告生成能力

高效的前后处理技术

ANSYS同CAD系统之间的协同



- Autodesk Inventor
- CATIA V5
- CoCreate Modeling
- MDT
- Pro/ENGINEER

- Solid Edge
- SolidWorks
- UG NX
- Teamcenter Engineering
- Readers
  - IGES, Step, ACIS, Parasolid, CATIA V5, CATIA V4

ANSYS 14.0 Geometry Interface

Associative Interfaces (Associative, bidirectional and parametric)

- Creo Parametric
- Creo Elements/Pro
- Creo Elements/Direct Modeling
- Inventor 2012
- SolidWorks 2011
- Solid Edge ST3 (103)
- Solid Edge ST4
- CATIA V5 R21
- Teamcenter 8.0, 8.1, 8.3

CAD Readers

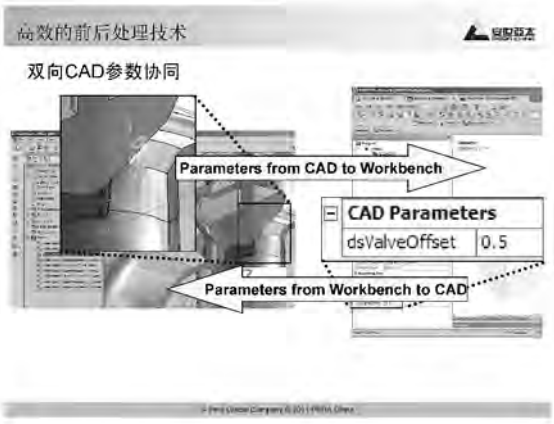
- AutoCAD 2012*
- Creo Elements/Pro
- NX 7.5
- Inventor 2011
- SolidWorks 2011
- Catia V5 R20
- Catia V4
- IGES and STEP
- Parasolid 24.0
- ACIS R20
- GAMBIT 2.4

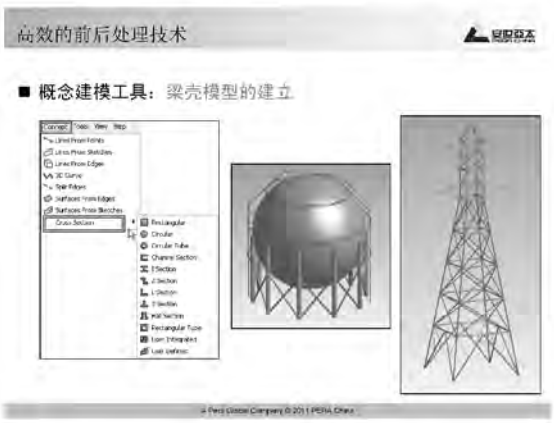
高效的前后处理技术

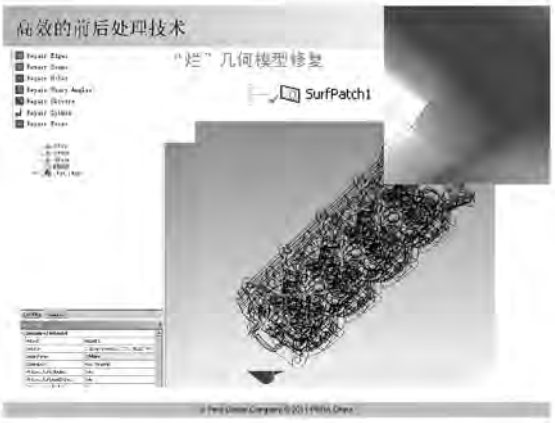
- CAD-CAE双向参数化模型共享
  - 设计(CAD)并行协同
  - CAD-CAE之间的并行协同
- 基于Parasolid标准的几何模型格式
  - 与UG、Solidedge、Solidworks等相同的几何内核
  - 输入/输出为x_t中性文件，完善的接口

在协同环境中将来自于Pro/E的支座和UG的齿轮零部组装成一个装配体

ANSYS 在塑膠產品設計中的應用







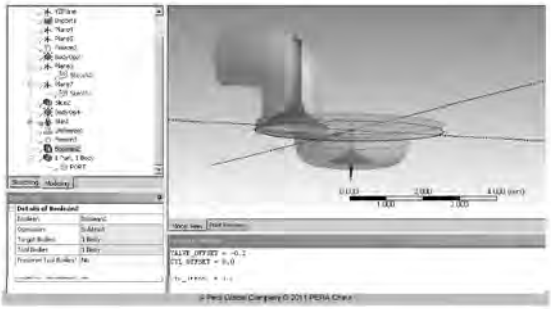
ANSYS 在塑膠產品設計中的應用

高效的前后处理技术

几何模型分解（便于网格划分或者施加边界条件）

高效的前后处理技术

- CAD模型的局部参数化



高效的前后处理技术

一次网格划分可用于多种分析类型

高效的前后处理技术

- Workbench平台下多学科同意网格划分工具ANSYS Meshing

Workbench Meshing Overview

- Workbench process automation:
  - Physics-aware meshing
  - Meshing in batch
  - Parametric/persistent meshing
- Automatic meshing
  - Automated hex meshing checks
  - Conformal tet meshing otherwise
  - Push-button meshing
- Adding controls for flexibility:
  - Mesh type/method, sizing
  - Mesh alignment,quality
  - Mesh feature capturing

Workbench Process Automation

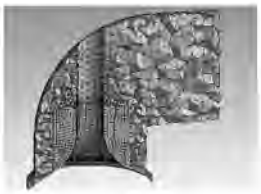
- Meshing comes as a cell of a Workbench Analysis System (Mesh/Model)
- Or as its own Component System

- Regardless of what System the Mesh/Model cell is invoked from the meshing tools are the same
- However, the meshing defaults are based on the physics preference of the system
- The mesh is provided to any downstream system

ANSYS 在塑膠產品設計中的應用

Meshing Methods for 3D Geometry

- There are several different meshing methods in the ANSYS Meshing Application for 3D Geometry:
  - Automatic
  - Tetrahedrons
    - Patch Conforming
    - Patch Independent
      - (ICEM CFD Tetra algorithm)
  - Swept Meshing
  - MultiZone
  - Hex Dominant



Defeaturing

Geometry/Mesh defeaturing

Virtual Topologies:
- Geometry defeaturing
- Group faces/edges to ignore features

Pinch Controls:
- Mesh defeaturing
- Pinch out mesh locally in tight regions

Automatic detection:
- With both virtual topologies and pinch you can create the controls automatically or manually

Size Functions 尺寸函数

Sizing functions

Standard Size Function:
- Ideal for structural meshing

Advanced Size Function:
- Ideal for CFD meshing

Local size functions:
- For more control user can insert local size functions

Hybrid meshing 混合网格

Hybrid meshing

Hex mesh:
- Automated hex meshing after decomposition:

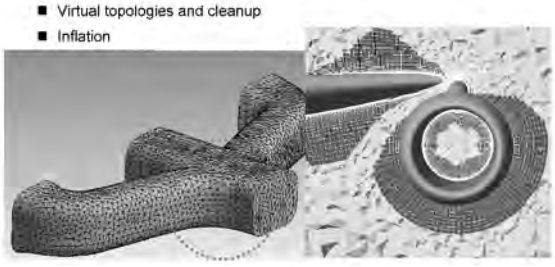
Tet + Hex mesh:
- Bodies are automatically found to be sweepable
- Bodies that can't be hex mesh are automatically tet meshed:

Swept bodies

Add inflation layers:
- To capture boundary layers, inflation can be generated into the tet+hex mesh:

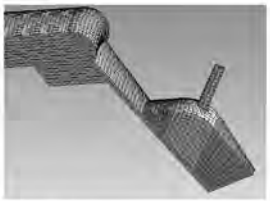
Tet Meshing Capabilities 四面体网格划分

Tetrahedral meshing:
- Patch conforming and Patch independent method
- Virtual topologies and cleanup
- Inflation



Sweep Meshing 扫掠网格

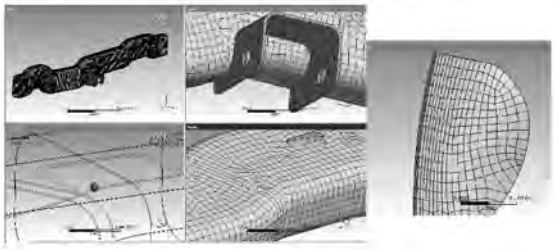
Sweep meshing with inflation



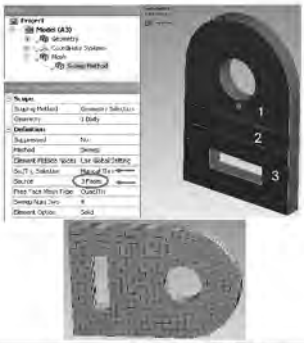
ANSYS 在塑膠產品設計中的應用

Thin Solid Sweep Meshing 薄壁扫掠

- Multiple source/target faces
- Works at body level with other methods
- Multiple elements through thickness possible for single body parts



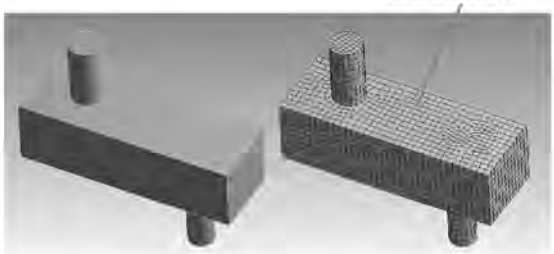
Thin Solid Sweep Meshing 薄壁扫掠



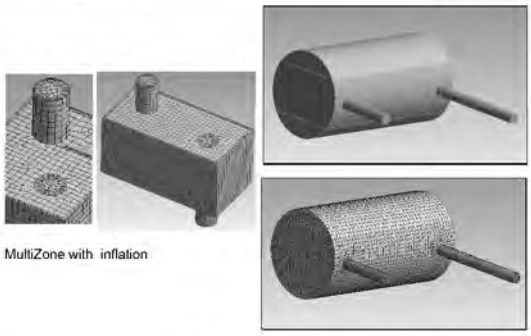
MultiZone Sweep Meshing

- Automatic geometry decomposition
  - With the swept method, this part would have to be sliced into 3 bodies to get a pure hex mesh

With MultiZone, it can be meshed directly!

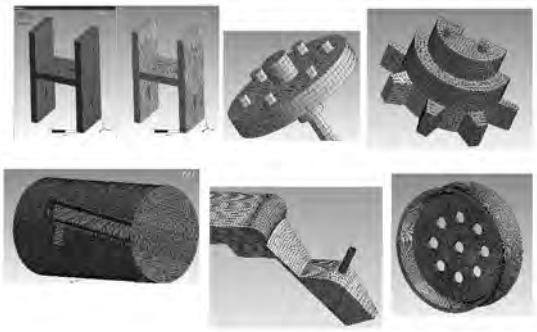


MultiZone Sweep Meshing



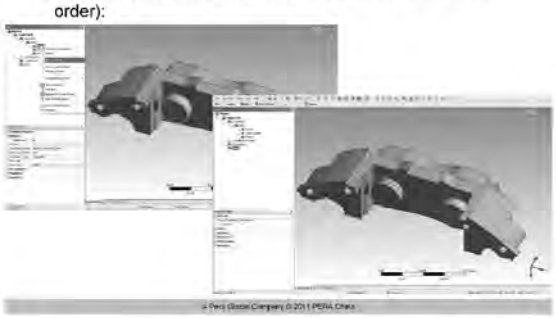
MultiZone with inflation

Examples for Sweep Meshing



Body by body meshing

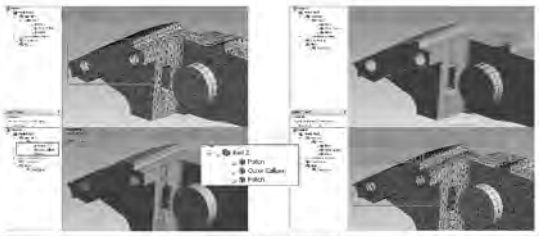
- Mesh body at time (allows user some control over mesh order):



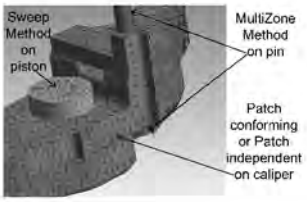
ANSYS 在塑膠產品設計中的應用

Body by body meshing

- If mesh has been generated and local mesh controls are added, only affected bodies become out of date:

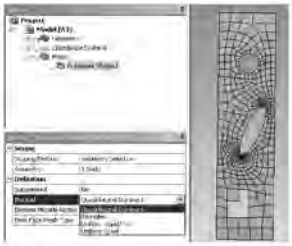


Body by body meshing



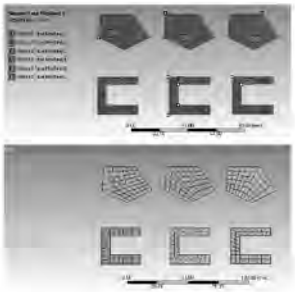
Meshing Methods for 2D Geometry

- There are four different meshing methods in the ANSYS Meshing Platform for 2D Geometry which can be applied to Surface Bodies or Shells:
  - Automatic Method (Quadrilateral Dominant)
  - All Triangles
  - Uniform Quad/Tri
  - Uniform Quad



Meshing Methods for 2D Geometry

Mapped Face Mesh Controls



ANSYS Mechanical

- ANSYS通用结构力学分析软件
- 丰富的单元库（200+）和材料模型（70+）
- 强大的非线性求解功能（几何非线性、材料非线性、接触非线性）
- 完备的动力学分析方法
- 稳态/瞬态热分析，热-结构耦合分析

ANSYS Explicit STR

- 基于ANSYS Workbench仿真平台的高度结构非线性显式动力学分析软件
- 成熟的单元算法与求解技术
- 可以求解二维、三维结构的跌落、碰撞、材料成形等非线性动力学问题

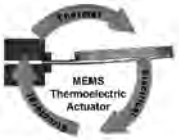
ANSYS 在塑膠產品設計中的應用

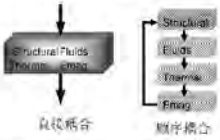
ANSYS CFD

- 流动
  - 湍流模型、多孔介质、可压和不可压流动、非牛顿流、多重参考坐标系...
- 传热与辐射
  - DO、DTRM、流固混合传热...
- 燃烧与化学反应
  - 化合燃烧模型、化学反应动力学、多组分流体...
- 多相流
  - 欧拉多相流、拉格朗日多相流、自由表面模型、沸腾...

ANSYS Multiphysics

- 具有结构、流体、热、电磁单场分析功能和多场耦合功能
- 网格随动
- FSI流固界面耦合分析技术
- 双向耦合求解技术





目 录

- 电子产品设计中的分析需求
- ANSYS在电子产品设计中的应用

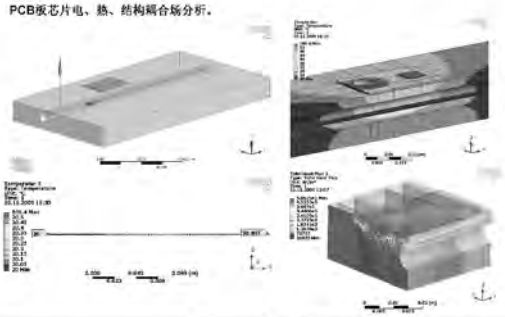
PCB板热应力及随机振动分析

WB中分析流程

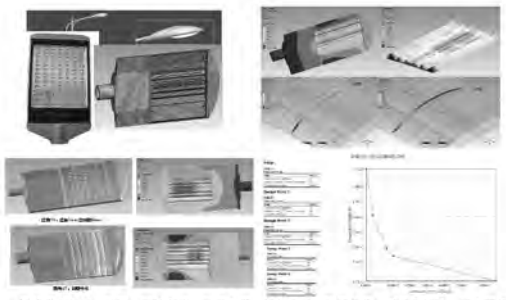
PCB温度场分布　PCB热应力分布　PCB随机振动应力分布

PCB板芯片生热、散热分析

PCB板芯片电、热、结构耦合场分析。

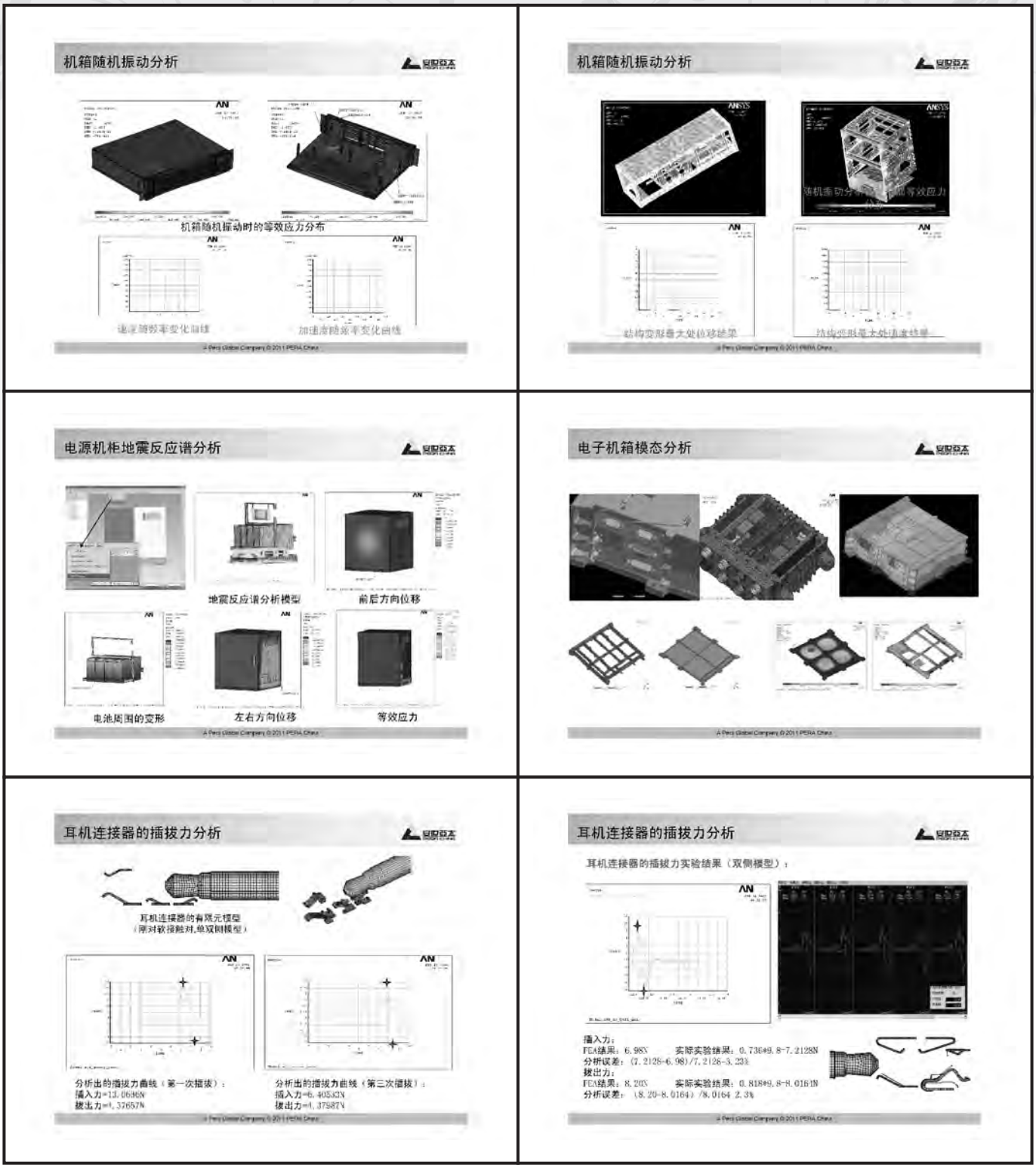


LED灯具散热、热应力分析与优化

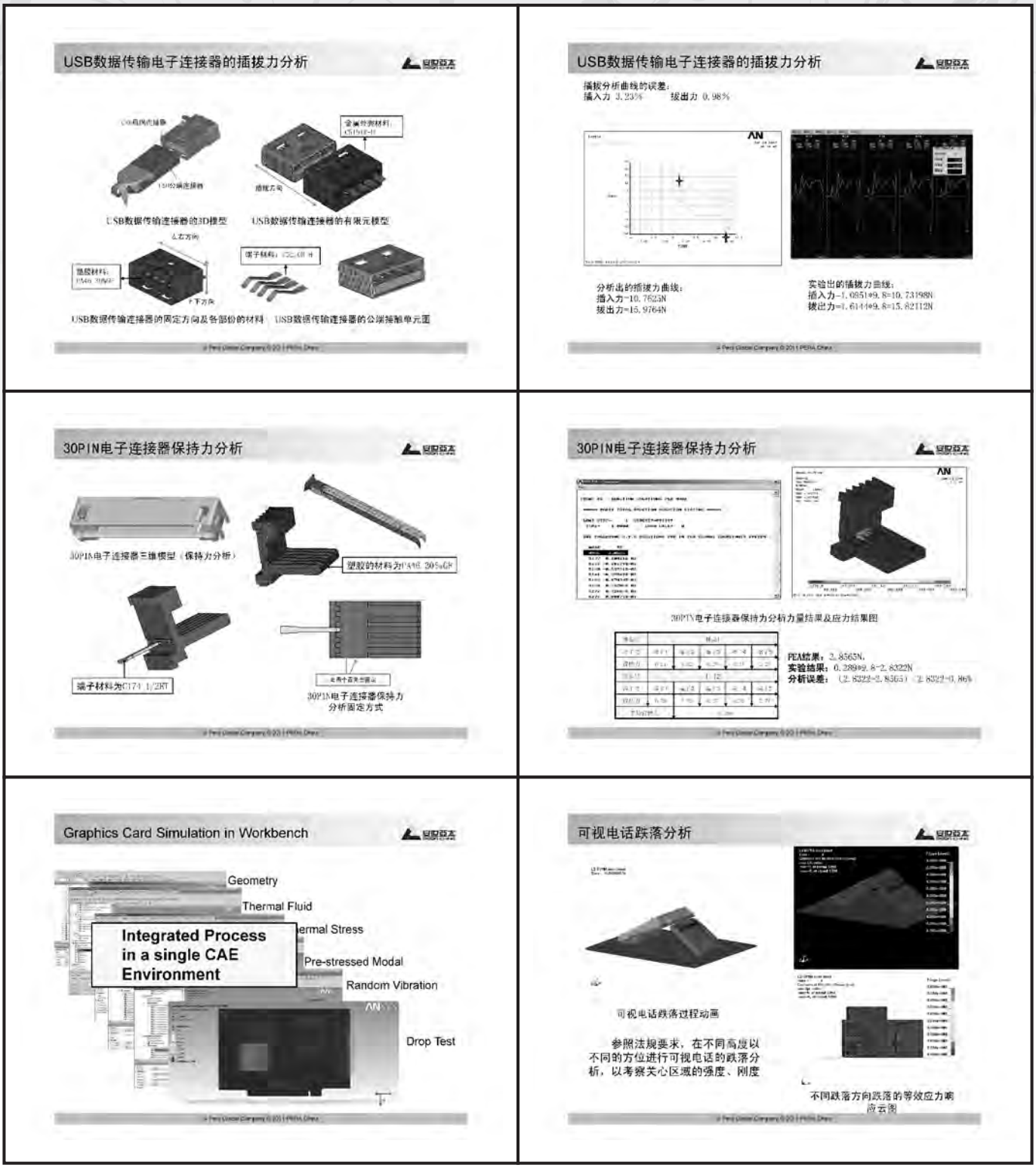


设计变量包括：材料、环境温度、对流系数、辐射系数、海拔高度、散热器设计、功率调整等

ANSYS 在塑膠產品設計中的應用



ANSYS 在塑膠產品設計中的應用



ANSYS 在塑膠產品設計中的應用

手机跌落分析

■ 手机跌落分析（续）

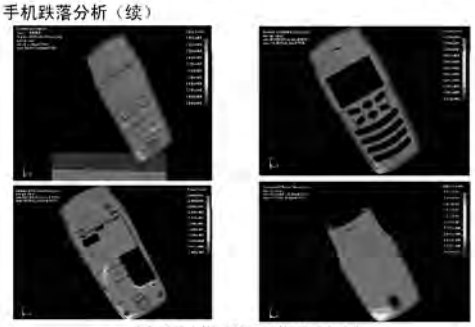
对讲机跌落分析

翻盖手机跌落，手机盖打开，并发生材料失效

NOKIA手机跌落等效应力云图

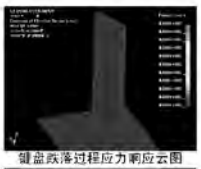
手机跌落分析

■ 手机跌落分析（续）

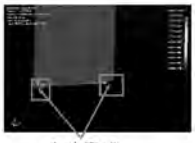


在某跌落方位下不同时刻等效应力分布

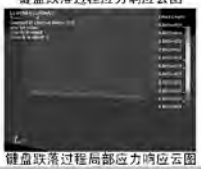
键盘跌落分析



键盘跌落过程应力响应云图



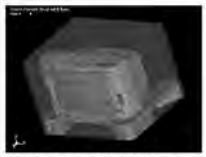
失效区域



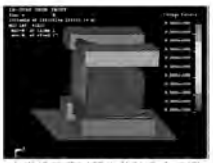
键盘跌落过程局部应力响应云图

键盘跌落过程键盘背面应力响应云图

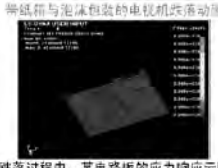
电视机跌落分析



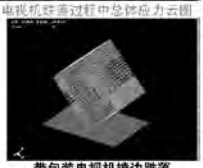
带纸箱与泡沫包装的电视机跌落动画



电视机跌落过程中总体应力云图

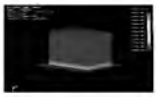


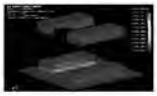
跌落过程中，某电路板的应力响应云图

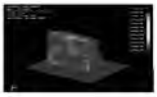


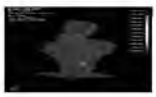
带包装电视机棱边跌落

电视机跌落分析



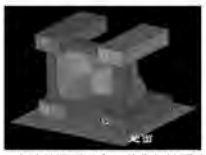


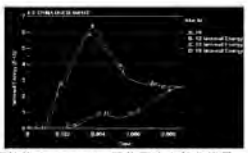




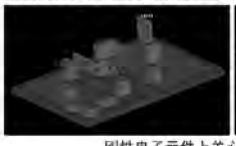
应力响应云图

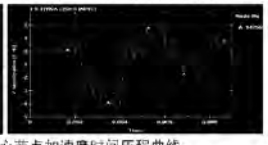
电视机跌落分析





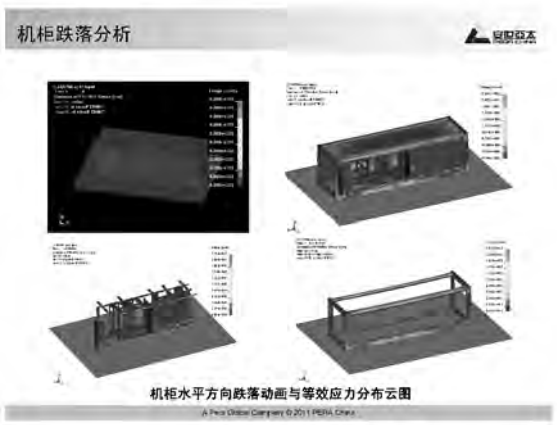
在该跌落工况中，首先与地面接触的两块泡方（10&12）吸收了绝大部分能量

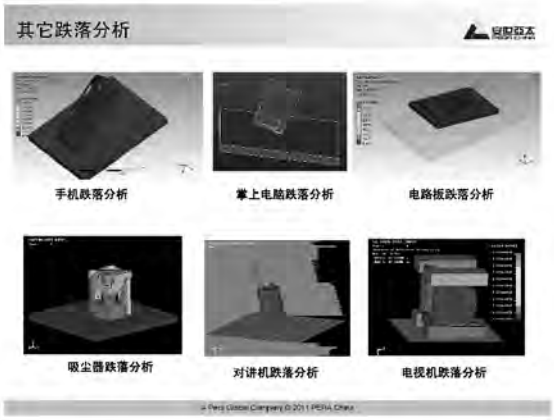


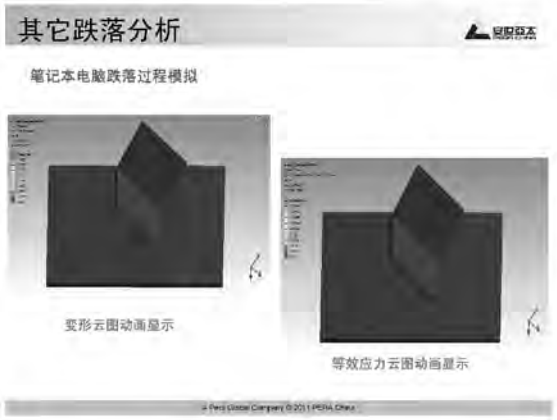


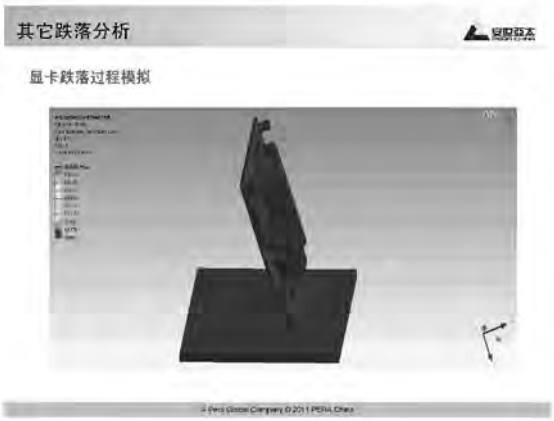
刚性电子元件上关心节点加速度时间历程曲线

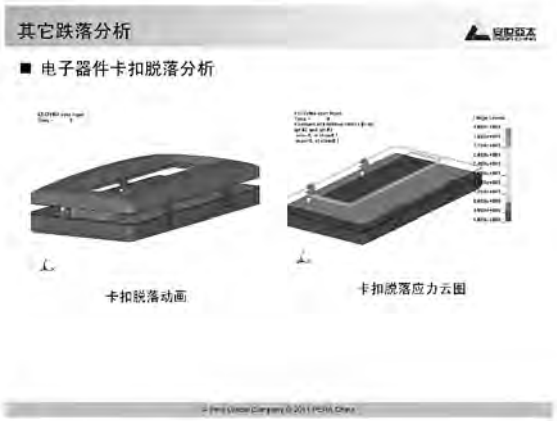
ANSYS 在塑膠產品設計中的應用











ANSYS 在塑膠產品設計中的應用

工作坊 3

「綠色製造」工作坊

低碳製造計劃 (LCMP)
由生產力促進局高級顧問孫國偉先生主講

塑膠機械能源效率
由生產力促進局助理顧問林子峯先生主講

快速模溫控制/無痕注塑技術 (Rapid Heat & Cool)
由生產力促進局顧問高耀祖先生主講

液態矽膠 (LSR) 注塑成型及覆蓋注塑成型
由生產力促進局顧問高耀祖先生主講

低碳製造計劃 (LCMP)

由生產力促進局高級顧問孫國偉先生主講

低碳製造計劃 (LCMP)

The Plastics Industry

Hong Kong Productivity Council
香港生產力促進局

Outline

1. Injection moulding industry
2. Blow moulding industry
3. Workshop good practice

Injection Moulding Industry

Injection Moulding Industry

The injection moulding machine:

Injection Moulding Industry

Energy saving devices:

inverter

Electric servo motor

Proportional pump

Injection Moulding Industry

The injection moulding machine:

-The performance is measured by:

1) % of machines that have these energy saving features.

% of machines with energy saving features.	Performance
100 %	Good
> 50 %	Fair
< 50 %	Poor

低碳製造計劃 (LCMP)

Injection Moulding Industry

The injection moulding machine:

-The performance is measured by:

2) % of machines that receive regular maintenance.

% of machines with regular maintenance.	Performance
100 %	Good
> 50 %	Fair
< 50 %	Poor

Auxiliary Machines

Auxiliary Machines

Auxiliary machines:

-The performance is measured by:

1) % of machines that have energy saving features.

% of machines with energy saving features.	Performance
100 %	Good
> 50 %	Fair
< 50 %	Poor

Auxiliary Machines

Auxiliary machines:

-The performance is measured by:

2) % of machines that receive regular maintenance.

% of machines with regular maintenance	Performance
100 %	Good
> 50 %	Fair
< 50 %	Poor

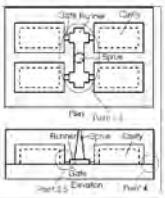
Mould

Mould design:

-The performance is measured by:

- Size of mould, runner and gate.

Mould size and gate size	Performance
optimal	Good
Large but reasonable	Fair
Large but unresonable	Poor



Plastic Resins

-The performance is measured by the setting of processing condition.

Processing Condition	Performance
Optimal temp and drying time according to data sheet	Good
Temp higher / drying time longer than required	Fair
Temp higher AND drying time longer than required	Poor

低碳製造計劃 (LCMP)

Secondary Operation

Secondary operation:

-Assembly

-Decoration

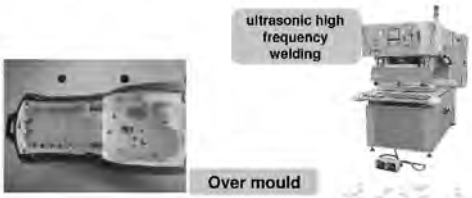
-Packaging

Secondary Operation

Secondary operation:

-Smart assembly methods

-Overmoulding, ultrasonic high frequency welding, snap-fit, etc.



Secondary Operation

Assembly

-The performance is measured by the efficiency of the assembly method.

Assembly method	Performance
Energy efficient, no better alternative	Good
Energy efficient, yet there are better alternative	Fair
Waste a lot of energy	Poor

Secondary Operation

Decoration

Screen Printing

Pad Printing

Secondary Operation

Decoration

In-mould decoration

Laser Printing

Secondary Operation

Decoration

-The performance is measured by the efficiency of the decoration method.

Decoration method	Performance
Energy efficient, no better alternative	Good
Energy efficient, yet there are better alternative	Fair
Waste a lot of energy	Poor

低碳製造計劃 (LCMP)

Secondary Operation

Packaging

-The performance is measured by the efficiency of the packaging method.

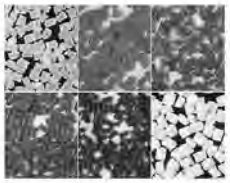
Packaging method	Performance
Energy efficient, no better alternative	Good
Energy efficient, yet there are better alternative	Fair
Waste a lot of energy	Poor

Recycling

Plastic scraps resulted from flash, gates from the plastic products.

- The performance is measured by the % plastic scraps being recycled.

% being recycled	Performance
> 80 %	Good
between 60 and 80 %	Fair
< 60 %	Poor



Recycling

The major machines that involved in recycling is Granulator.

- The performance is measured by the % of machines that receive regular maintenance.

% of machines receive maintenance	Performance
100 %	Good
> 50 %	Fair
< 50 %	Poor

Blow Moulding Industry

Blow Moulding Industry

Energy saving devices:

inverter

Electric servo motor

Proportional pump

Blow Moulding Industry

The blown moulding machine:

-The performance is measured by:

1) % of machines that have these energy saving features.

% of machines with energy saving features.	Performance
100 %	Good
> 50 %	Fair
< 50 %	Poor

低碳製造計劃 (LCMP)

Blow Moulding Industry

The blow moulding machine:

-The performance is measured by:

2) % of machines that receive regular maintenance.

% of machines with regular maintenance.	Performance
100 %	Good
> 50 %	Fair
< 50 %	Poor

Workshop Good Practice

Workshop good practice:

-No. of mould trials

-Mould trial records for min. setup time

-Amount of unnecessary secondary operation

-Yield rate of primary operation

-Yield rate of secondary operation

Workshop Good Practice

Workshop good practice:

-No. of mould trials

No of mould trials	Performance
Less than 3 times	Good
3 times	Fair
More than 3 times	Poor

Workshop Good Practice

Workshop good practice:

-Mould trial records for min. setup time

% of mould with record for min. setup time	Performance
> 50 %	Good
< 50 %	Fair
0 %	Poor

Workshop Good Practice

Workshop good practice:

-Amount of unnecessary secondary operation

Amount of unnecessary secondary operation	Performance
None	Good
Reasonable	Fair
Unresonable	Poor

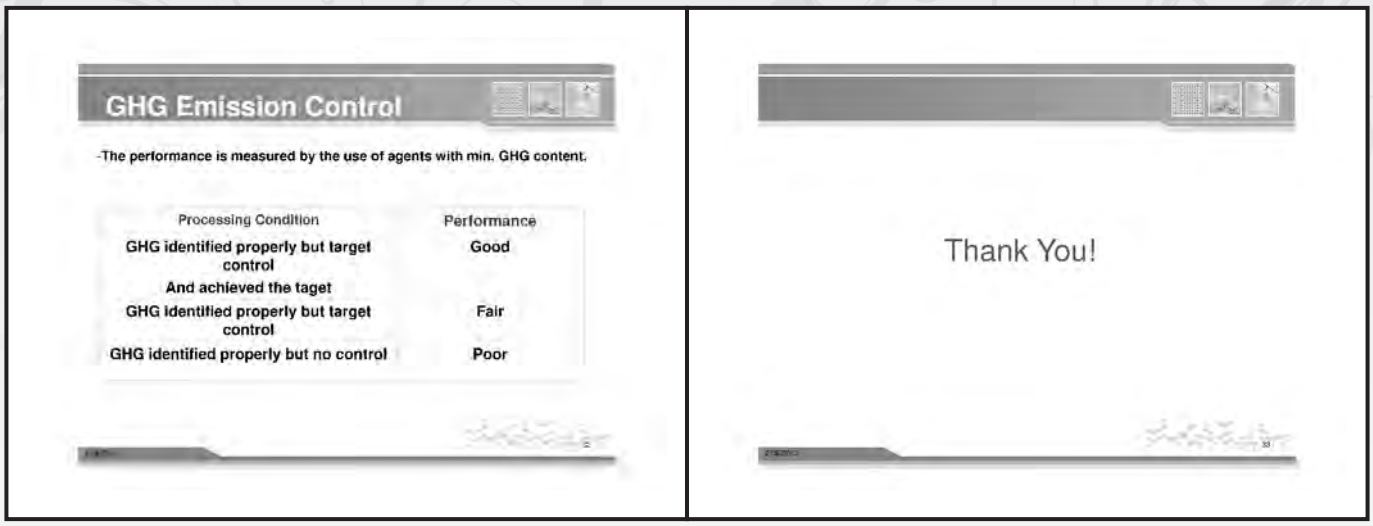
Workshop Good Practice

Workshop good practice:

-Yield rate of primary and secondary operation

Max. yield rate of primary and secondary operation	Performance
> 95 %	Good
80 – 95 %	Fair
< 80 %	Poor

低碳製造計劃 (LCMP)



GHG Emission Control

-The performance is measured by the use of agents with min. GHG content.

Processing Condition	Performance
GHG identified properly but target control And achieved the taget	Good
GHG identified properly but target control	Fair
GHG identified properly but no control	Poor

Thank You!

塑膠機械能源效率

由生產力促進局助理顧問林子峯先生主講

塑膠機械能源效率

Energy measurement standard
for injection moulding machines,
mould temperature controller, hopper dryer

Background

↑ Concern of the global warming

↑ Fierce business competition

Local plastic product manufactures
Adopt greener production

Energy consumption

✓ Save cost
✓ Attract buyers

Background

Plastic products manufacturing
- Plastic injection moulding machine
- Hopper dryer
- Mould temperature controller
- Robot arm
- Conveyer

Plastic processing & auxiliary machinery
With energy saving devices

Save 30-60% electricity

Background

How can users make purchase decision?
→ A standard to measure energy consumption of injection moulding machines, auxiliary equipment ...

→ Energy efficiency labeling scheme

Good standard & Labeling scheme
→ reflects the result of energy-saving features designed into the injection moulding machine, auxiliary equipment ...

Two common standards

Europe made plastic machinery
Adopted advanced technology
& achieve high energy saving performance
→ No standardized energy efficiency labeling scheme

歐洲塑膠及橡膠機械生產商協會
Europe' s Association for plastics and rubber machinery manufacturers
EUROMAP 60
第一版 (1995年4月)
第二版 (2009年6月)
- 注塑機能耗測試方法
- Only a general guideline
Determine energy consumption of injection moulding machines

EUROMAP
European Plastics and Rubber Machinery

Two common standards

中國注塑機行業 (2009年10月)
《塑膠注射成型機能耗檢測和等級評定的規範》
(簡稱中國行業標準)
China National Energy Saving Certification

节能型注塑机

Four types of drive technologies

A rough idea of energy consumption of an injection moulding machine.

1. Fixed displacement pump
2. Variable displacement pump
3. Servomotor/pump
4. Fully electric machine

Page • 7

Four types of drive technologies

注塑機要產生如**鎖模**及**注塑**等動作
亦要產生**熱量**將料筒內的塑膠**加熱/塑化**

油泵
-將**旋轉**的動能轉換爲**液能**（壓力及流量）
-油泵內的**摩擦力**會降低輸出壓力
-油泵的**內漏**會降低輸出流量
➔ 輸出的（有用）**液能**是比輸入的**旋轉動能低**
(熱能轉到**壓力油**去，使其升溫，這注塑機爲何要安裝壓力油**冷卻器**的原因之一)

油馬達、油缸
-將**液能**轉返**旋轉動能**及**線形動能**
來**驅動**如**螺杆的塑化**及**注射動作**
-如油泵一樣，轉換過程中產生了熱量，提高了油溫

Page • 8

Four types of drive technologies

油管
-**壓力油**在油管內流動
-在管壁傳導時，都會與管壁及自相**摩擦**而**降低了壓力**，產生了**熱能**

-普遍的注塑機都會用**小的管徑**來**降低成本**
-但必然便提**高**了油在管內的**流速**，**摩擦**的損失**增加**，
-油溫便升得**更高**，便**浪費**更多的**能量**

驅動油泵 ➔ 油流過管道到達油馬達或油缸 ➔ 再轉換爲動能

節能的本質在於減少浪費
-當注塑機動作不是全速時，降低流量便能減少浪費
-新的技術如**變量泵**及**伺服電機**能夠降低**流量**

Page • 9

Four types of drive technologies

定量泵爲何耗能？
用**恒定轉速**的，油泵是輸出**恒定的流量**的

-但注塑週期中的**各個動作**，如開合模、頂出、塑化、注射及保壓，甚至待機狀態對**流量的要求都不同**

-動作**用不著的流量**便在當時的設定壓力下**流回油箱**
-所需動作越慢，流回油箱的量越多，浪費的能量便越多
-設定的壓力越大，流回油箱的損耗便越大
-浪費了的能量都變爲熱能，將油溫提高

在注塑週期中，**保壓**所需的**油量很低**
因**螺杆**前行的**速度**只需要足夠**填補**成品**冷卻**時的**收縮量**
(估計不會超過油泵流量的5%，而油泵95%以上的流量便在保壓壓力下流回油箱)

成品壁厚越大，保壓時間便越長，浪費的能量便越多

Page • 10

Four types of drive technologies

變量泵如何變量？

能夠改變流量 ➔ 節能

變量泵
-提供從**零到最大的流量**，
-是在非同步電機恒速轉動下能提供的

最常用的**變量泵**採用**斜盤軸向柱塞**設計
-當斜盤的角度是零，柱塞的排量便是零
-按流量的需要將斜盤的角度改變，從而達到流量的調節

Page • 11

Four types of drive technologies

變量泵
-在轉速不變的情況下，通過改變**液壓泵排量**
-同時**電機負載**也會隨着排量而改變
-達到**省電**的目的

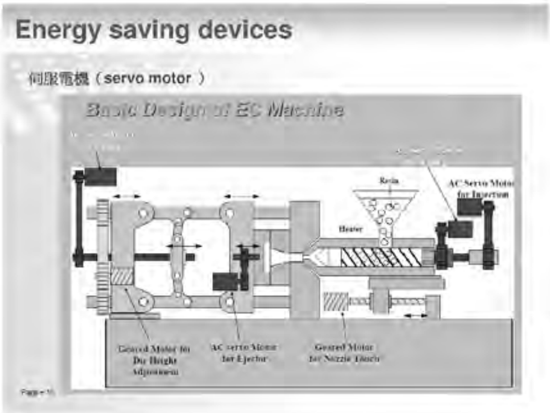
變量泵與標準定量泵的主要區別
-輸出功率不同
-變量泵的輸出**功率**是**隨負載**的變化而變化
-定量泵的輸出**功率**相對**恒定**
-在小流量動作情況下，變量泵輸出功率很低，定量泵的輸出功率基本恒定

Page • 12

塑膠機械能源效率


Four types of drive technologies
伺服電機
- 是為加速減速優化的
- 伺服電機從0 rpm達到2000 rpm
- 用變速來驅動油泵
- 可使控制速度，位置，精度非常準確
主要特點
- 轉速隨著轉矩的增加而勻速下降
伺服電機驅動油泵比傳統定量泵節能60%
-比變量泵節能40%
Page • 13


Four types of drive technologies
全電機
- 省電效果最佳
- 全電機的驅動也是用伺服電機
- 只不過最少用四個伺服電機來直接驅動注射，塑化，開合模及頂出動作
直接驅動
-採用螺絲或曲臂將旋轉的動能變為線性的動能
-或採用皮帶或齒輪將高速的旋轉動能變為低速的旋轉動能
與全電機比較，直接驅動節省了兩個轉換過程 (估計可節約10%的能量)
Page • 14


Energy saving devices
伺服電機（servo motor）
Basic Design of EC Machine
Resin
AC Servo Motor for Injection
Heater
Geared Motor for Die Height Adjustment
AC Servo Motor for Ejector
Geared Motor for Nozzle Touch
Page • 15


EUROMAP 60
EUROMAP 60
測試的目標：作出注塑機能耗比較
EUROMAP
注塑機的範圍
- 只限於熱熔塑膠
- 單一注射單元的（不是多物料）
- 往復螺杆的（不是含預塑器）
- 不包括模具的水冷及壓縮空氣的能耗
- 輔助設備的能耗不計在內
Page • 16


塑膠
EUROMAP 60
-新的PP料
EUROMAP
-沒有乾燥過
-沒有預熱
-熔融指數（Melt Flow Rate）MFR = 20～25 g/10min（230 ℃/2.16 kg）
-環境溫度在30 ℃以下
Page • 17


模具
EUROMAP 60
EUROMAP 60指定用EUROMAP 7的測量塊，
EUROMAP
EUROMAP 7
-測定最大鎖模力的一個標準
-指定了空心圓柱型及四柱方型的兩種測試塊
-按注塑機的四柱空間定出14x2種測試塊
Page • 18

塑膠機械能源效率

電耗

EUROMAP 60

電耗要含以下的動作
- 合模/開模
- 料筒加熱（含小咀及大咀）
- 塑化
- 注射
- 不含台載的頂出/頂退
- 電及/或油壓的噴咀驅動器要打開
- 電腦
- 內置的保養設備，如風扇、潤滑油泵、壓力油冷卻器

不含以下的能耗
- 輔助設備的能耗
- 如接在注塑機電插座的輸送帶、熱流道、色母混合機等
- 如裝在注塑機電腦上的機械手
- 外邊的液體供應，如冷卻水、壓縮空氣及壓力油

Page • 19

週期

EUROMAP 60

- 沒有指定模具/製品，
- 將製品分為三類，以**壁厚**及**精准度**區分

指定了三種週期，稱為

1、週期 I ，薄壁製品

2、週期 II ，技術製品 (對尺寸要求精准的製品)

3、週期 III ，商品 (沒有精准要求, 如碗碟等日用品) 或厚壁製品

每種週期對鎖模及注射參數都有所規定 (見表1)

Page • 20

[illegible]		週期 I 薄壁製品	週期 II 技術製品	週期 III 商品 / 厚壁製品	公差
[illegible]	[illegible]	最大	最大	最大	
	壁厚[mm]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	設定值的100 %	設定值的100 %	設定值的100 %	
	[illegible]	設定值的100 %	設定值的100 %	設定值的100 %	
	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	≥1000	≥750	≥500	
	[illegible]	—	<最大值的50 %	<最大值的50 %	
	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	—	—	
	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	0.5	5	10	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	50	50	50	[illegible]

1) S = 150 + 850* [illegible] 150 mm ≤S≤1000 mm
2) [illegible]
3) d = [illegible] mm
4) [illegible]
5) [illegible]

Page • 21

測量

EUROMAP 60
- 測量能耗時只能用**全自動模式**
- 在注塑機已達**穩定狀態**後進行
  - 料筒測溫點在30分鐘內變化在±3 ℃以內
  - 對油壓注塑機而言，壓力油要達到穩定溫度（在規格之內）
- 測量要含連續注射的全部次數
- 並不短於10分鐘及最少5次注射
- 螺杆≥80 mm時，3次注射便可
- 測出值: 每千克能耗kWh/kg、平均功率（kW）、週期時間

Page • 22

中國行業標準

中國行業標準

測試的目標: **評定能耗等級（共6級）**及作出**節能評價**

注塑機範圍
- 注射容積大於16 cm³ 的單螺杆
- 水平位熱塑性注塑機

含輔助設備的電耗

輔助設備 種類繁多
- 吸料機、水塔、模溫機、空壓機、機械手、輸送帶、熱流道等
- 應允自使用類似注塑機的能耗標準來測量
- 不宜將其能耗算在注塑機能耗內，影響注塑機能耗比較

Page • 23

塑膠

中國行業標準
- PS粒料
- 沒有乾燥過
- 沒有預熱
- 密度1.05 g/cm2
- 熔融指數MFR（Melt Flow Rate）MFR = 4.5 ~ 5.5 cm3 /10min
- 料溫250±10 ℃
- 熔融指數按ISO 1133-2005來測試
- 環境溫度15 ~ 35 ℃
  當注射容積 > 3888 cm3 或特殊情況下，則用沒有乾燥沒有預熱的PP粒料

- PS is brittle
- The circular plates moulded **cannot free fall** without breaking
  Either **semi-automatic** operation or **robot arm removal** has to be used.
- Both would **complicate** the purpose of measuring energy consumption.
  Semi-automatic operation introduces **variation in cycle time**.

Page • 24

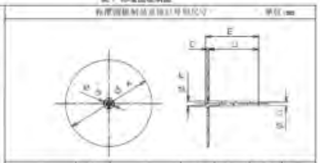
塑膠機械能源效率

模具

中國行業標準

Specified **5 moulds** named #1 to #5 moulds to cover the range of Injection moulding machines from **16 to 3888 cc shot volume**.

表1 标准圆板制品



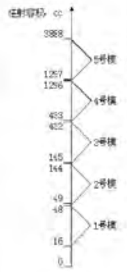
理论注射容积 cm^3	A		B	C		D	E	F	G
16~48	118.00	±0.57	14	1.00	±0.30	60	71	6.5	3
49~144	172.30	±0.80	14	1.37	±0.26	80	71	6.5	3
145~432	211.00	±0.98	16	2.70	±0.26	75	80	8	3.5
433~1296	348.00	±1.40	20	4.02	±0.22	89	102	8	4.5
1297~3888	473.00	±1.98	20	5.77	±0.22	115	122	8	5.5

Page • 25

模具

中國行業標準

- 注塑機大小分五等，以注射容積界分
- 每等的高限是低限的 **3** 倍
- 幾何等級
- 每等配一個標準模具
- 模具是冷流道的
- 產品是圓盤，冷料柄



Page • 26

注塑製品

中國行業標準

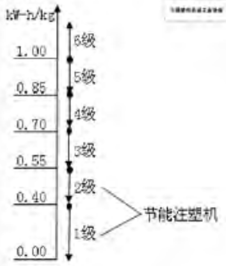
- 對製品要求
- 無變形
- 壁厚均勻
- 表面無氣泡

Page • 27

指標與節能等級

中國行業標準

- 指標為注塑每千克 (kg) PS 料的耗電量kW-h
- 注塑50次
- 耗電分6級
- 1級、2級為節能注塑機
- 數學等級
  每 0.15kW-h/kg 一級



Page • 28

指標與節能等級

中國行業標準

Class quantization

-There is **no class below class 1**

e.g.

Servomotor/pump machines using #3 mould could attain class 1,

If the more energy saving **fully electric machine** is also class 1,

it could not be distinguished from a servomotor/pump machine.

中間的3號模具涵蓋145 - 432 cc注射容積 (對應75噸 - 180噸鎖模力)

e.g.

- 1級是伺服電機驅動
- 2級是變量泵驅動
- 由於理論上全電機比伺服電機驅動油泵的更節能，全電機也能達1級
- 如何將全機分辨出來

Page • 29

指標與節能等級

中國行業標準

小型注塑機採用最小的一號模具時

- 配變量泵的小型注塑機並不能達2級
- 而配伺服電機驅動油泵的小型注塑機亦不能達1級

主要原因

- 螺杆直徑小，塑化1千克的PS料的時間長，使使能耗指標增加
- 要注塑1千克的PS料，開合模次數亦多，能耗也增加

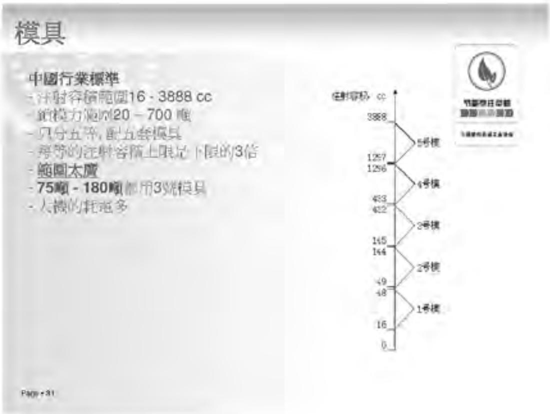
大型注塑機採用最大的五號模具時

- 變量泵機亦能輕易達到1級

主要原因

- 由於"量產"提高效率，不到兩次注塑便達1千克的注射量了，自然就更節能（以每千克能耗來算）

Page • 30


模具
中國行業標準
- 注射容積範圍16 - 3888 cc
- 鎖模力範圍20 – 700 噸
- 只分五等, 配五套模具
- 每等的注射容積上限是下限的3倍
- 範圍太廣
- 75噸 - 180噸都用3號模具
- 大機的耗電多
注射容积 cc
3888
1257
1256
433
432
145
144
49
48
16
0
5号模
4号模
3号模
2号模
1号模
Page • 31


EUROMAP 60 v.s.中國行業標準
EUROMAP 60
- 沒有指定週期時間（但要表示出來）
- 但有指明測試的最短時間（10分鐘）及/或最少週期次數（3次或5次）
- 指定了全自動操作
EUROMAP
中國行業標準
- 沒有指定週期時間
- 指定了週期次數為50次
- 就使在大機用大模具（如5號模具）測試時耗料很多，而小機用小模具（如1號模具）的產量解析度不太足夠
- 沒有指定操作模式，但由於大的PS圓碗重量不小，只能用半自動操作，人手取出才不會破裂。這樣便影響了週期時間，亦影響了能耗。
手動取件時間的不一致性便影響了指數的可比性


EUROMAP 60 v.s.中國行業標準
EUROMAP 60
- 注射是模擬出來的，故指定的參數較多
EUROMAP
- 沒指定參數便影響了可比性
中國行業標準
- 指定了5種模具/製品
- 全部參數都沒有指定
- 能成型便可用比較
EUROMAP 60 /中國行業標準
輔助設備 種類繁多
- 吸料機、水塔、模溫機、空壓機、機械手、輸送帶、熱流道等
- 兩個標準都沒有個別測量輔助設備的能耗
Page • 33


Thank you!

快速模溫控制/無痕注塑技術 (Rapid Heat & Cool)

由生產力促進局顧問高耀祖先生主講

快速模温控制/無痕注塑技術
(Rapid Heat & Cool)

快速模具加熱冷卻技術

香港生產力促進局
製造科技部

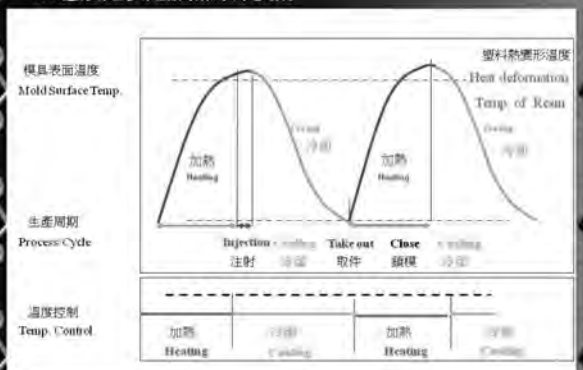
1. 基本原理

1.1 甚麼是快速加熱冷卻技術

- 能夠快速把模具表面加熱至溫度高於塑料的熱變型溫度10℃
- 由於模具溫度處於高溫狀態，就能夠保持塑料的流動性
  - 與傳統注塑比較，塑料能夠於比較高的速度及低的壓力下充填模腔
- 能夠生產出擁有無熔合線及高光潔度表面的產品
- 能夠快速冷卻模具，令冷卻周期時間縮短
  - 即使產品厚度十分厚也適用

1. 基本原理

1.1甚麼是快速加熱冷卻技術



1. 基本原理

1.1甚麼是快速加熱冷卻技術

傳統注塑	快速加熱冷卻技術
模溫 = 低於 90℃	模溫 = 100-140℃

1. 基本原理

1.2 其他優點

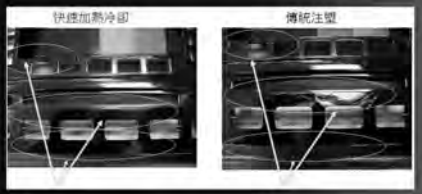
- 減少變形
  - 高的模具溫度 > 低的注射壓力 > 減低內應力

- 能有效轉移模具表面蝕紋的紋理
  - 比較好的充填條件 > 容易將模具表面的蝕紋有效地轉移至塑膠成品表面

1. 基本原理

1.2 其他優點

- 免除噴油工序
  - 優良的表面光潔度 > 不用再採用噴油工序以遮蓋熔合線等注塑缺陷
- 減少流動紋
  - 高的模具溫度 >比較好的充填條件



快速模温控制/無痕注塑技術
(Rapid Heat & Cool)

1. 基本原理

1.3 應用範圍

良好的表面光潔度
- 汽車外觀件

低內應力
- 光學鏡片
- 導光板

低變形
- 支架
- 連接器

無熔合線
- 電視面板
- 手提電腦
- 手提電話

薄壁注塑
- 電視箱
- 手提電腦
- 手提電話

提升強度-無熔合線
- 產品外殼
- 結構件

無壓制紋及流動紋
- 產品外殼
- 面板

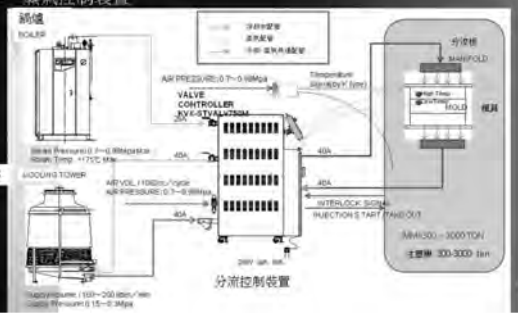
不用噴油
- 電視面板
- 影音產品面板

7

2. 生產技巧

2.1 蒸汽

硬件要求
- 鍋爐 (電/油)
- 蒸氣控制裝置

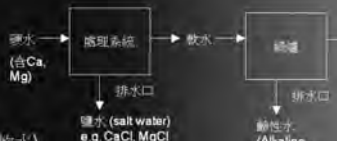


8

2. 生產技巧

2.1 蒸汽

其餘周邊要求
- 鍋爐操作人員
- 鍋爐安裝位置
- 水質處理 (硬水轉 軟水)
- 鹼水中和處理系統 (鍋爐排水)
- 培訓安全操作概念
- 良好的喉管連接避免洩漏

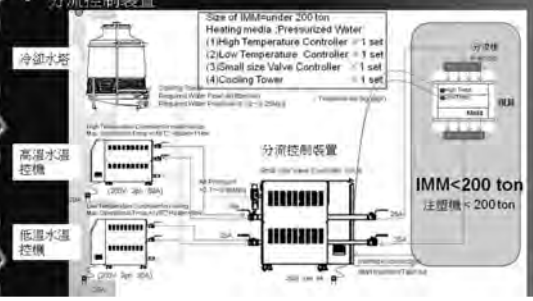


9

2. 生產技巧

2.2 加壓熱水

硬件要求
- 高溫水溫控機 – 加熱模具
- 低溫水溫控機 – 冷卻模具
- 分流控制裝置



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2. 生產技巧

2.1 加壓熱水

其餘周邊要求
- 良好的水質
- 水塔擁有優良的冷卻效能
- 良好的水道佈置
- 充足的水流量

11

2. 生產技巧

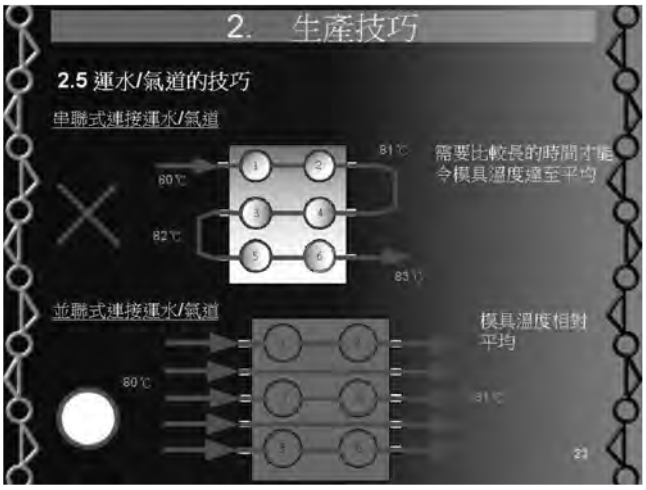
2.3 蒸氣與加壓高溫水的比較

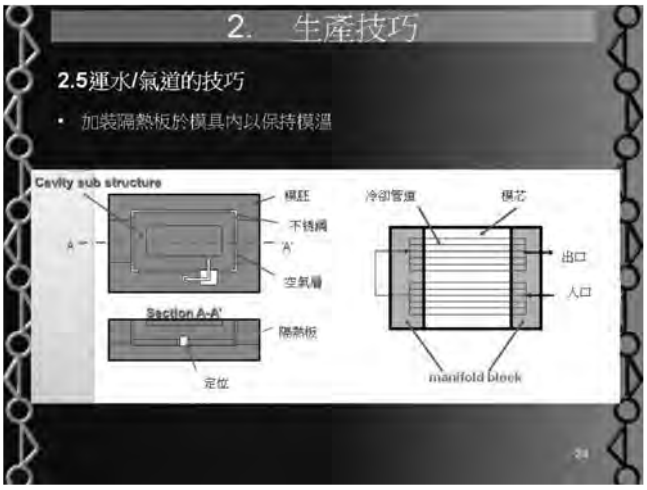
	蒸汽	加壓高溫水
設備	鍋爐	溫控機
最高溫度	170℃	150-160℃
最大流量	200-1500kg/h	20-100 l/min
熱含量	107,800-808,500 kcal/hr	5,160-68,800 kcal/hr
最大壓力	0.8-0.98MPa	0.7-0.8MPa
能量來源	電 / 油 / 氣體	電
管道直徑	3-5mm	8-10mm
模具加熱時間	10-15s (室溫至140℃) 模具420x550x600mm	50-60s

12

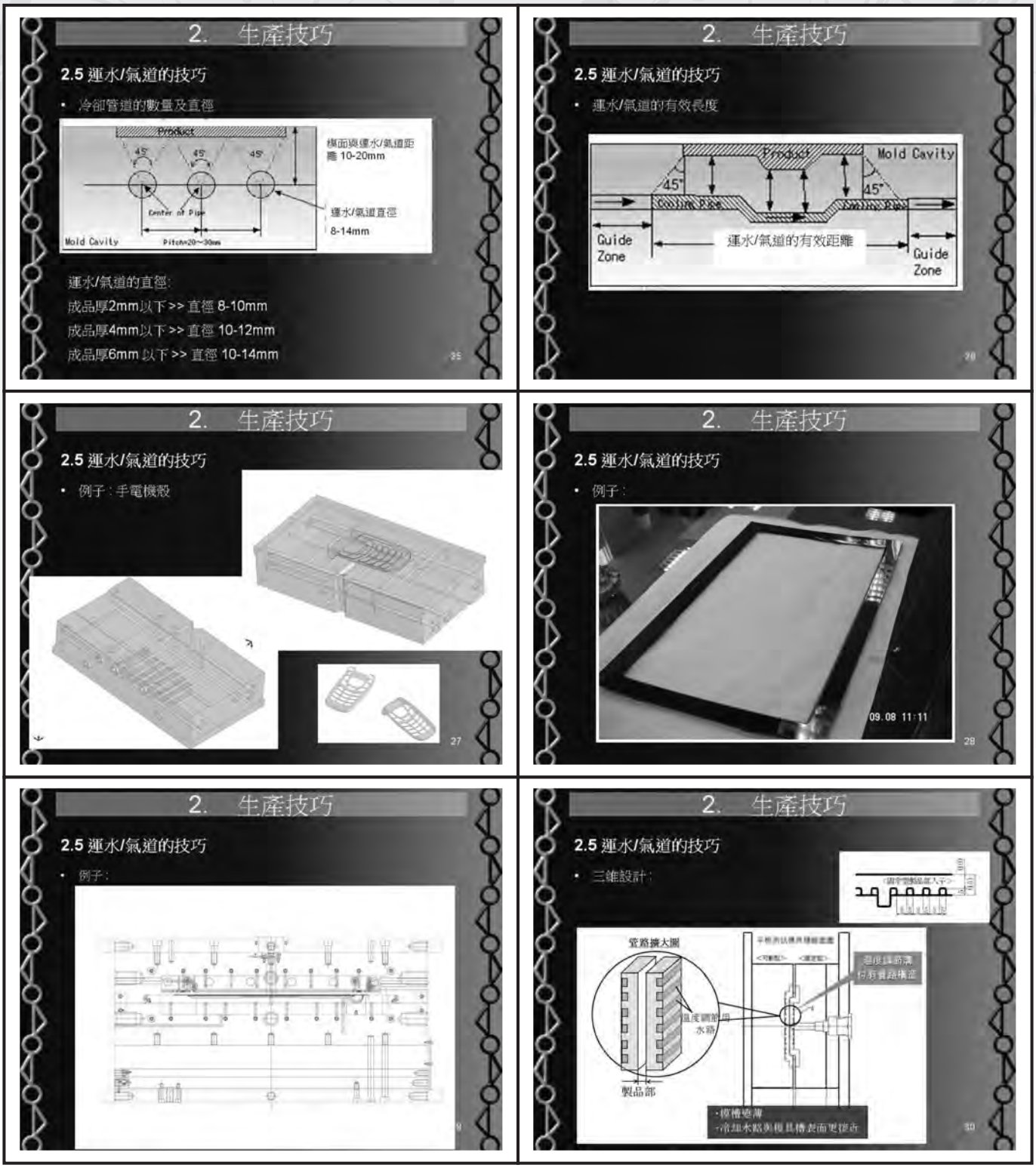
快速模温控制/無痕注塑技術
(Rapid Heat & Cool)

快速模温控制/無痕注塑技術
(Rapid Heat & Cool)





快速模温控制/無痕注塑技術
(Rapid Heat & Cool)



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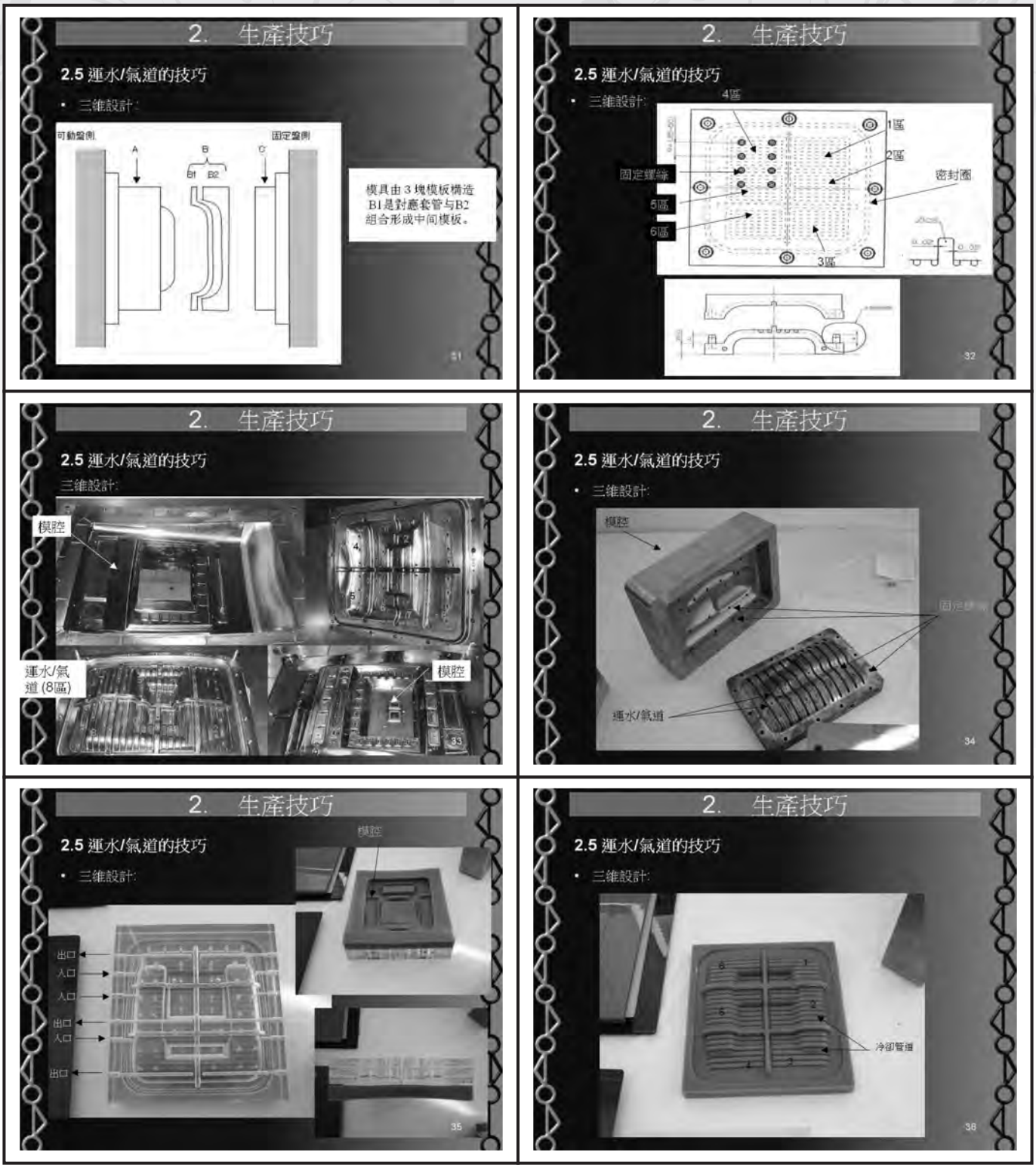

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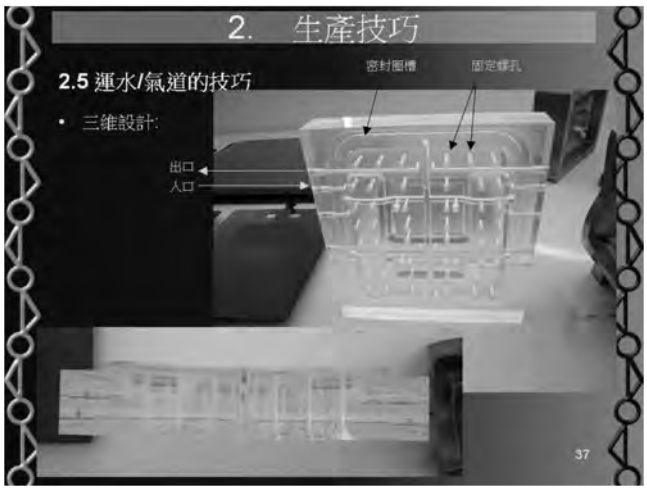
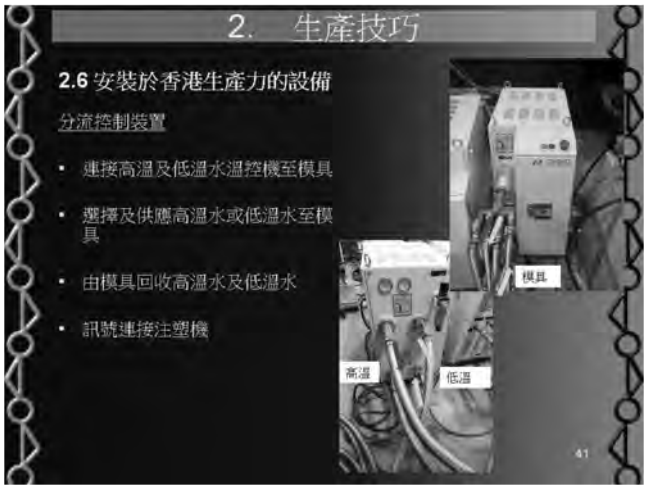
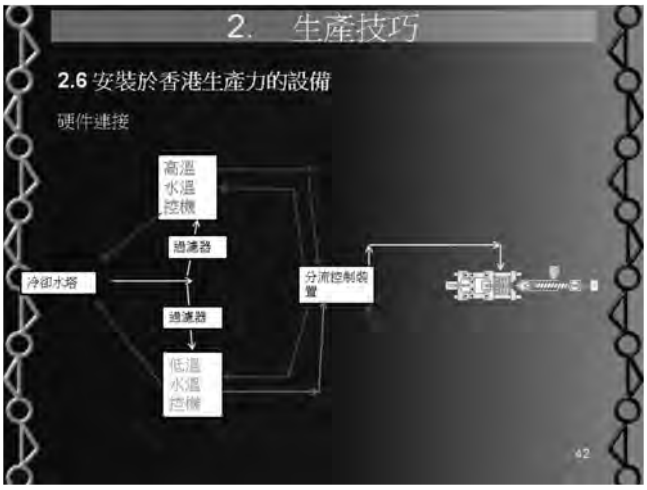
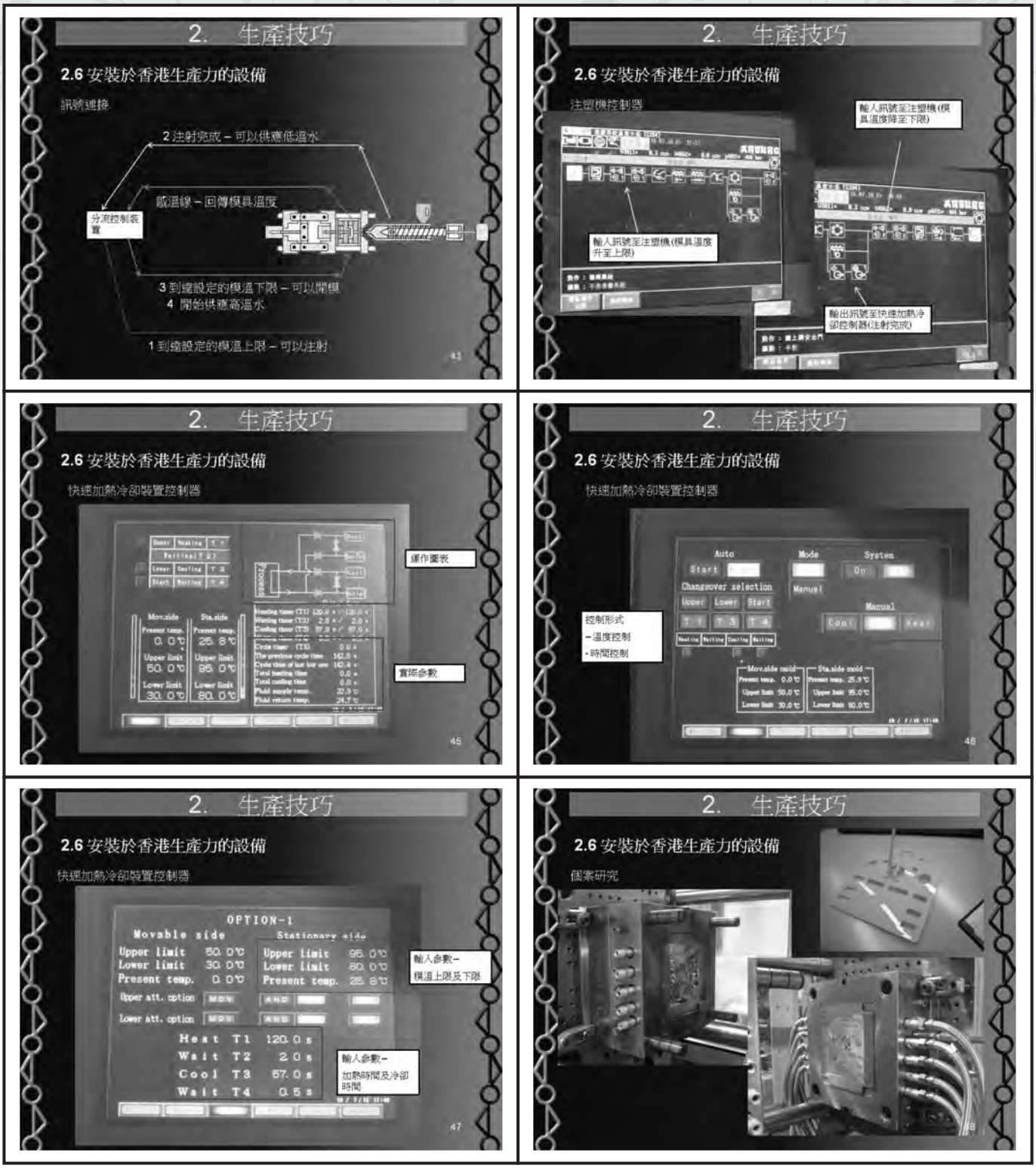


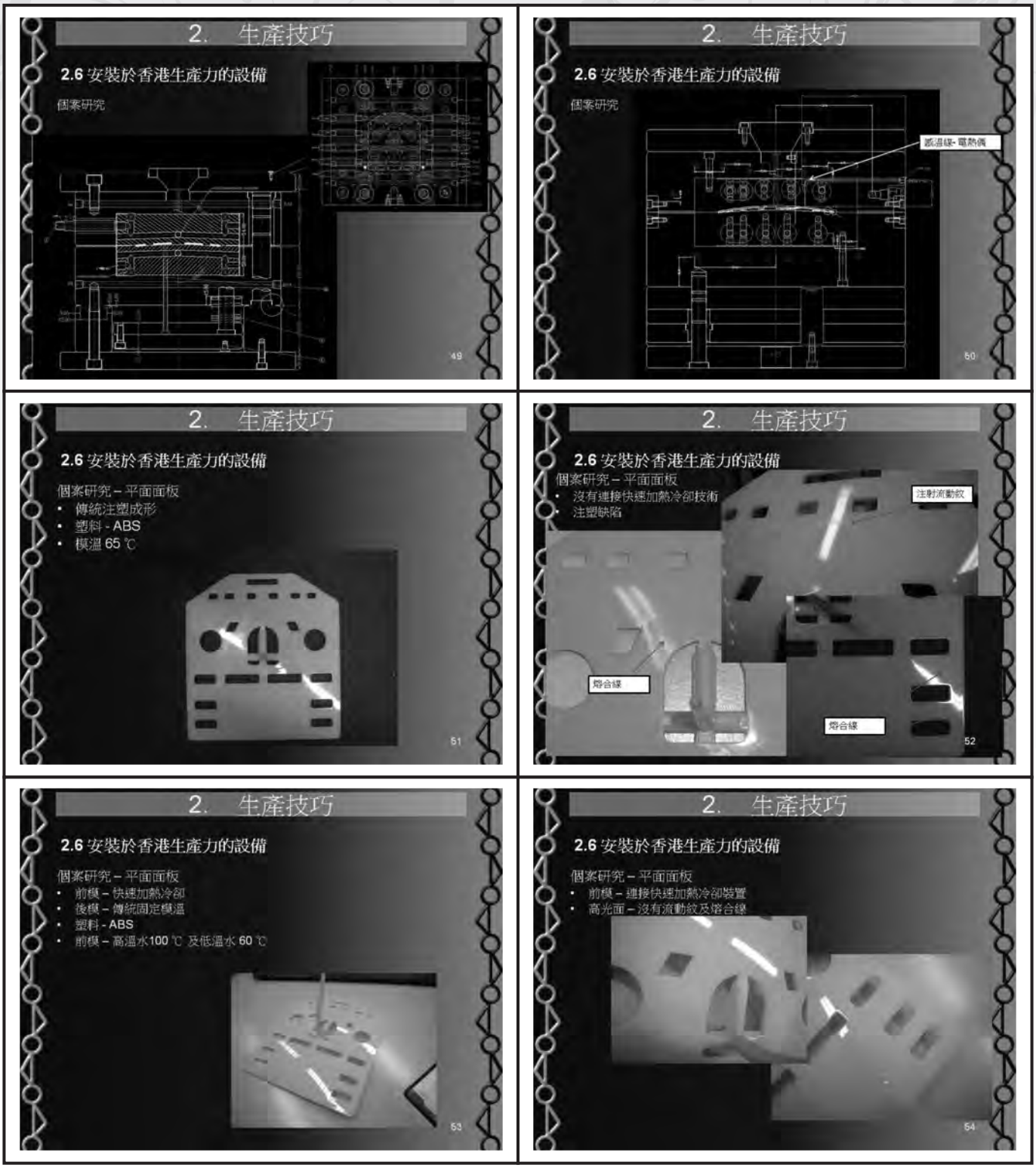




快速模温控制/無痕注塑技術
(Rapid Heat & Cool)



快速模温控制/無痕注塑技術
(Rapid Heat & Cool)



快速模温控制/無痕注塑技術
(Rapid Heat & Cool)

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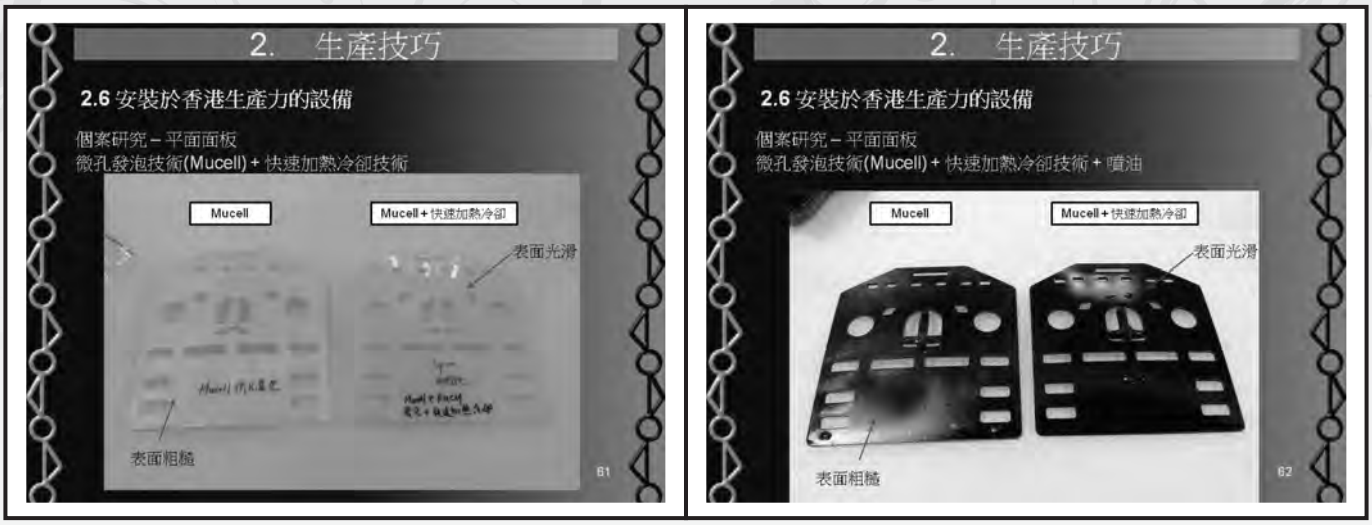
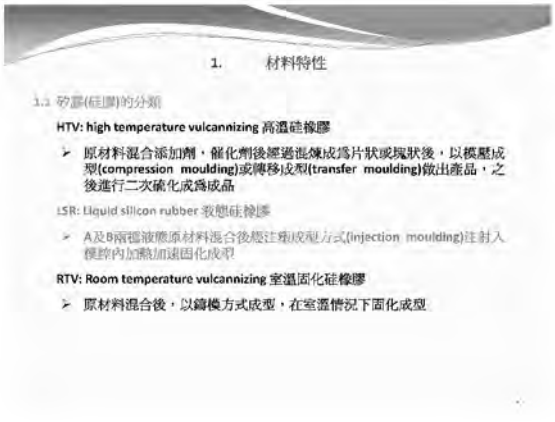
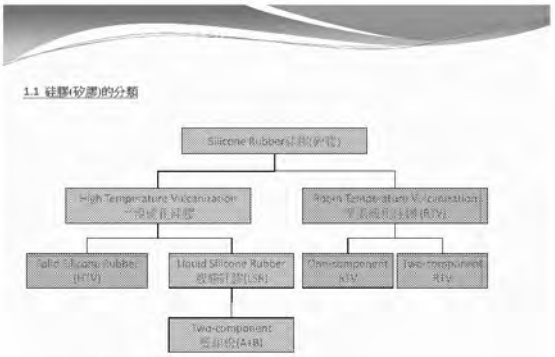


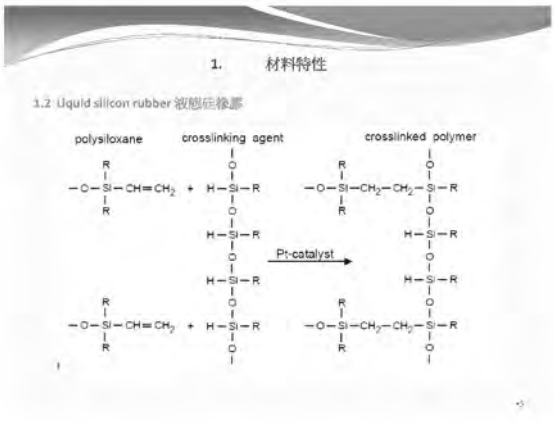
液態矽膠 (LSR) 注塑成型及覆蓋注塑成型

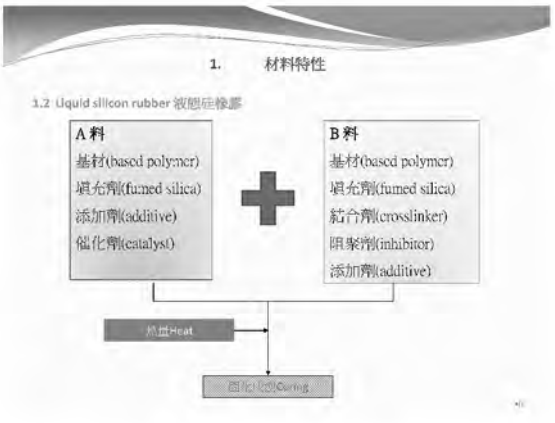
由生產力促進局顧問高耀祖先生主講

液態矽膠 (LSR) 注塑成型及覆蓋注塑成型









液態矽膠 (LSR) 注塑成型及覆蓋注塑成型

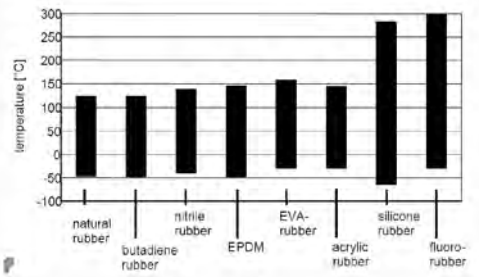
1. 材料特性

1.3 矽膠(硅膠)的特性

- 良好的橡膠特性 (延伸度可達至600%)
- 寬闊的工作溫度 (-50℃至280℃)
- 耐高溫與及於低溫時保持良好的彈性
- 良好的耐化學性
- 生物兼容，無氣味
- 抗UV，抗老化

1. 材料特性

1.3 不同橡膠的工作溫度



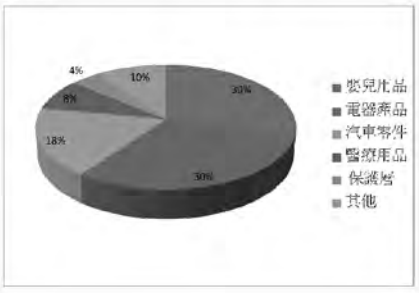
1. 材料特性

1.3 矽膠(硅膠)與其他彈性物料的比較

LSR與TPE的比較	LSR與橡膠的比較
✓ 良好的緩衝特性	✓ 不需要混煉
✓ 低溫時保持良好的彈性	✓ 相對地比較短的生產周期時間
✓ 耐高溫	✓ 良好的送料系統

2. 應用範圍

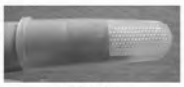
2.1 應用範圍



2. 應用範圍

2.2 嬰兒用品


奶瓶


嬰兒牙刷

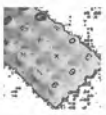

學習

2. 應用範圍

2.3 電器產品

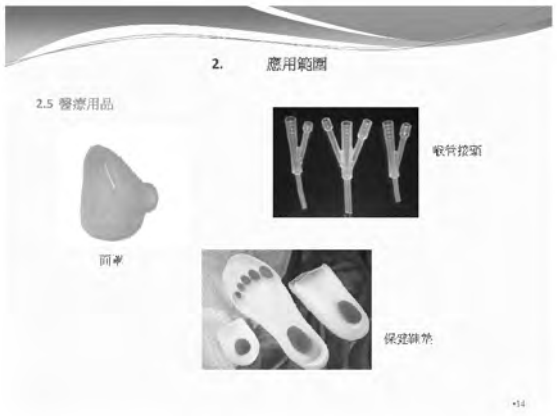

鍵盤

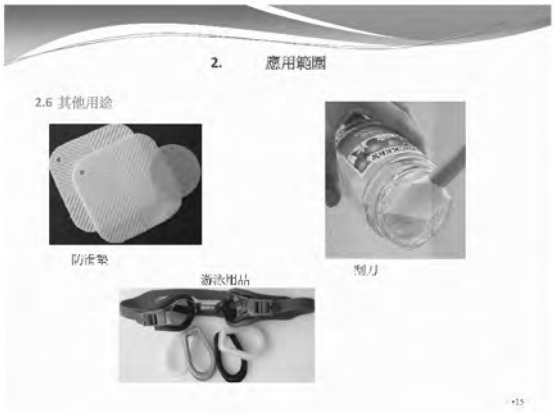

熱水器接頭

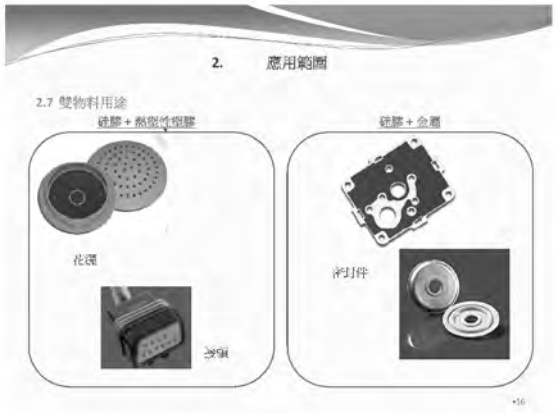

按鍵

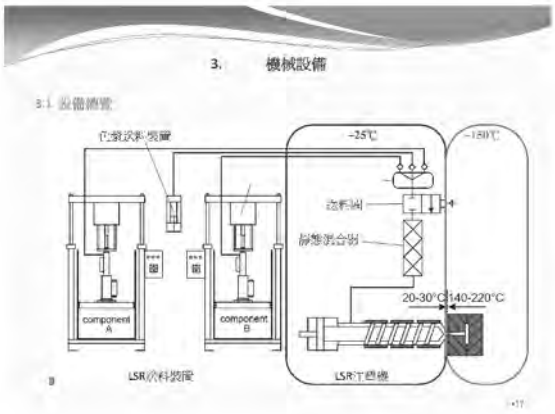

高溫油封

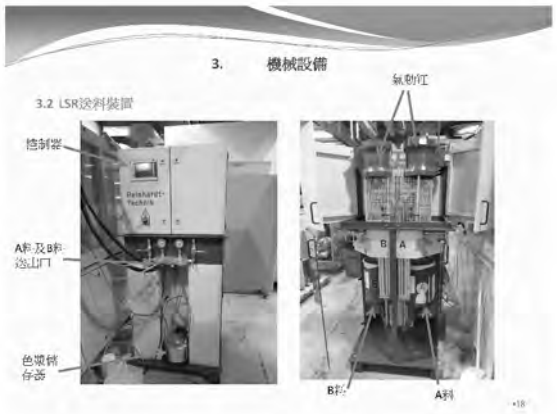
液態矽膠 (LSR) 注塑成型及覆蓋注塑成型



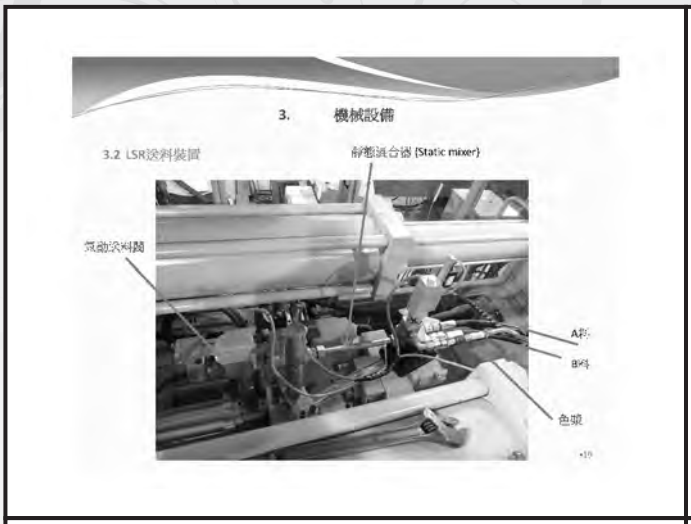


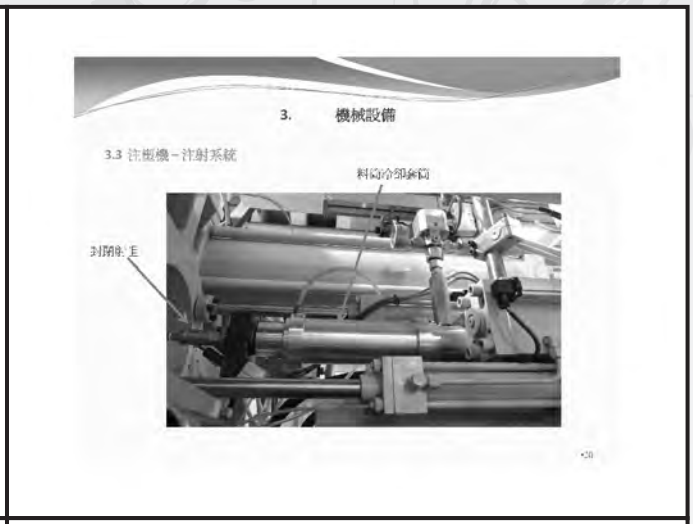


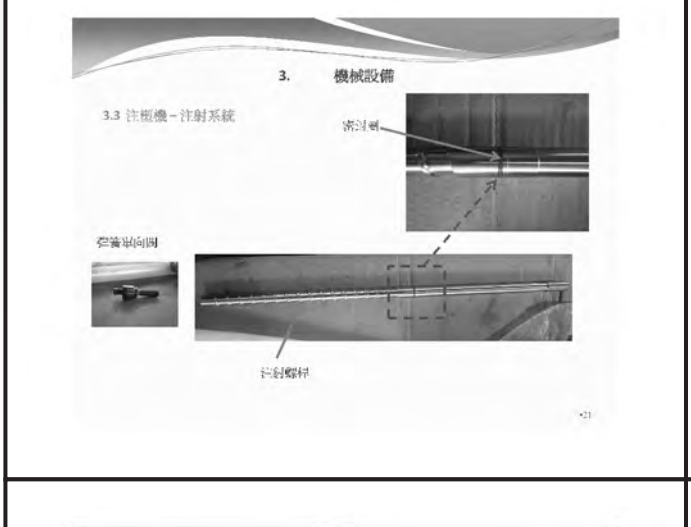


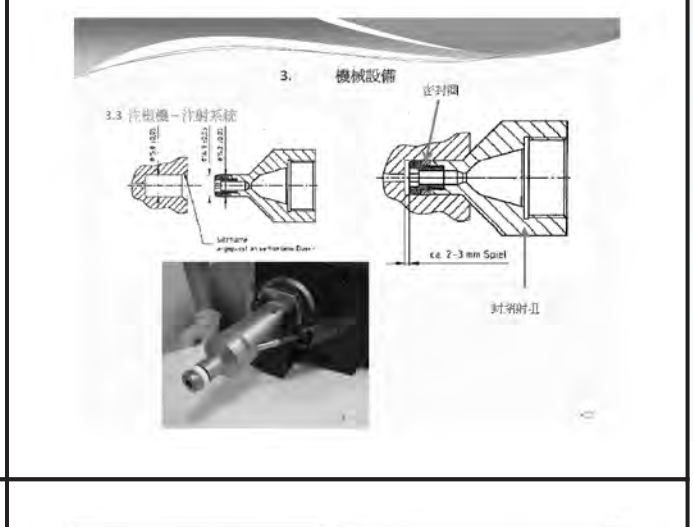


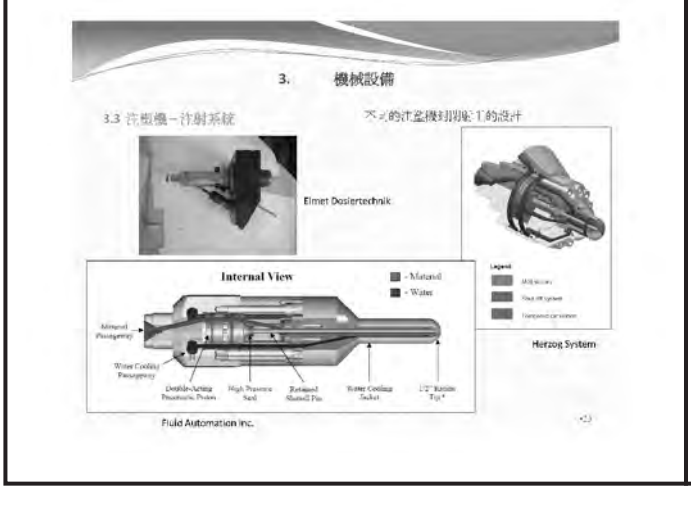
液態矽膠 (LSR) 注塑成型及覆蓋注塑成型



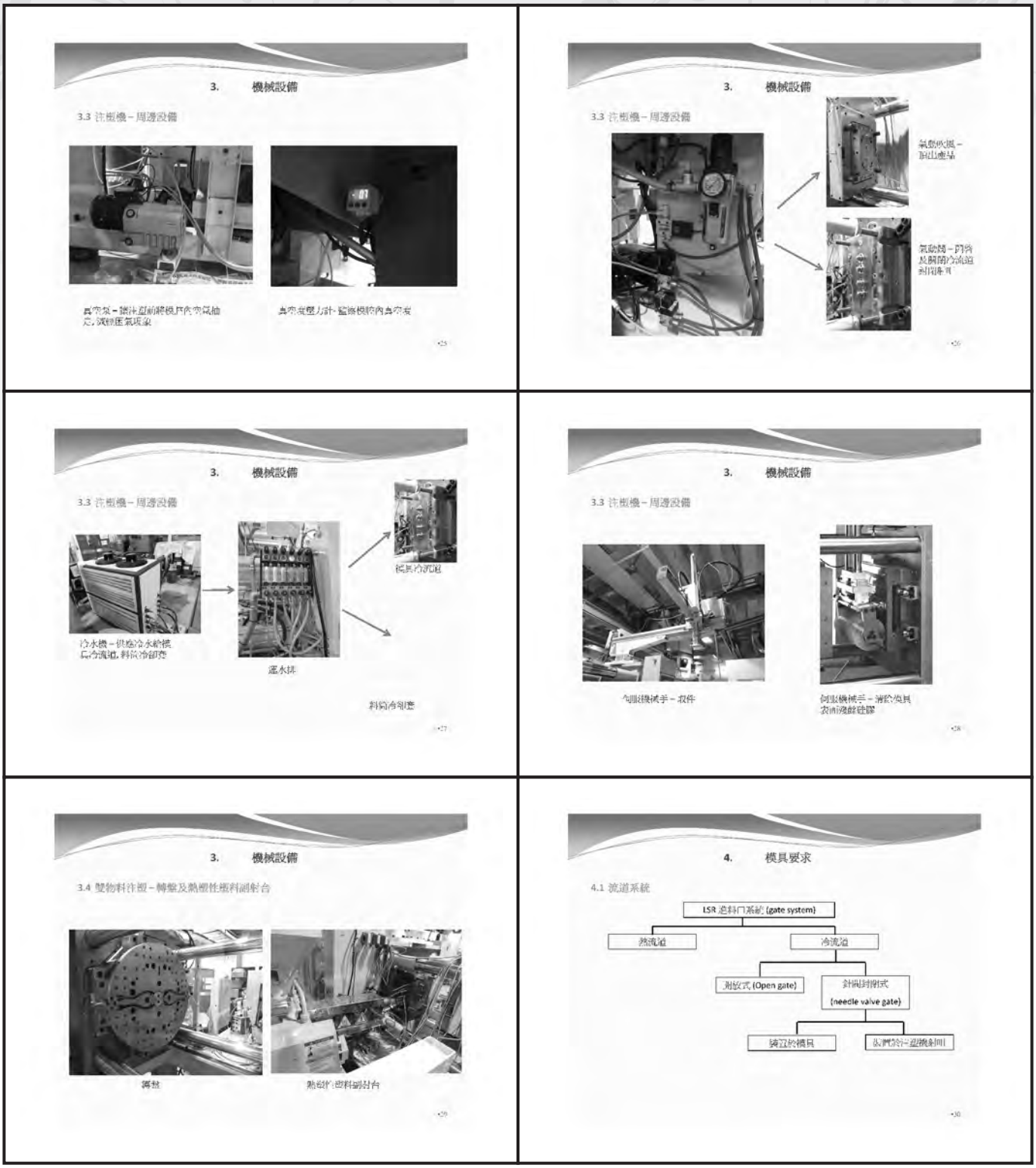








液態矽膠 (LSR) 注塑成型及覆蓋注塑成型



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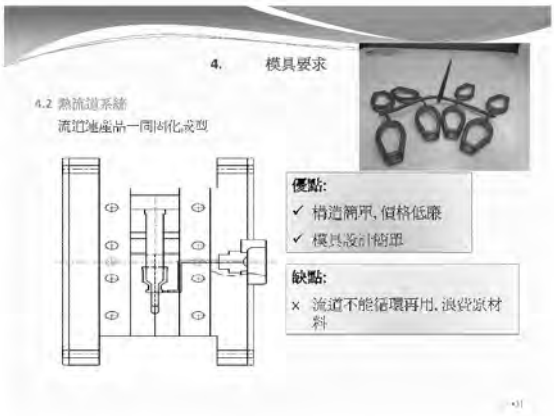

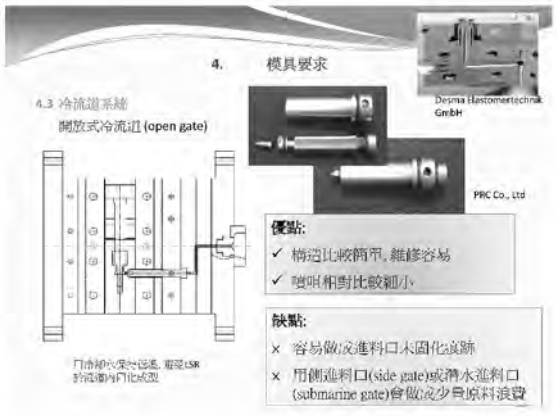

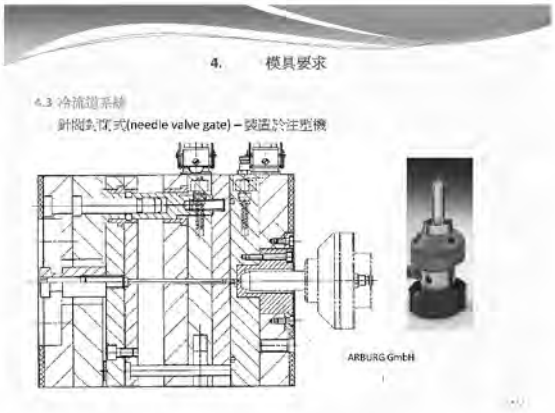

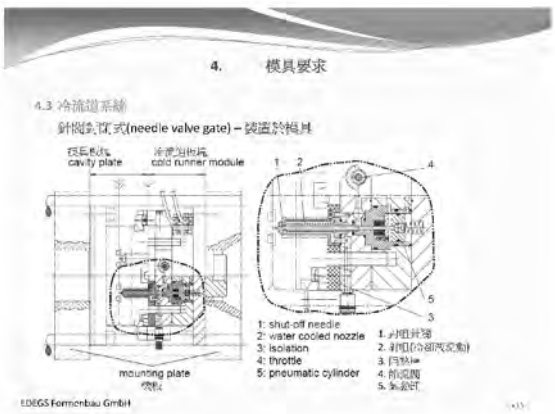

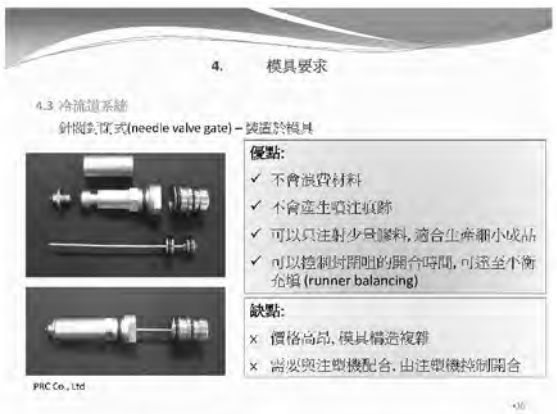

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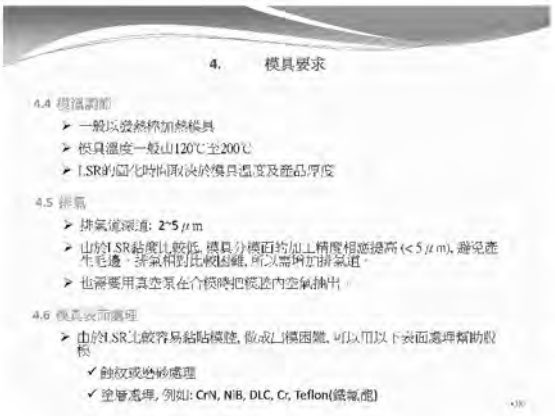

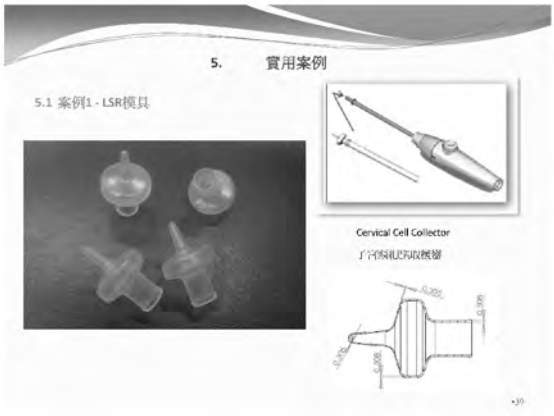

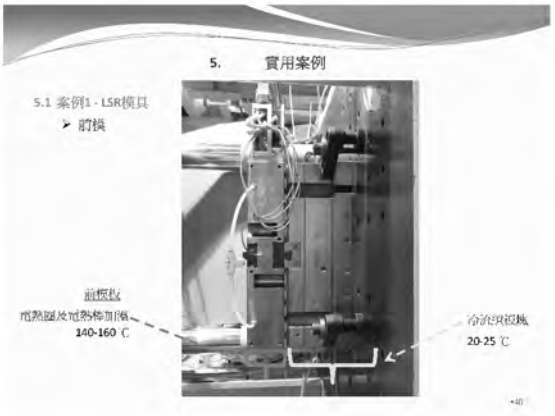

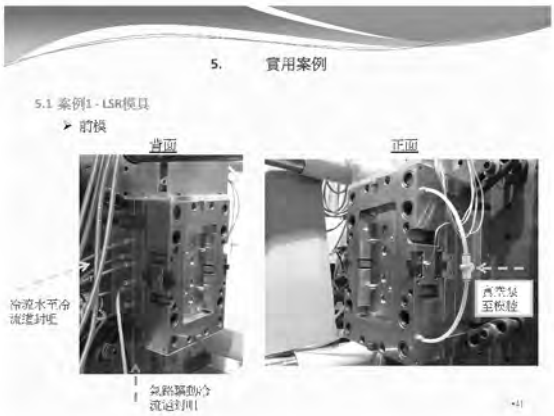

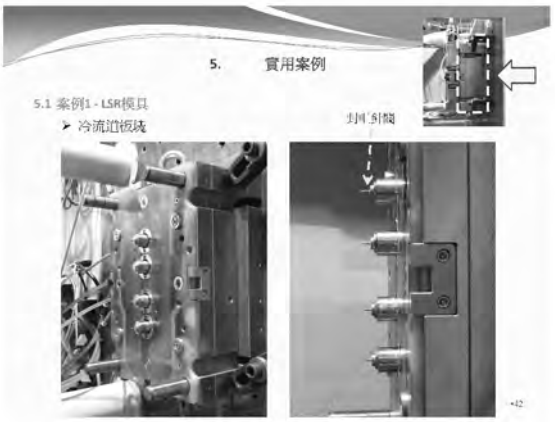

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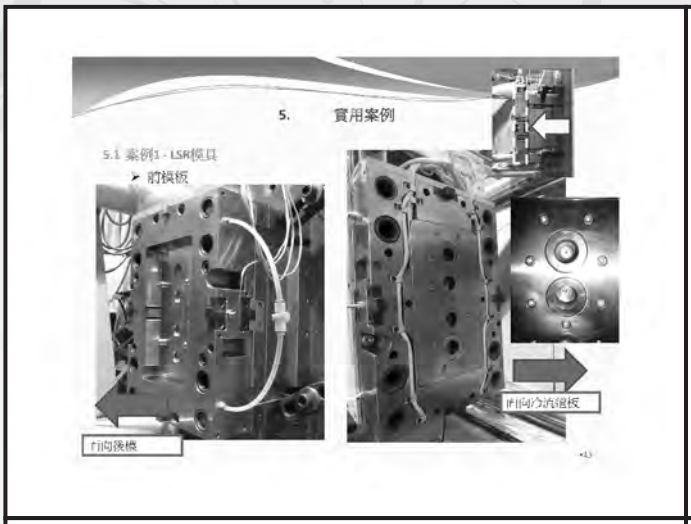

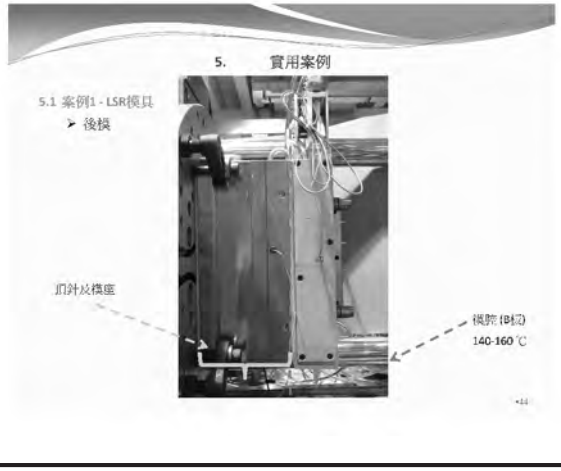

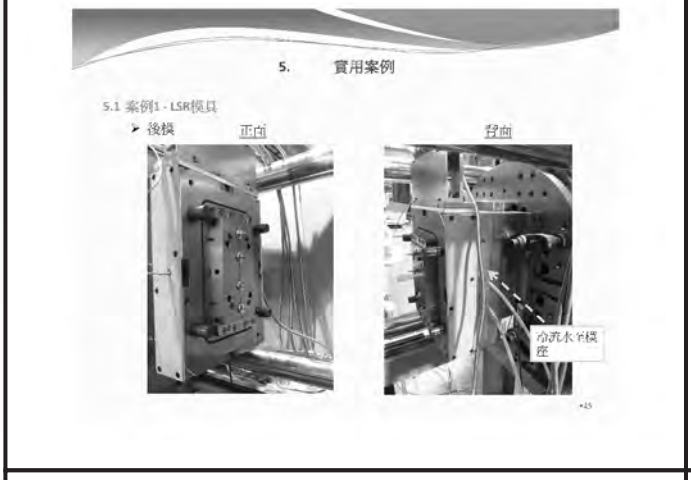

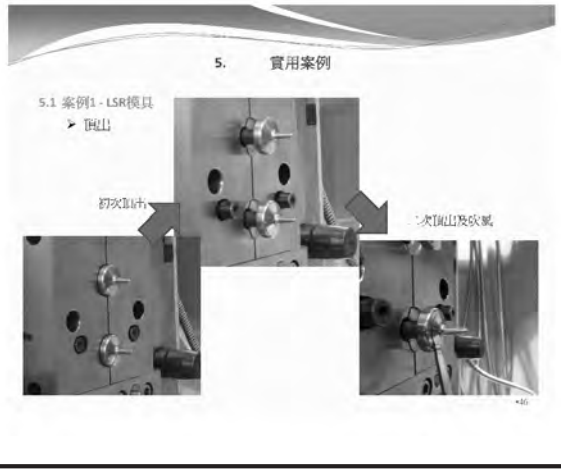

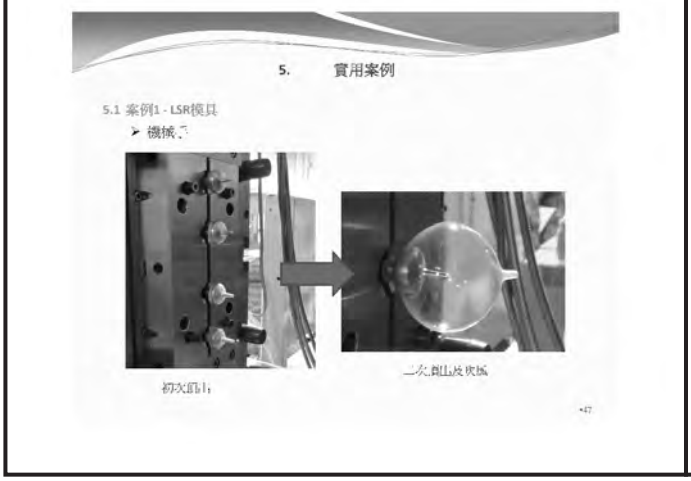

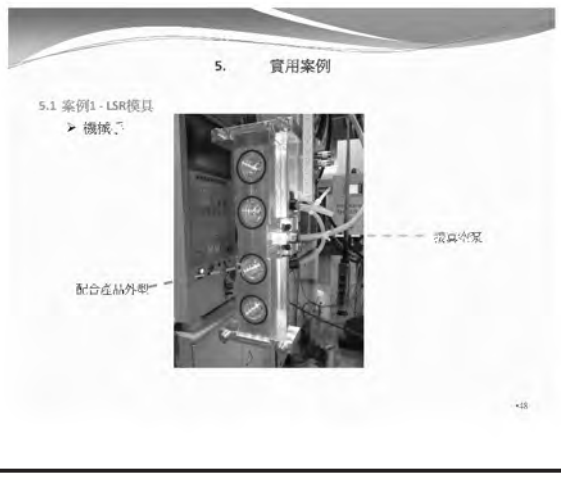

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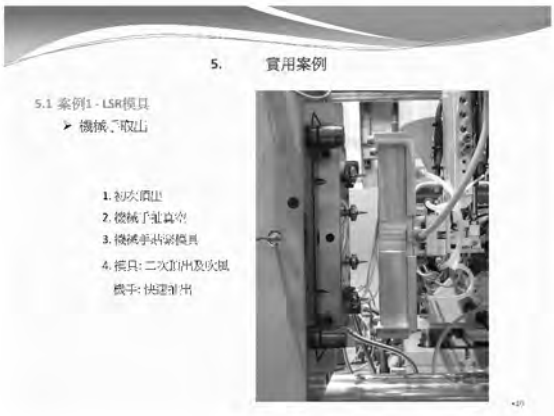

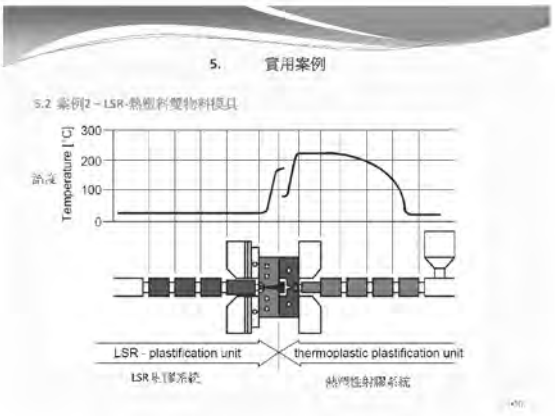

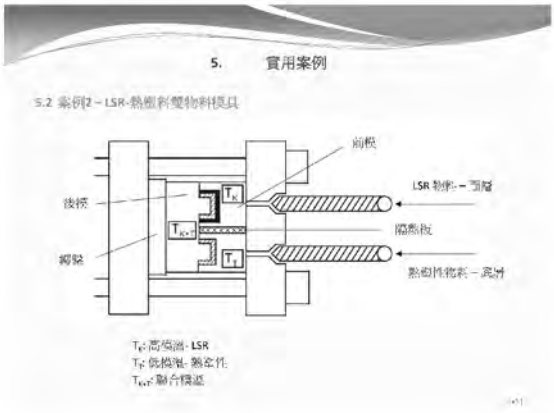

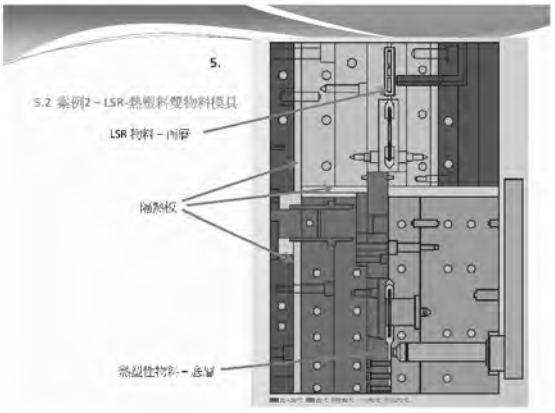

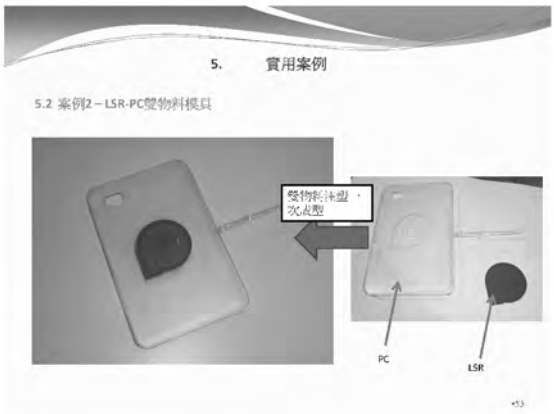

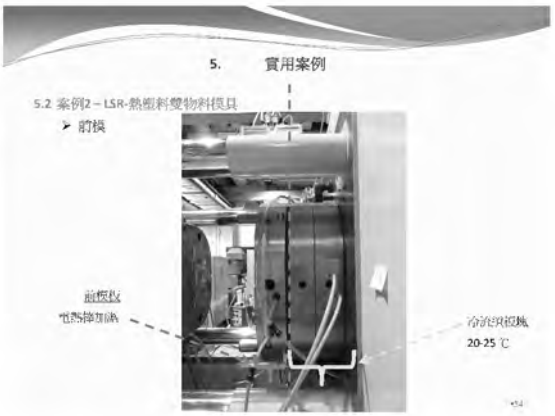

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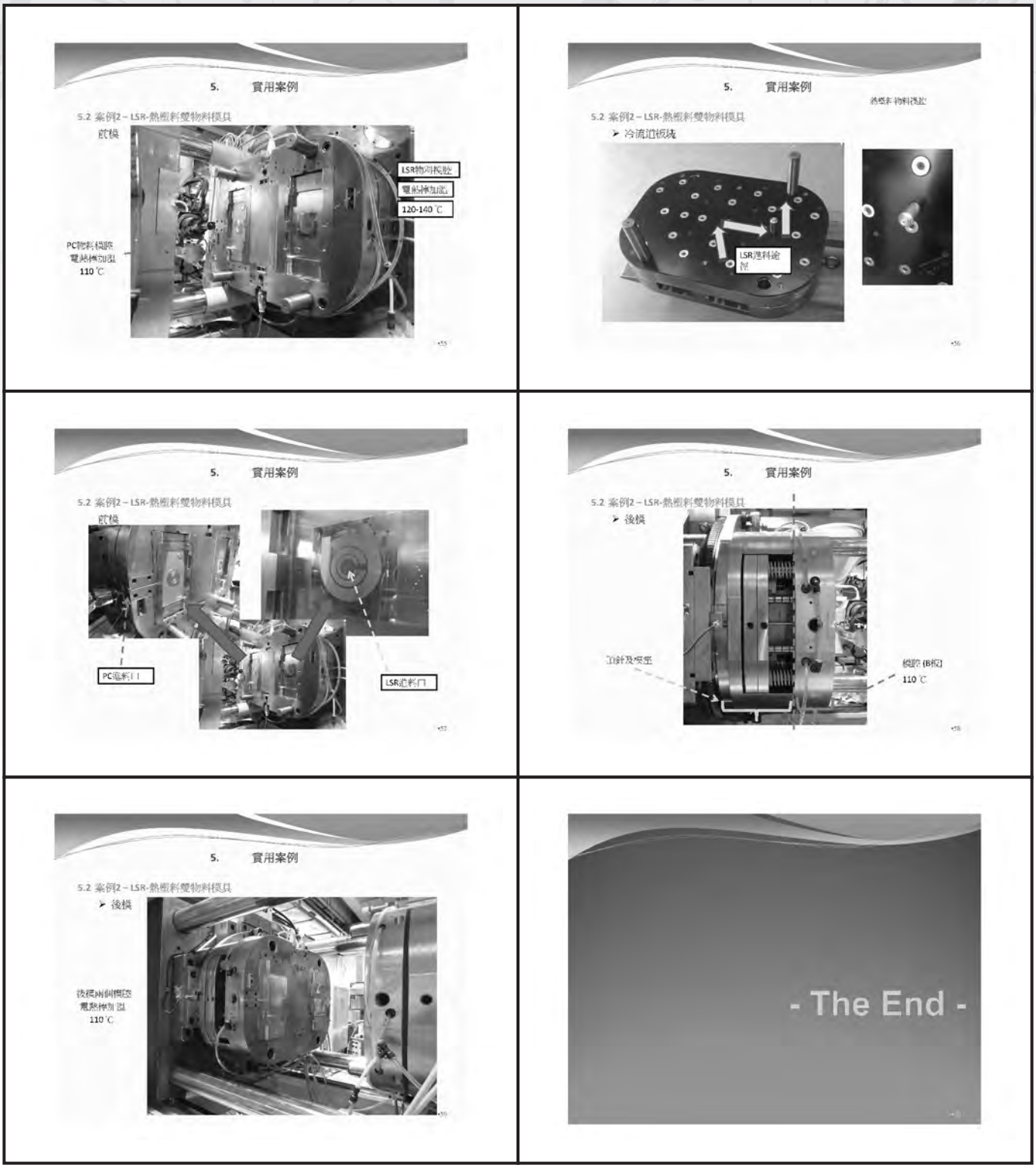

工作坊 4

「環保生產與工廠管理系統」工作坊

Raising Standards , Global Environmental and Energy Systems

Presented by Ms. Mel Blackmore, Managing Director of Blackmores

Raising Standards , Global Environmental and Energy Systems

Presented by Ms. Mel Blackmore, Managing Director of Blackmores

Raising Standards , Global Environmental and Energy Systems

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Raising Standards
Global Environmental and Energy Systems

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Agenda

- Why Environmental standards have been created
- The growth of EMS certification
- The Global EMS Landscape
- Energy and Environmental standards:-
  - ISO 14001
  - BS 8555
  - ISO 50001
  - EMAS
  - Energy Reduction Verification
  - GHG Emissions verification

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Agenda

- Implementation of ISO 14001 and ISO 50001
- ISO 14001 and ISO 50001 Case study
- Commonality across ISO Standards
- Making a case for integrated management systems

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About us…..

Provide knowledge and expertise in implementing and maintaining international standards

- Leading ISO 14001 and integrated management system consultants
- Approved by European Professional Bodies and Certification Bodies
- International Registered Certified Auditors (IRCA)
- 100% success rate
- Easy access to London and Amsterdam (UK Airports and Eurostar)
- Dynamic and results driven professionals

Blackmores

We **'Cherry pick'** aspects of European and International standards to ensure that we meet and exceed stakeholders expectations.

- Environment
- Energy
- Corporate Social Responsibility
- Sustainability Management
- Business Continuity Management
- Information Security Management
- EMAS
- Health & Safety

Why EMS Standards have been created

Standards help businesses improve all sustainability aspects of their business from environmental management, energy management, corporate social responsibility, product carbon footprinting and many other areas.

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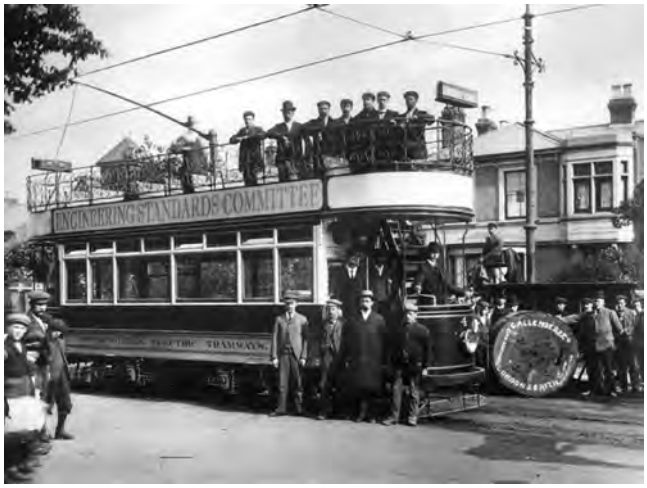

Why EMS standards have been created

Good for business

- Resource efficiency can:
- Cut costs and improve efficiency
- Help secure resource supplies
- Meet customer demand for sustainable business practice
- It makes good commercial sense - waste costs money, not only through the cost of disposal, but also through the lost value of wasted materials

Good for our environment

- It helps ensure best use of raw materials
- It reduces waste going to landfill
- It cuts CO2 emissions

Good for the economy

- It stimulates jobs and growth
- It reduces costs for individuals

The growth of EMS certification

The concept of external certification expanded with the introduction of the British Standard 7750 in the early 1990s, followed by the development of EMAS in 1993, and the promulgation of the ISO 14000 series in 1996.

By mid-2001 more than 30,300 organizations worldwide had their EMS certified under ISO 14001.

EMS - Manufacturing

By 1998, Ford had certified all140 of its manufacturing plants in 26 countries.

By 1999, it was requiring that all its suppliers and Manufacturing facilities worldwide also adopt and certify an EMS as a condition for continuing to do business with Ford (Wilson, 2001).

Motivations for EMS in manufacturing

An international survey of 33 companies in the furniture industry indicated other reasons why they would seek ISO 14001 EMS certification (Ruddell and Stevens, 1998).

Among the strongest motivations (83%) were to prevent potential negative environmental impacts, improve employee environmental awareness, and respond to customer demand.

More than 65% were motivated by the prospect of improving corporate image, and 50% by the hope of gaining market access.

The growth of EMS Certification

- ISO standards are updated every 5 years, requiring 75% support from the world network to make changes.
- Launched 15 years ago as a guideline for measuring and monitoring organizational activities that impact the environment, the ISO 14001 standard is today a widespread benchmark for thousands of organizations around the world that want to communicate to the public and stakeholders that they are environmentally responsible.
- While a paltry 14,000 certifications were registered in 1999, the year the standard was launched, more than a quarter-million organizations are certified today.

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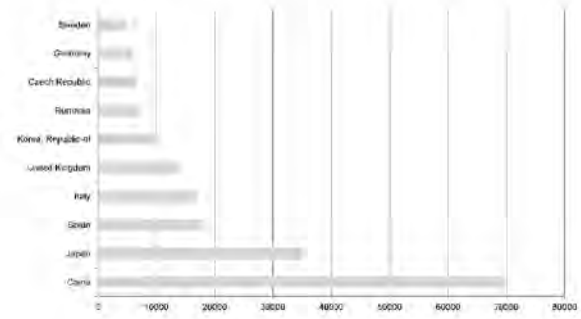
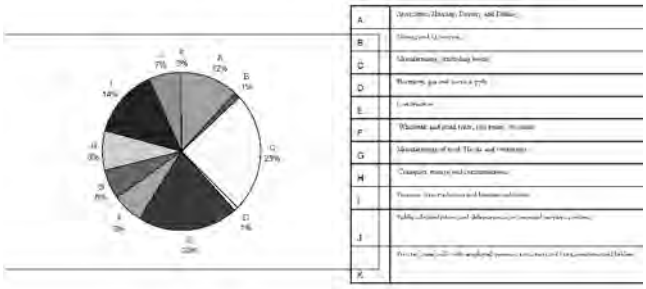
The Global EMS Landscape

EMS Certification 2010 – Top 10



ISO 14001 – By sector



UK Research – EMS Benefits

- 84% report improvements to their corporate reputation
- 79% improve their compliance
- 62% attribute direct cost savings to ISO 14001
- 31% report higher morale among staff

Certification drivers

- Sustainable procurement
- Local Authorities
- Sustainable aviation
- Supply chain
- Stakeholders

ISO 14001

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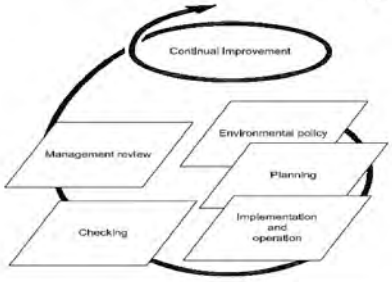
Environmental 'Best Practice'

- ISO 14001 is the Internationally recognised standard for environmental management
- Defines best practice for managing environmental issues and performance
- Aim: to improve identification and management of environmental risks
- Applicable to any organisation, any sector, any size
- 188,815 registrations across 155 countries

ISO 14001 Model



Features & Benefits of ISO 14001

Feature	Benefit
Environmental policy, objectives and targets are defined	Clear direction for the organisation and means of measuring performance
Procedure and process for the identification of environmental aspects and impacts	Systematic – nothing is left out. Focus on those that are most significant and offer the greatest opportunities for improvement
Procedure for the identification of applicable legislation	Awareness and understanding of how legislation applies means you are more likely to comply

Features & Benefits of ISO 14001

Feature	Benefit
Operational controls put in place	Efficient use of resources is increased Waste is minimised Risk of environmental breaches is reduced
Monitoring and measuring of activities is undertaken	Deviations from the norm can be spotted and acted upon.
Regular reviews of performance is conducted by top management.	Trends can be spotted. Areas of weakness can be identified and acted upon. Opportunities for improvement continue to be identified

Benefits of managing your environmental performance

- More efficient use of natural resources
- Reduction in waste
- Reduction in the likelihood of incidents
- Fewer regulatory visits
- Fewer instances of prosecution and fines
- Reduced operating costs

Greening the Plastics Manufacturing industry

EMS Workshop

How prepared are you?

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BS 8555

BS 8555

- 2005 - IEMA Acorn Scheme of accredited recognition
- 6 Inspection Bodies
- 483 organisations have registered on the scheme in total (as @ Sept'08)
- Transition to ISO 14001 (~ 20 companies)
- STEM / BREW Projects

Capitalizing on opportunities with BS 8555 / Acorn Scheme

Phase 1

Commitment and establishing a baseline

Phase 1 Audit

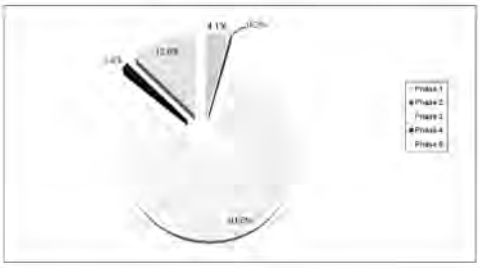
Phase 2 Audit

Phase 3

Developing objectives, targets and programmes

Phase 3 Audit

Breakdown of registrations by phase registered



ISO 50001 – Energy Management

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Energy

- Firstly, What sources of energy do we use?
- Secondly, why is it important to manage our energy?

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You're using energy if you use..

- Heat
- Refrigeration and cooling
- Lighting
- Motive Power
- Compressed Air
- Electrical Services
- Boilers
- Steam, Hot water and Chilled water
- Building Maintenance

And in running your home or office

So, let's now consider some facts and figures about energy usage...

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Energy

- Energy comes from many sources including electricity, gas, oil and steam and is a resource used by organisations worldwide.
- Energy is becoming increasingly more expensive as the Earth's non renewable resources are used up.
- Reducing an organisation's energy consumption will not only reduce its cost, but will also reduce its carbon footprint and help protect the natural environment.
- Reducing energy consumption also reduces an organisations reliance on others to provide the energy they need to operate, hence reducing the risk to the organisation.

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1 kW of electricity can power how many of each of these...?

A-Rated (Energy) Fridge	
32" LCD/LED TV	
Small Pool Pump	
Small Air Conditioner	

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Did you know?

- Each year, home entertainment equipment in the UK uses around £150 million worth of electricity whilst on standby.
- If every house hold turned down their heating by just 1degree, savings would be equivalent to the energy consumed by all hospitals and health care facilities in the UK... Cutting off up to 10% heating bills.
- If every household changed just two of its regularly used lamps for energy efficient ones (CFLs), the energy saved would be enough to power all the UK's street lighting.

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Did you know?

Compact fluorescent lamps are much more efficient at giving off the required lux levels than standard filament lamps.

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Did you know?

- If all housenolds turned off one (unnecessary) 100 watt filament lamp, it would be equivalent to the output of two large power stations
- In 2010 the energy consumed by UK released about 496 million tonnes of carbon dioxide into the atmosphere

Just imagine what would happen if all businesses joined in too . . .

Digest of UK Energy Statistics, DECC, DTI and ETSU

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How we use our energy

- The UK's annual energy spend for 2010 (latest consistent figures) has been estimated around **£64 BILLION** and most businesses could save 10% off their energy bills through no or relatively low cost measures *(DECC)*
- The most compelling business reason for saving energy is reducing energy costs
  - Most organisations can save up to 20% on their fuel bills through better management of their energy and cost-effective measures
  - Good energy management delivering 5%-25% saving
  - Typical payback periods of 2 years or less, across a diverse range of companies
  - Typically savings of 5%-10% with just minimal capital expenditure.

(The Carbon Trust)

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Recent statistics - Graphs

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Energy Management

In your groups, please consider and prepare an answer to the following...

- What are the drivers and benefits of energy management for business?

By this, we mean

- Driver... Legislation
- Benefit... Avoiding fines and prosecution

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Business Market Drivers for Energy Management

Drivers
- Price Increase
- Reliance on others to provide energy
- Depleting energy sources
- legislations and regulation of carbon emissions
- Pressure to reduce costs
- Stakeholder concerns for their 'green' claims

Benefits
- Cost reduction
- Reputation
- Legal compliance
- Feel good
- Satisfy stakeholders
- Security of supply
- Continuity of supply
- Competitive advantage
- USP
- Access to funds
- Expansion within existing supply allowances.

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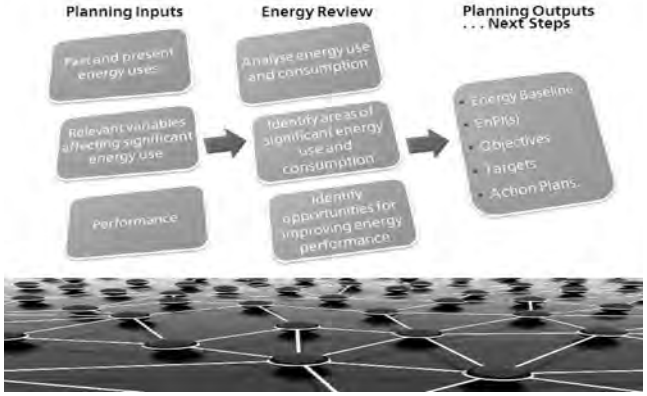
Energy Review



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Energy Management System Model

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Benefits of having an Energy Management System

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Having such a system will enable an organisation to demonstrate commitment to energy efficiency by:

- cutting energy usage and costs
- meeting legislation
- reducing risk
- improving energy use performance in a systematic way
- establishing an energy management system
- ensuring energy management conforms with stated policy
- demonstrating the organisation's commitment to energy use improvement to its stakeholders and others
- certifying the energy management system via an accredited third party

So, Why Choose ISO 50001 as well as ISO 14001?

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- ISO 50001 concentrates entirely on energy management
- ISO 50001 demonstrates a commitment to **energy management** to the organisation's stakeholders
- There are areas within ISO 50001 which are not requirements within ISO 14001
  - Energy Review
  - Energy Baseline
  - Energy Performance Indicators
- As well as
  - Design
  - Procurement of energy services, products, equipment and energy.

Management System Core Elements

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Common Management System Elements	ISO 9001	ISO 14001 & OHSAS 18001	ISO 50001
Policy	5.3	4.2	4.3
Objectives	5.4.1	4.3.3	4.4.6
Responsibilities	5.5	4.4.1	4.2
Competence, training & awareness	6.2.2	4.4.2	4.5.2
Management Review	5.6	4.6	4.7
Internal Audit	8.2.2	4.5.5	4.6.3
Documentation requirements	4.2.1	4.4.4	4.5.4.1
Control of Documents & Records	4.2.3, 4.2.4	4.4.5; 4.5.4	4.5.4.2; 4.6.5
Legal & other requirements	7.2.1	4.3.2	4.4.2
Evaluation of	7.3.4	4.5.2	4.6.2
Design	7.3	4.4.6	4.5.6
Planning	5.4, 7.1	4.3, 4.4.6	4.4
Controls	7.5	4.4.6	4.5.5
Checking	8	4.6	4.6
Monitoring & Measurement	8.2.3	4.5.1	4.6.1
Non conformity/Corrective action/ Preventive action	8.3, 8.5.2, 8.5.3	4.5.3	4.6.4

The Reality... Northern Rail

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Energy Management System implementation

- Improved data collection for more accurate monthly invoice data and metering information which in turn allows better management at site level
- Energy responsibility moved from Head Office control to three Area Directors, meaning all staff are aware monthly of how they impact energy consumption
- Northern's core driver skills training now includes a responsible driving module
- Framework to target consumption and agreed Energy Budgets for 2012. This was a step change in Northern's approach to energy management

"With ISO 50001 certification from LRQA Business Assurance, we have embedded a system-wide strategy for energy management, instead of approaching it on a project-by-project basis."

Ian Bevan, Managing Director, Northern Rail.

The Reality... Northern Rail

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Performance and In…

- Engineering has u… …el consumption, e.g., the introduc… …bility, reduce idling and allow cleanin… …gine
- Up to Dec-11, No… …2% compared to 2010, despite a 4… …nd a switch to ultra low sulphu… …t less efficient)
- Northern's reduct… …o 2009 baseline
- Efficiency impro… …10 and 2009 respectively (litres…
- 11% less electric… …11 versus 2010)

Northern Rail won the coveted award of **Sustainable Business of the Year 2011** *at the Environment and Energy Awards*

The **Environment** and **Energy** Awards 2011

EMAS

Raising Standards , Global Environmental and Energy Systems

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EMAS – Key Principles

Performance:
Carrying out annual updates of environmental policy targets and actions to implement and evaluate these targets

Credibility:
Third party verification by independent auditors guarantees the value of both actions taken and disclosed information

Transparency:
Environmental statements provide public information about the organisation

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Steps to achieving EMAS

Conduct an environmental review considering all environmental aspects of the organisation's activities, products and services, methods to assess these, relevant legal and regulatory requirements and existing environmental management arrangements and procedures.

Adopt an environmental policy containing commitment both to comply with all relevant environmental legislation and to achieve continuous improvement in environmental performance.

Develop an environmental programme that contains information on specific actions and the deadlines and targets. The environmental programme is a tool to help the organisation in its everyday work when implementing the environmental policy.

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Steps to achieving EMAS

Based on the results of the review, establish an effective environmental management system (EMS) aimed at achieving the organisation's environmental policy and at improving the environmental performance continually.

The management system needs to set responsibilities, means to achieve objectives, operational procedures, training needs, monitoring and communication systems.

Carry out an environmental audit assessing in particular the management system in place and conformity with the organisation's policy and programme as well as compliance with relevant environmental regulatory requirements.

Provide an environmental statement of its environmental performance which lays down the results achieved against the environmental objectives and the future steps to be undertaken in order to continuously improve the organisation's environmental performance.

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EMAS – Case studies

Key to the EMAS process is to report on environmental performance against the environmental objectives to be undertaken in order to continuously improve the organization's environmental performance.

- ✓Pureprint Group become the First CarbonNeutral® printer in the world
- ✓The Bovince Sustainability report 2006 stated that CO2 produced by electricity had decreased by 39.05%, gas had decreased by 46.12%
- ✓In 2009 Kirklees Council was recognised because of its commitment to cutting greenhouse gas emissions and for its performance in energy efficiency.

Energy Reduction Kitemark

Energy Reduction Verification Kitemark

- The Kitemark scheme for Energy Reduction Verification has been developed to enable organisations to verify the reduction in carbon dioxide (CO_2) emissions resulting from energy use
- The scheme has been specifically designed to meet the requirements of the Carbon Reduction Commitment Energy Efficiency Scheme (CRC) enabling organisations that are required to annually report their emissions to the regulatory body to qualify for points under the Early Action Metrics (EAM) of the CRC
- However, the scheme is not restricted to such organisations and may also be used by any organisation wishing to verify its CO_2 emissions from energy use

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ERV Kitemark

- A Kitemark certificate is awarded to a company that has:
- an effective energy management system
- identified and assessed their significant energy uses
- reduced their energy use by a minimum of 2.5% each year
- They can determine the boundaries of both their organisation and their activities, including transport, to be covered in the scheme.

GHG Emissions Verification – ISO 14064

European Union Emissions Trading Scheme (EU ETS) Greenhouse Gas Emissions Verification

Understanding greenhouse gas (GHG) inventory techniques, emissions verification and emissions trading is fundamental to any organisation wishing to manage greenhouse gases.

Identify opportunities for energy consumption savings and process improvement whilst demonstrating the objectively assessed measurements which key stakeholders are demanding.

Steps to understanding your GHG Emissions

1. **Strategic analysis** – gives an overview of the project activities and an understanding of the significance of emissions
2. **Process analysis** – provides an on-site verifi cation of information involving spot checks to determine data reliability
3. **Risk analysis** – verifi fes risk control methods minimising uncertainty and evaluating the reliability of data from each source
4. **Reporting** – highlights the issues uncovered in the verifi cation work and provides a qualifi ed opinion so that reported emissions

Verification process

The verification will be designed to meet your requirements. However, a typical verification is split into a number of stages that can occur separately or concurrently.

Splitting the verification process ensures early identification of any issues and allows sufficient time for their closure in advance of the submission of the final emissions and or tonne/km report.

Verification Process

- Confirm scope of verifications to include any changes and impact of changes.
- Confirm appropriate identification of emissions sources, airport pairs etc.
- Review monitoring and reporting plans.
- Identify any opportunities for improvement and report findings
- Agree verification plan for the delivery of the remaining verification

- Review monitoring and reporting plans, annual emissions and tonne/km data and management system controls to include data collection, calibration etc
- Review procedures for EU ETS data collection and confirm compliance in accordance with scheme rules.
- Interim data verification - verify available data in accordance with agreed sampling plan both annual emissions and tonne/km (repeat at agreed intervals throughout the reporting year as necessary)
- Identify opportunities for improvement
- Report findings

- Verify in accordance with sampling plan final submitted data for both annual emissions report including determination fuel density and emission factor (where appropriate) and/or tonne/km report.
- Close out any outstanding actions.
- Verify final submitted annual emissions report is consistent with previously verified data
- Verify final submitted tonne/km report is consistent with previously verified data.
- Complete the verification process.
- Preparation of the verification report and verification opinion

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What is Carbon Footprinting?

- A carbon footprint measures the total greenhouse gas emissions caused directly and indirectly by a person, organisation, event or product.
- A carbon footprint is measured in tonnes of carbon dioxide equivalent (tCO2e). The carbon dioxide equivalent (CO2e) allows the different greenhouse gases to be compared on a like-for-like basis relative to one unit of CO2. CO2e is calculated by multiplying the emissions of each of the six greenhouse gases by its 100 year global warming potential (GWP).

A carbon footprint considers all six of the Kyoto Protocol greenhouse gases:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)

Types of Carbon Footprinting

The main types of carbon footprint for organisations are:

1. **Organisational carbon footprint**
   Emissions from all the activities across the organisation, including buildings' energy use, industrial processes and company vehicles.
2. **Product carbon footprint**
   Emissions over the whole life of a product or service, from the extraction of raw materials and manufacturing right through to its use and final reuse, recycling or disposal.

Greening your products

A carbon footprint of a product of service is an assessment of the greenhouse gas emissions that are released as part of the product's lifecycle. This lifecycle consists of all the activities associated with that product, and typically includes the following stages:

Why calculate the carbon footprint of my products?

- Identify cost savings across the supply chain
- Identify opportunities to reduce environmental impact through reductions in material use, water, waste and energy
- Inform innovation for low carbon and sustainable product design
- Enhance your brand and win tenders with business-to-business customers though better environmental credentials, carbon labelling and communications.
- Understand supply chain risks
- Prepare for future legislation

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Subject Areas

- Integrating Management Systems
- Implementing and Embedding systems
- The Certification Process

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Defining The Scope

- Head Office
- Regional Offices
- Building Sites / Live Projects
- Boundaries (50k)

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PDCA In Action

Source : PAS 99:2006 (BSi)

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Integration of Planning

Management System Policies:

- Quality Policy (ISO9001)
- Environmental Policy (ISO14001)
- H&S Policy (OHSAS18001)
- Energy Policy (ISO 50001)
- Information Security Policy (ISO27001)

- Equal Opportunities Policy
- Diversity Policy

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Policy Development

- Scope and Boundaries (50k)
- Commitment to comply with Legislation & Other requirements
- Establish Objectives and Targets
- Commit to Continuous Improvement
- Make policy available to the Public

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Integration of Planning

Planning To Minimise Risk:

- Environmental Aspects & Impacts (14k)
- Energy Aspects (50k)
- Health & Safety Risk Assessments (18k)

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Aspects & Impacts

Environmental Aspects: ISO14001

- Emissions to air
- Releases to water
- Releases to land
- Use of raw materials and natural resources
- Use of energy (See energy aspects)
- Energy emitted, e.g. heat, radiation, vibration
- Waste and by-products
- Physical attributes, e.g. size, shape, colour, appearance.

Source: ISO14001:2004 (Annex A, A.3.1)

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Aspects & Impacts

Energy Aspects: ISO 50001

- Building & fabric
- Heating and ventilation
- Combustion equipment
- Air conditioning and refrigeration
- Lighting
- Hot water services
- Catering
- Compressed air
- Steam
- Process thermal insulation
- Motor driven equipment

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Integrating Planning

Legal Requirements

- Environmental Legislation (14k)
- Health & Safety Legislation (18k)
- Energy Legislation (50k)
- Statutory & Regulatory Requirements (9k)
- Identification of "Other" Requirements

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"Other" Requirements

Examples:

- Professional Bodies
- Client requirements
- Local authority requirements
- Standards – ISO 50001, ISO14001 etc...

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Legislative Requirements

Questions to ask..

- Is the legislation Applicable to us?
- How does it affect us?
- What Evidence would a regulator expect to see?
- Are Records retained and available?

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Contingency Planning

- Emergency Preparedness & Response (14k & 18k)
- Business Continuity Standard (BS 25999)

2006 – Scaffold Collapse, Jury's Inn Milton Keynes

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Contingency Planning

- Emergency Preparedness & Response (14k & 18k)
- Business Continuity Standard (BS 25999)

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Establishing Significance

Consider:

- Likelihood of the aspect occurring
- Severity of the potential Impact
- Normal, Abnormal and Emergency conditions
- Need for Legislative compliance
- Need for compliance with Other requirements

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Setting SMART Objectives

S pecific
M easureable
A chievable
R ealistic
T ime constrained

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Benefits

- Significant aspects identified for Specific locations
- Localised objectives created
- Increased Ownership of objectives
- Maximise the Impact of the system(s) across the organisation

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Roles & Responsibilities

Define:

- Organisational structure (Family Tree)
- Individual Roles
- Individual Responsibilities
- Individual Authority
- Individual "Accountability"

9001, 14001, 16001, 18001

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Accountability...!

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Operational Control

System Procedures

- Document Control
- Records Control
- Internal Audits
- Non Conformity
- Corrective Action
- Preventive Action

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Operational Control

Operating Procedures

- Project delivery process
- Environmental management
- Energy management
- Health and Safety – safe methods of work
- Emergency preparedness & response

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File Structure Options

- Hard Copy files & folders
- Server based file structure
- Local Intranet Access
- Web Based Portals

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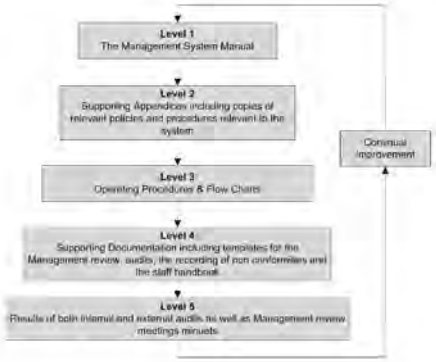
System Documentation



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Communication Methods

- E-mails
- Company news
- Webinars (e-learning)
- Display screens
- Posters & Notices
- PC screen savers
- Formal & Informal Training sessions

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Phase 1 – Summary

- Gap Analysis
- Establishing Scope & Boundaries
- Legislation & Other Requirements
- Aspects & Impacts
- Establish Objectives
- Create Documentation
- Communication

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Internal Auditing

- Audit schedule
- Key areas of focus
- Audit checklists
- Audit reports
- Feedback to auditees

Use as a tool for driving Improvement...!

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Internal Auditing

"I keep six honest serving men, They taught me well and true, Their names are:

WHAT and **WHY** and **HOW**

WHEN and **WHERE** and **WHO**"

Rudyard Kipling – The Elephant Child

Show me..!

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Monitoring & Measurement

- Monitor and measure the key characteristics of the system:
  - Progress against objectives
  - Wastes
  - Energy consumption
  - Incidents
  - Accidental Deviations

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Accidental Deviations

Monitor and measure consumption to identify and eliminate accidental deviations

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Non Conformance

- Identify Non Conformities
- Establish Causes
- Implement Corrective and Preventive actions
- Verify actions have been effective

Use as a tool for driving Improvement...!

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Management Review

Inputs:

- Results of audits
- Legislative changes & Compliance
- Monitoring and measurement activities
- Feedback & Complaints

Outputs:

- Changes to Policies
- Revised / New Objectives
- Resource Needs

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Phase 2 – Summary

- Internal auditing
- Monitoring & Measurement
- Corrective & Preventive actions
- Management Review
- Certification

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Certification Process

Stage 1 – Document Review

Stage 2 – Evidence based assessment

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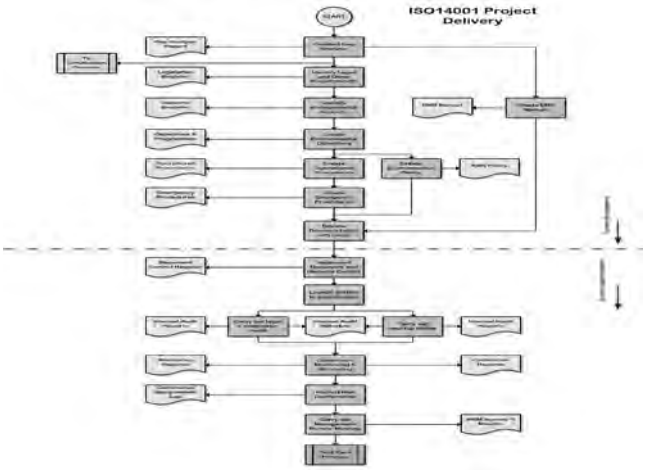
Summary

- Integrating Management Systems
- Implementing an EnMS
- The Certification Process



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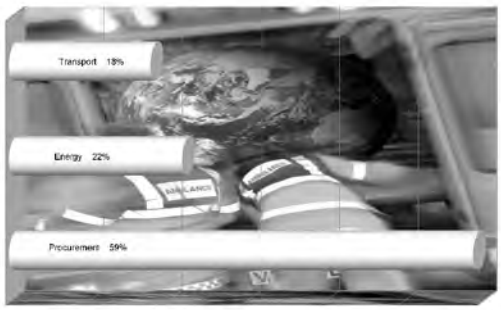
Delivering innovation through Environmental Management Systems

Source: Department of Health - 2009 ANNUAL REPORT OF THE CHIEF MEDICAL OFFICER

The challenge

- 22 million tonnes of carbon dioxide a year
- NHS Buildings consume over £410 million worth of energy and produce 3.7 million tonnes of CO2 every year
- 'Saving Carbon, improving health' strategy – reduce carbon by 60% by 2050



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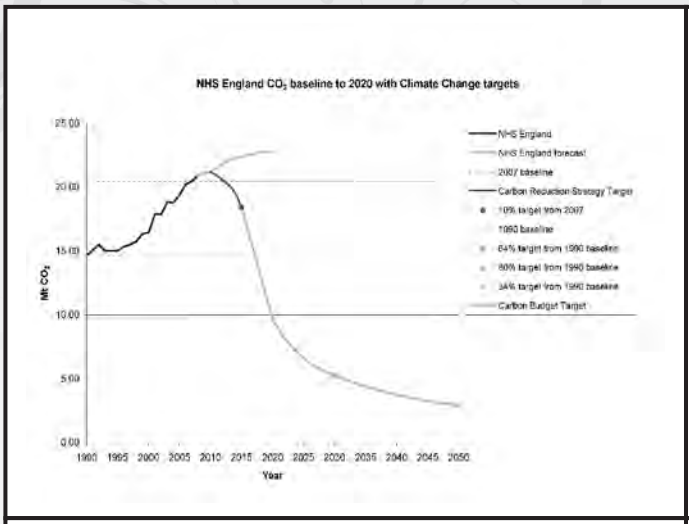

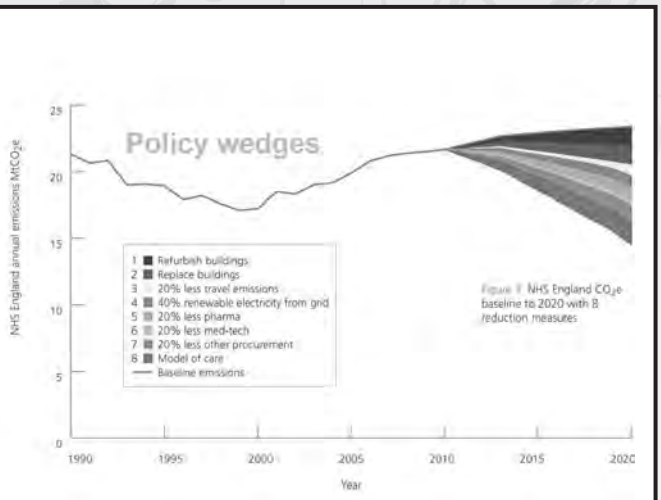

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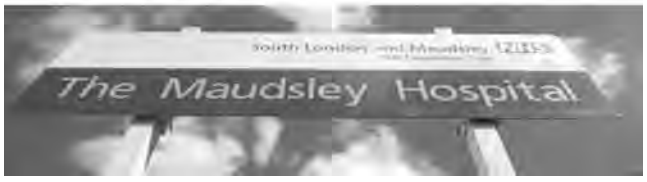
South London and Maudsley NHS
NHS Foundation Trust

Case Study

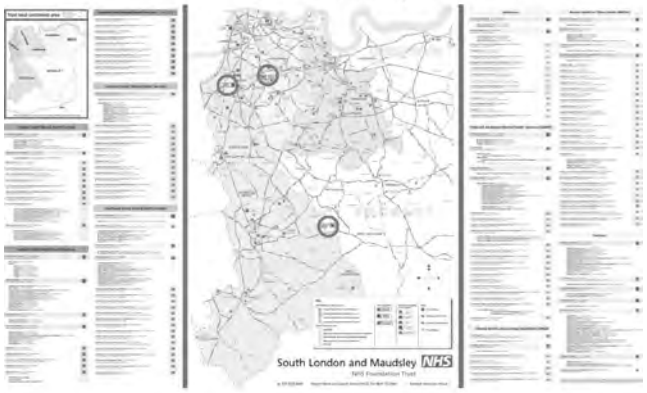
Implementation of an ISO 14001 & ISO 50001 compliant Environmental Management System

South London and Maudsley NHS
NHS Foundation Trust

- Provider of the most extensive portfolio of mental health services in the United Kingdom
- A world leader in research, working in partnership with the Institute of Psychiatry, King's College London
- The largest mental health training institution in the country.



Establishing Boundaries



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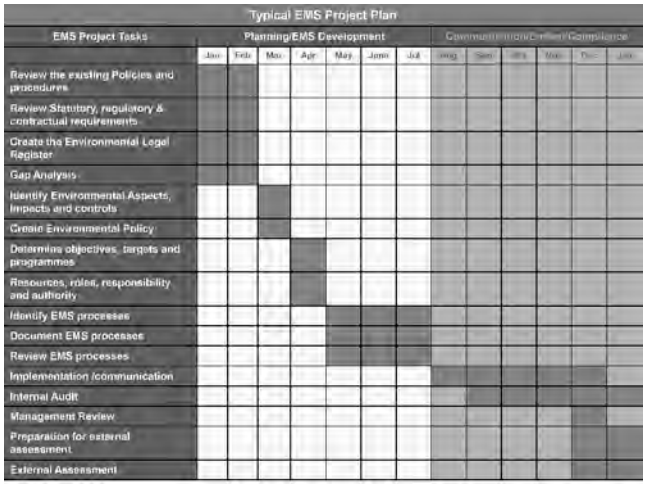
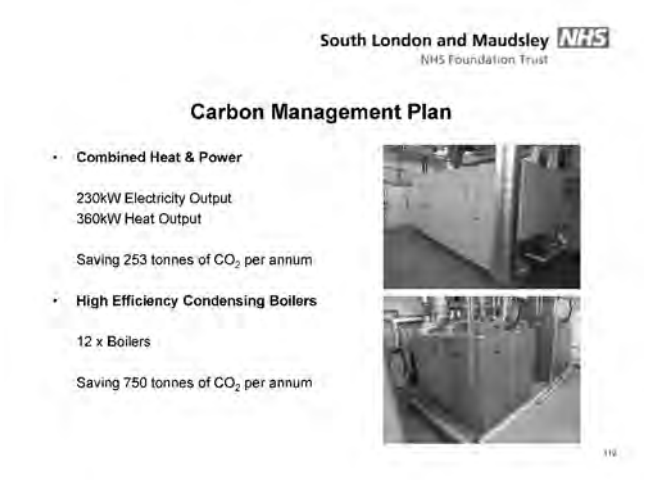
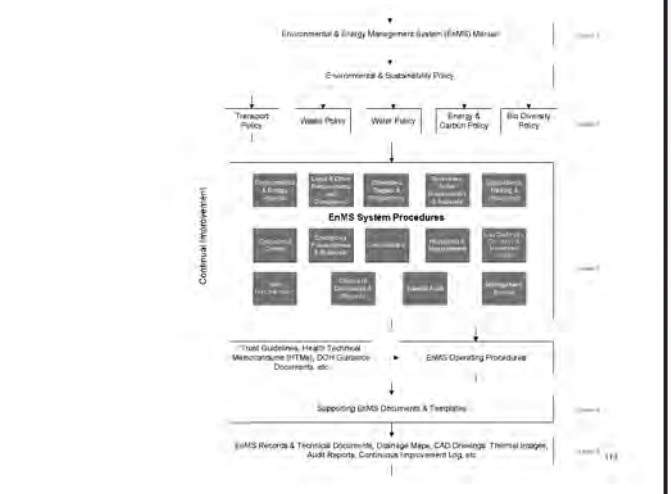
South London and Maudsley NHS
NHS Foundation Trust

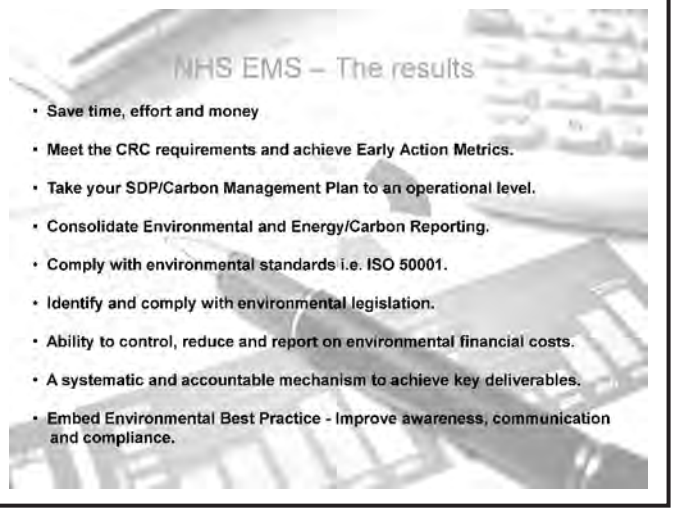
Carbon Management Plan

Raising Standards , Global Environmental and Energy Systems









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- **Energy spend is £2.8m per annum**
- Employees claim over 900,000 miles per year in vehicle travel
- **A measurable carbon footprint of 28,700 tonnes**

As a large public sector organisation they fully appreciated that they had a key role in leading the necessary change.

- First NHS provider to achieve ISO 50001 and ISO 14001.
- Over 100 environmental champions trained.
- 70% in lighting costs is being saved.
- Voltage reduction sockets reduce electricity consumption by 10% = CO2 Reduction of 500 tonnes p.a + £83,000 cost saving.
- Ground Source Heat Pump = reduce 126 tonnes p.a. + save £67,000 p.a.

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Best Environmental Project | Green Innovation | Creative Innovation

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South London and Maudsley NHS
NHS Foundation Trust

Case Study

Implementation of an ISO 14001 & ISO 50001 compliant Environmental Management System

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Thank you

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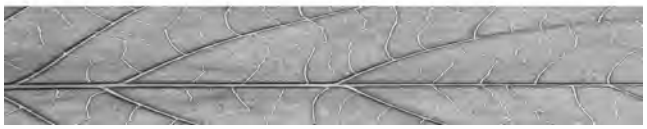
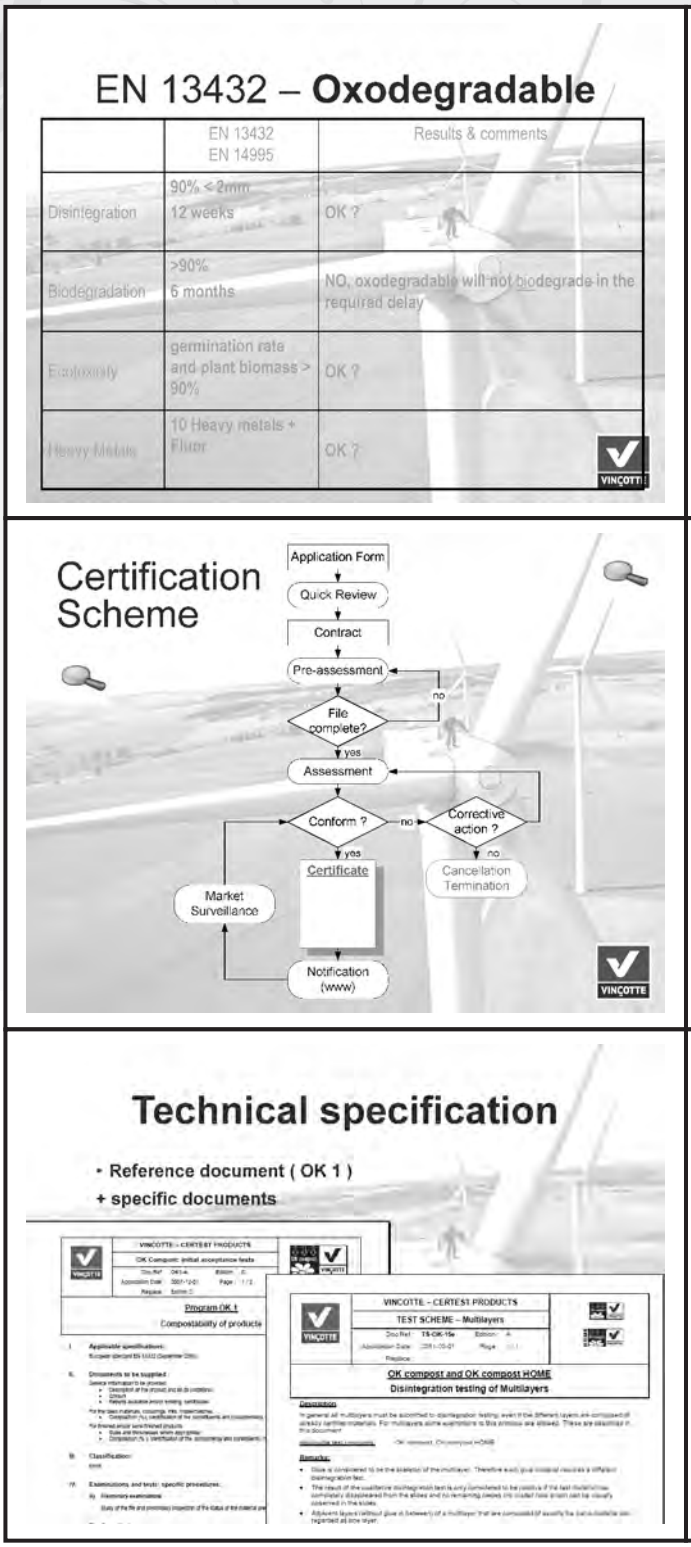
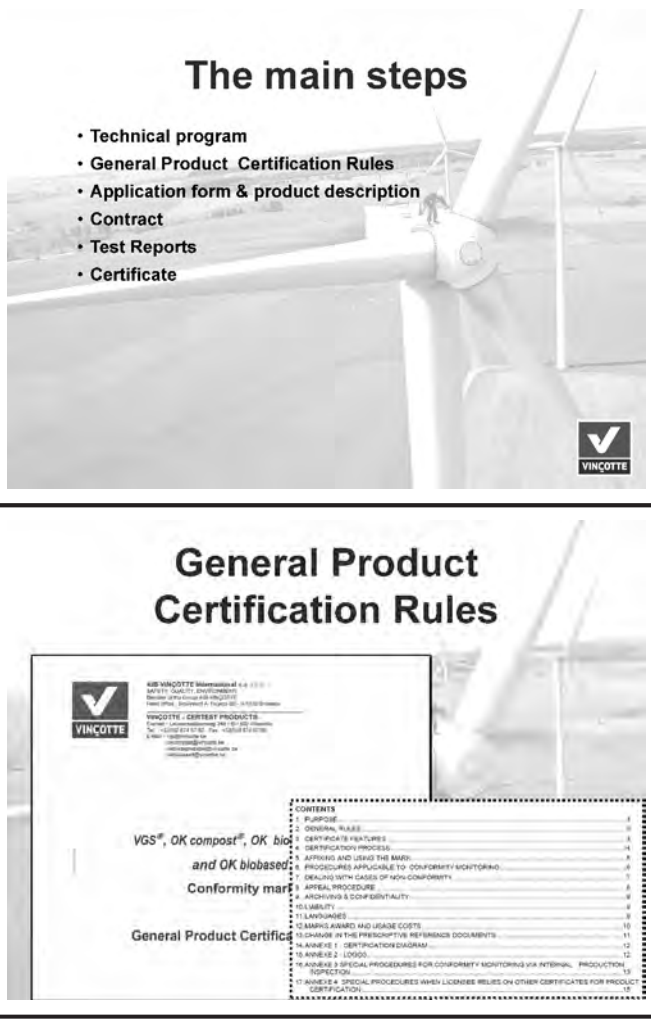
www.bqms.co.uk



Certification of Compostable products and Biobased Products





Certification of Compostable products and Biobased Products

Application form & product description

Application form & product description

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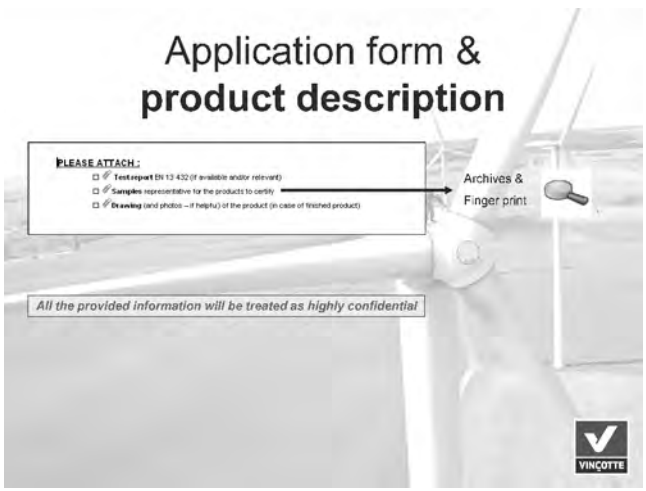
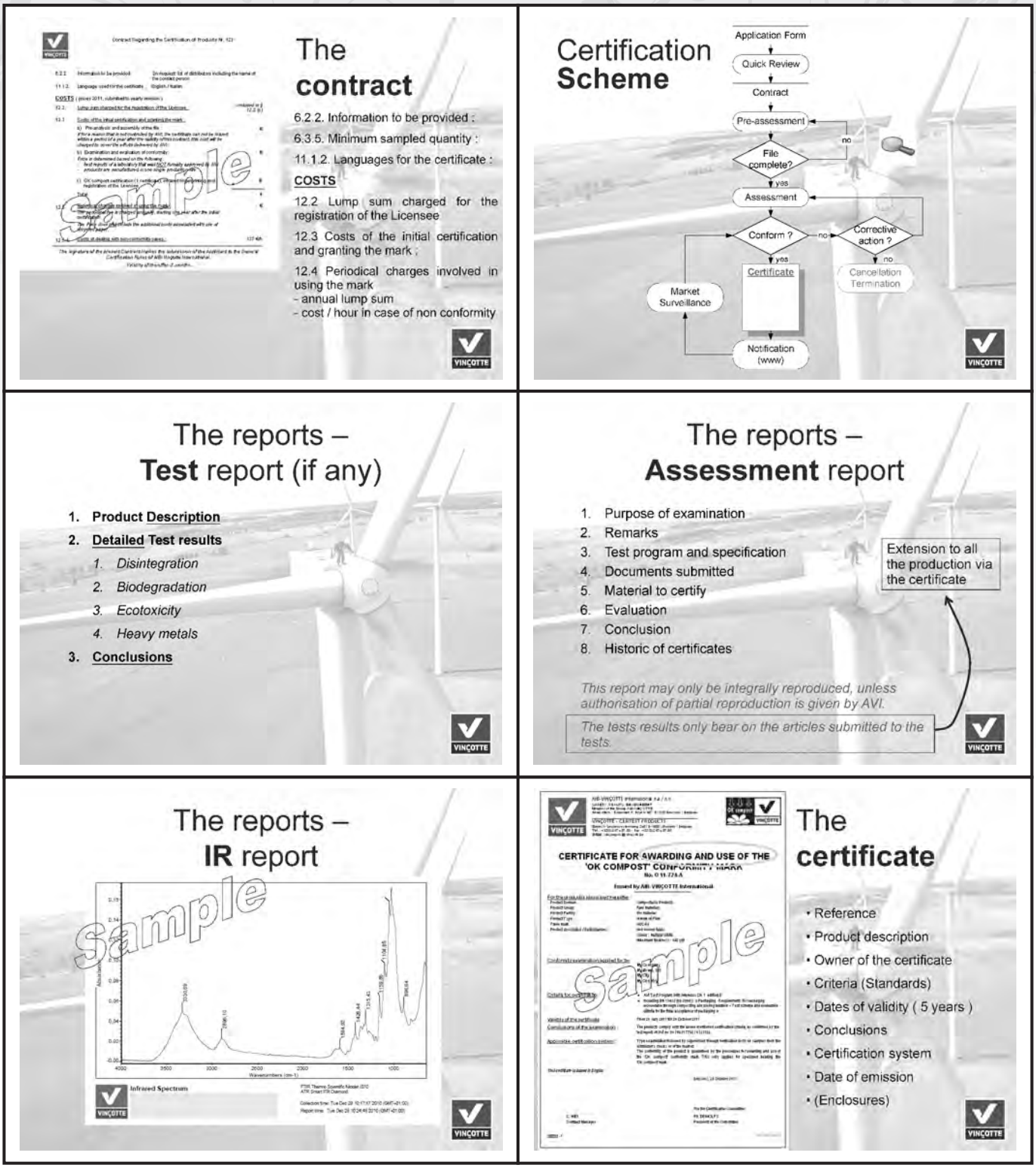


The contract

Certification of Compostable products and Biobased Products



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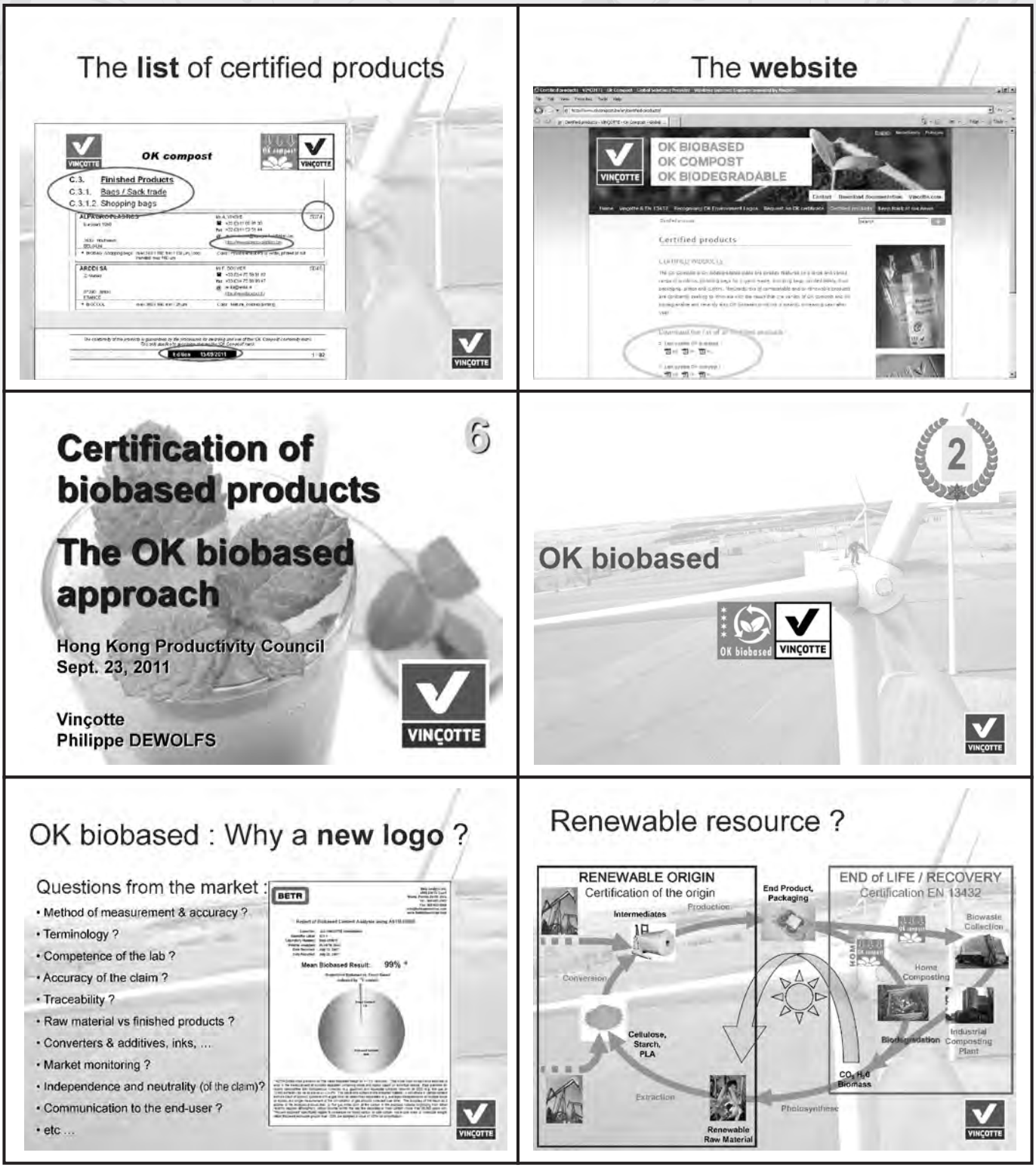

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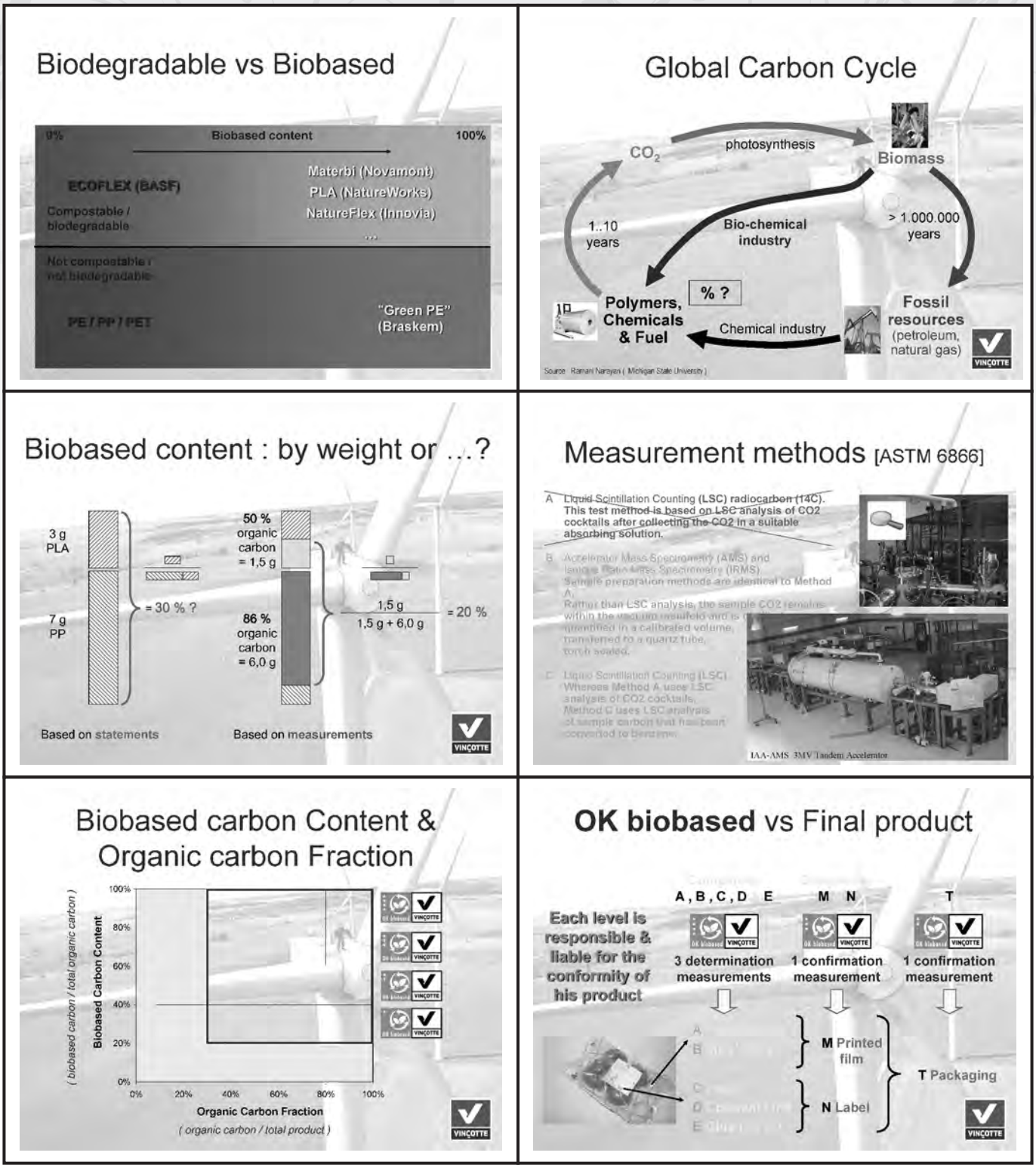

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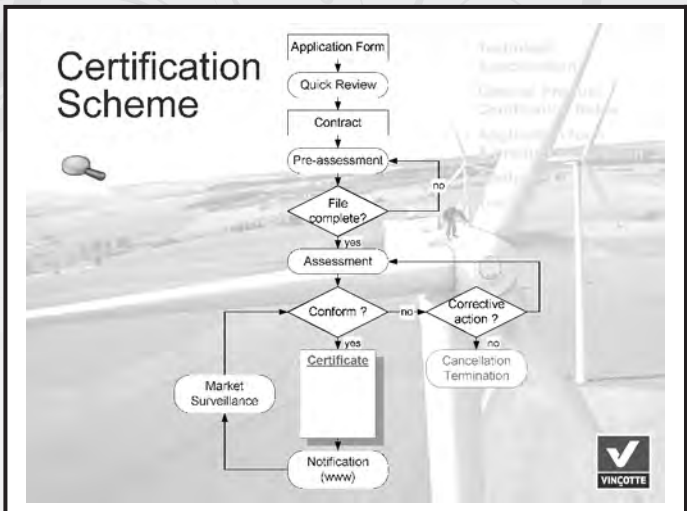

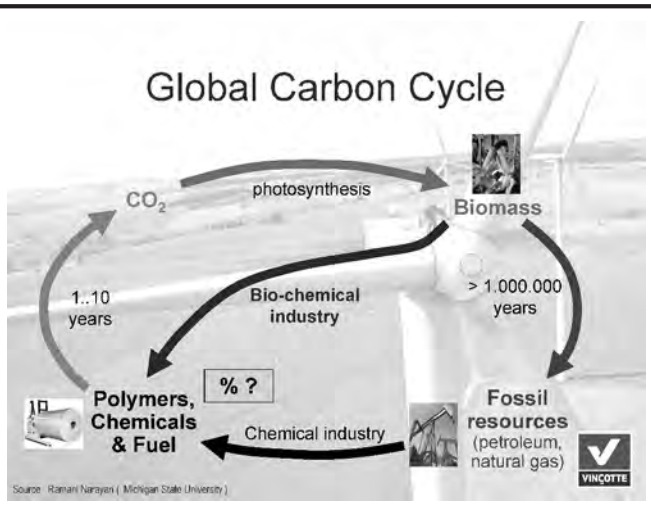

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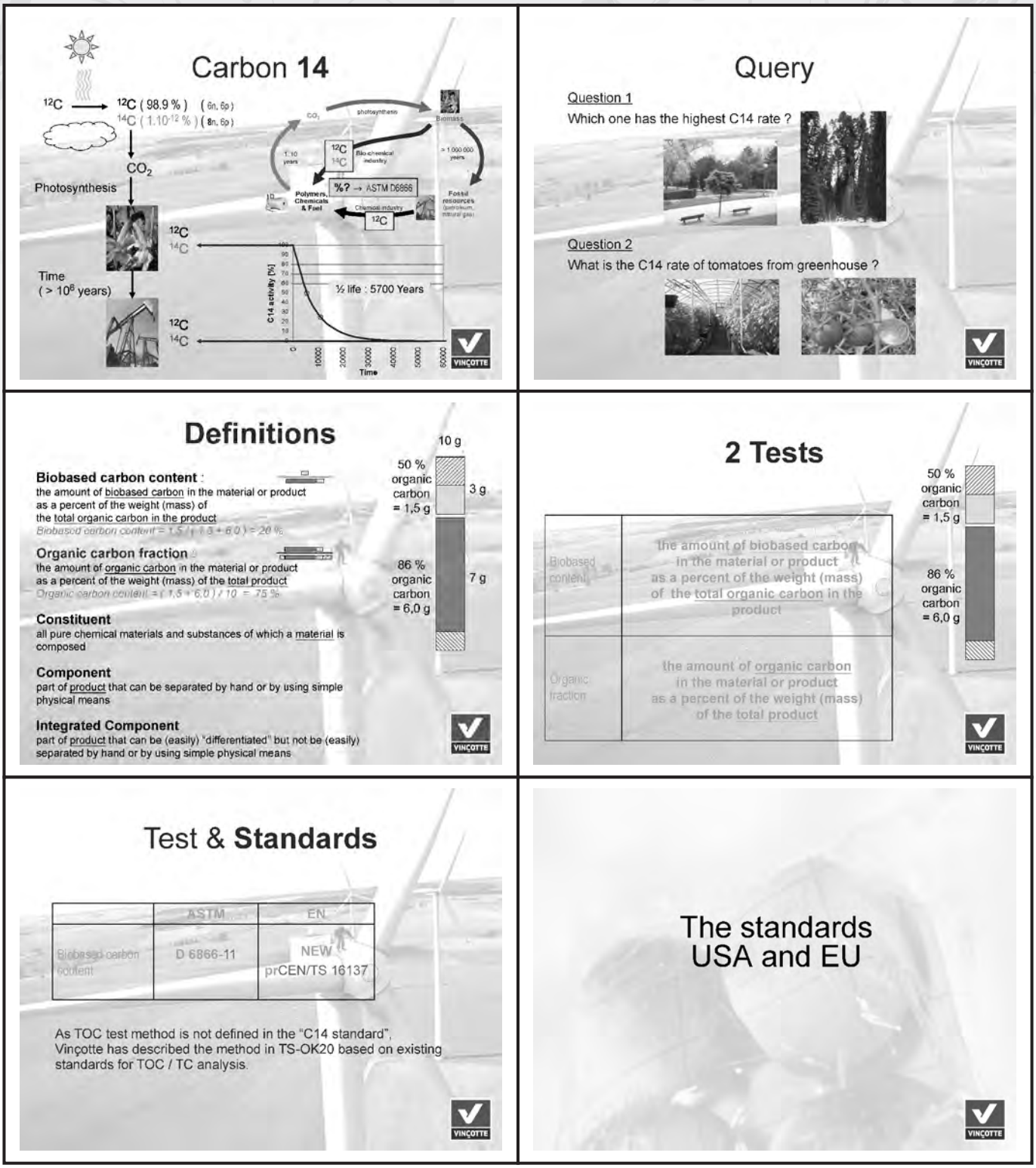


Certification of Compostable products and Biobased Products

European Standards

- Vinçotte is an active member of the CEN TC 249 WG 17 for bioplastics standardisation.
- European standards are in accordance with the ASTM standards (D 6866-11)
- OK biobased complies with the future European Standards
  - biobased **carbon** content
  - based on the **organic** carbon

European Standards

Recent standardisation works in Europe (CEN TC 249 WG 17) :

CEN TR 15932
Plastics — Recommendation for terminology and characterisation of biopolymers and bioplastics

Draft prCEN/TS 16137
Plastics – Determination of the bio-based carbon content (based on the ASTM D 6866)

Final draft FprCEN/TS 16295
Plastics - Declaration of the bio-based carbon content

ASTM - Method A

A Liquid Scintillation Counting **(LSC) radiocarbon (14C).**
This test method is based on LSC analysis of CO_2 cocktails after collecting the CO_2 in a suitable absorbing solution.

± 15 %

ASTM - Method B

± 2 %

B Accelerator Mass Spectrometry **(AMS)** and Isotope Ratio Mass Spectrometry (IRMS).
Sample preparation methods are identical to Method A.
Rather than LSC analysis, the sample CO_2 remains within the vacuum manifold and is distilled, quantified in a calibrated volume, transferred to a quartz tube, torch sealed.

ASTM - Method C

± 3 %

C Liquid Scintillation Counting **(LSC).**
Whereas Method A uses LSC analysis of CO_2 cocktails, Method C uses LSC analysis of sample carbon that has been converted to benzene.

Scope & Requirements

- ELIGIBLE PRODUCTS
  - Made of Bioplastics
  - Made of Natural fibers
- METHOD
  - Measurements of the biobased carbon content according to ASTM 6866
  - Measurement of the organic carbon fraction
  - 3 determination measurements => average
    + addtional measurements if > 3%

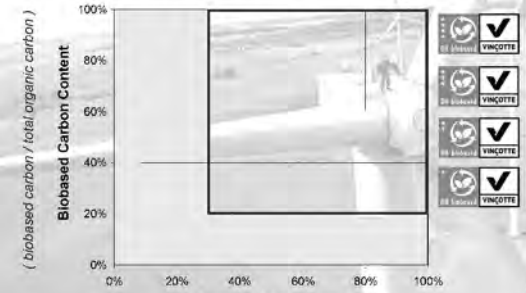
(3 measurements are necessary for a better accuracy)

Certification of Compostable products and Biobased Products

Scope & Requirements

- REQUIREMENTS
  - Organic carbon fraction : ≥ 30% of the product to certify
  - Biobased carbon content : ≥ 20% of the product to certify
  - Constituents, components : ≤ 1%, and for a total ≤ 5% ; no data for organic carbon fraction & biobased carbon content required => **default value**
- PRODUCTS
  - Calculation of the biobased content based on the biobased carbon content and the organic carbon fraction of each certified component/constituent
  - + 1 confirmation measurement

Biobased carbon Content & Organic carbon Fraction



How to understand the standard ?

OK biobased vs Final product

The standard describe a test method.

For products, especialy for complex products (combination of components), it is necessary to define specific rules.

=> **Programme Vinçotte OK biobased : ref OK 20**

OK biobased vs Final product

Each level is responsible & liable for the conformity of his product

A, B, C, D E	M N	T
3 determination measurements	1 confirmation measurement	1 confirmation measurement

M Printed film

N Label

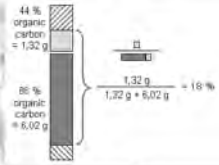
T Packaging

Combination of certified components / constituents

The formula to use is :

$$BCC_{product} = \Sigma (BCC_i \cdot OCF_i \cdot W_i) / \Sigma (OCF_i \cdot W_i)$$

$$OCF_{product} = \Sigma (OCF_i \cdot W_i) / \Sigma W_i$$



Where

$BCC_{product}$: Biobased Carbon Content of the finished product [%]
BCC_i : Biobased Carbon Content of the component/constituent i [%]
$OCF_{product}$: Organic Carbon Fraction of the finished product [%]
OCF_i : Organic Carbon Fraction of component i [%]
W_i : Dry Weight of the component/constituent i [g]

Certification of Compostable products and Biobased Products

Vinçotte : **Multilayers**

Can be assessed by :
- **3 determination mesurements** on the multilayer
- **1 confirmation measurement** on the multilayer if each component is certified.

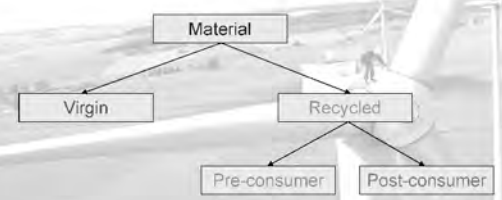
Second approach is more flexible for future extensions.

Always assessment and certification of the new multilayer by Vinçotte

Vinçotte : **Hollow bodies**

- Hollow bodies is not an issue (no effect of the thickness)

Vinçotte– **Recycled material**



Periodical analyse of the material
Flow of materials
Effect on biobased carbon content

Vinçotte – **Combination** of constituents / components

- Assessment is done for the combination of all components (finished product as a whole)
- The logo shall be applied once on the finished product, with the corresponding number of stars obtained for the finished product as a whole.

Vinçotte – **Combination** of constituents / components

- biobased bags (for green waste collection) packaged in not-biobased packaging.
- The information printed on the packaging (claiming that the packaged bags are biobased) may not confuse the end user..
- This is also true for other biobased items (plates, cutlery, ...) packaged in a not biobased packaging.

Agreement of Labs

Certification of Compostable products and Biobased Products

Certification of Compostable products and Biobased Products

Application form & product description

OK BIOBASED - APPLICATION FORM
FOR CERTIFICATION OF
MATERIALS, INTERMEDIATES, ADDITIVES OR PRODUCTS

APPLICANT (requested for drawing up the contract between Vinçotte and the Applicant)

A. Contact details

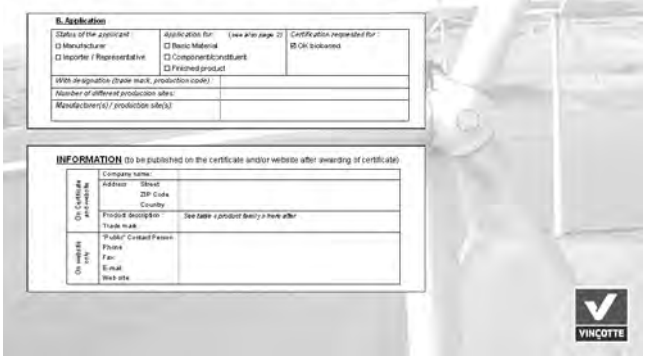
☐ My company is already registered and my contact data have not changed:

Licensee code (Gcode):

☐ My company is not registered yet or my contact data have changed:

Company name:
Address Street:
ZIP Code, City
Country
Contact Person
Phone:
Fax:
E-mail:

Application form & product description



B. Application

Status of the applicant :	Application for: (see also page 2)	Certification requested for :
☐ Manufacturer ☐ Importer / Representative	☐ Basic Material ☐ Component/constituent ☐ Finished product	☒ OK biobased

With designation (trade mark, production code):
Number of different production sites:
Manufacturer(s) / production site(s):

INFORMATION (to be published on the certificate and/or website after awarding of certificate)

On Certificate and website

Company name:
Address: Street
ZIP Code
Country
Product description — See table « product family » here after
Trade mark

On website only

Public* Contact Person
Phone
Fax:
E-mail
Web site

Application form & product description

PRODUCT FAMILY

Please, tick the family of product you ask the certification for:

1	Raw materials	1.1	Bio Material	1.1.1 In form of Resin or Granulates ☐
				1.1.2 In form of Film ☐
		1.9	Other	1.9.1 Description : ☐
2	Components & constituents	2.1	Films, Sheets & Plates	2.1.1 Bio-Material ☐
				2.1.2 Natural Material ☐
				2.1.3 Paper ☐
		2.2	Ink, Colorant, Adhesive & Additives	2.2.1 Adhesive ☐
				2.2.2 Additive ☐
				2.2.3 Colorant ☐
				2.2.4 Ink for printing ☐
				2.2.5 Masterbatch ☐
		2.3	Packaging - Miscellaneous components	2.3.1 Bottle neck ☐
				2.3.2 Printed Paper Labels ☐
				2.3.3 Lid ☐
				2.3.4 Tube ☐
		2.9	Other:	2.9.1 Description ☐
3	Finished products	3.1	Bags / Sacks/pads	3.1.1 Bags for collection of biowaste, refuse ☐
				3.1.2 Shopping bags ☐
		3.2	Catering	3.2.1 Trays & Plates ☐
				3.2.2 Cup ☐
				3.2.3 Cutlery ☐
		3.3	Packaging	3.3.1 Food packaging – Rigid ☐
				3.3.2 Food Packaging – Flex ☐
				3.3.6 Non-Food Packaging – Rigid ☐
				3.3.7 Non-Food Packaging – Flex ☐
		3.4	Garden, horticultural & agricultural products	3.4.1 Clippers ☐
				3.4.2 Films (mulching) ☐
				3.4.3 Plastic pots ☐
		3.9	Other:	3.9.1 Description ☐

Application form : data

PRODUCT DATA :

Please, fill in the form carefully! The more accurate the form is filled in, the easier and faster the treatment!

A. BIO MATERIAL(S) INCLUDING ADDITIVES, MASTERBATCHES, FILLERS, ...)

Raw(s) or semi-ready(s) of the material	Supplier of the material	Percentage in weight (product(s) as sum (%)	Origin of material	Organic carbon content (OC) (%)	Biobased carbon content (BC) (%)

B. Biobased

Description of the raw (biomass) (origin, quality, ...) of each component of the product	Value

C. SPECIFICATIONS AND/OR REMARKS

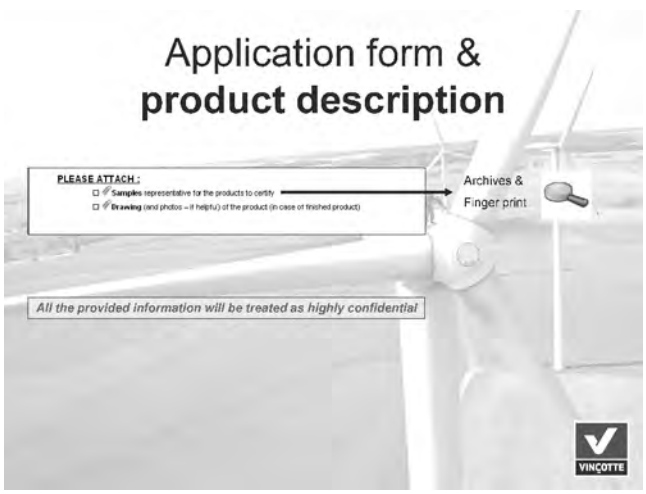
(e.g. properties of the blend of components, colorants, etc. of packaging, etc...)

D. CARBONATE CONTENT

Does the product contains Calcium Carbonate ($CaCO_3$)?

☐ Yes % ☐ No ☐ I don't know

Application form & **product description**



PLEASE ATTACH :

☐ **Samples** representative for the products to certify → Archives & Finger print

☐ **Drawing** (and photos – if helpful) of the product (in case of finished product)

All the provided information will be treated as highly confidential

The **contract**

CONTRACT REGARDING THE CERTIFICATION OF PRODUCTS
OFFER Nr 2BRxxxx

Sample

Information regarding the Applicant & the products to be certified:

- relevant mark(s) :
- nature of the product to be certified :
- production units affected :
- products or components already certified :

4.3.1.According to the technical specifications :

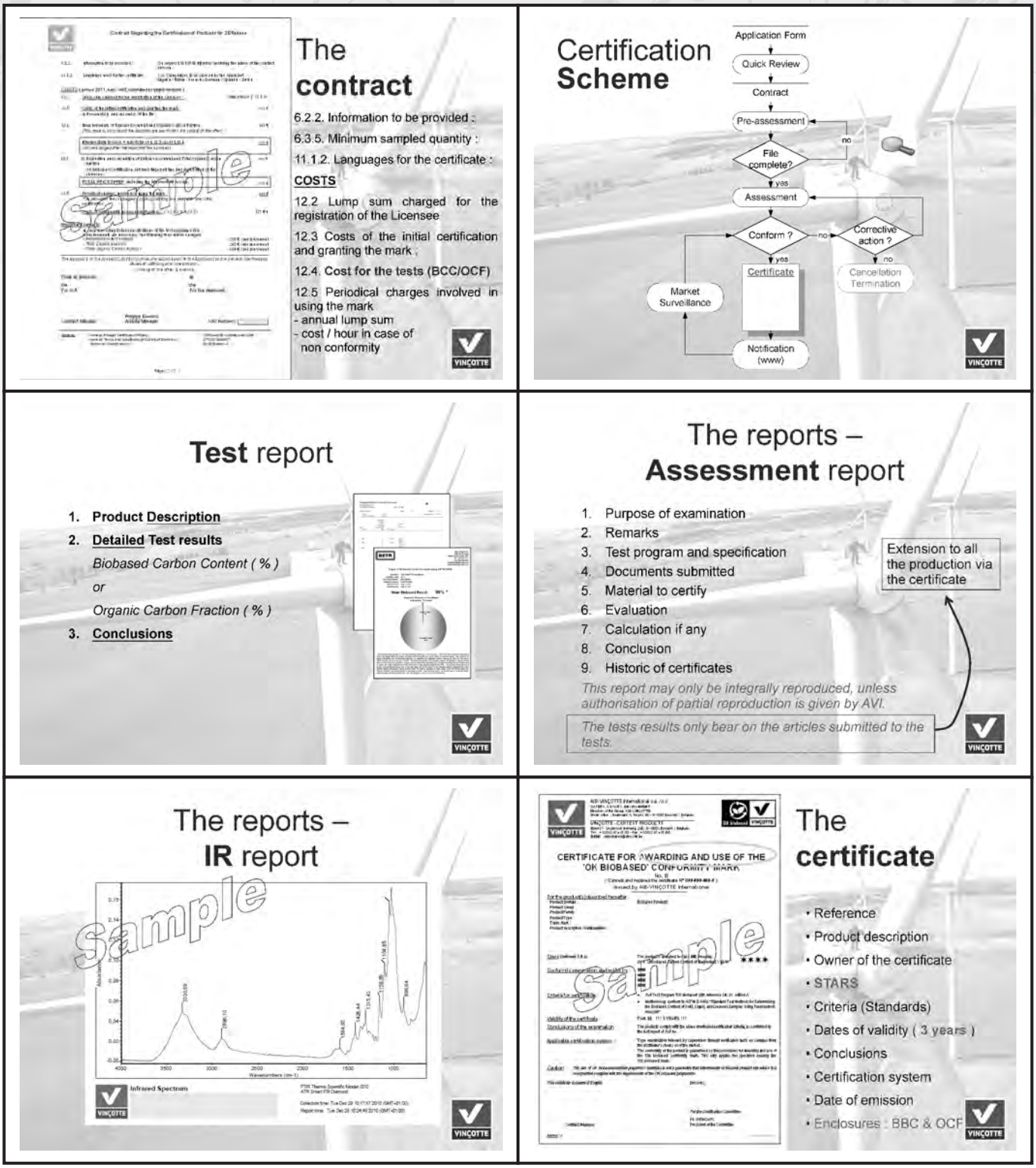
5.1.2.Logo to be affixed

5.2.5. Affixing mark procedure :

6.1.1. Sampling procedure :

6.1.3. Monitoring procedure :

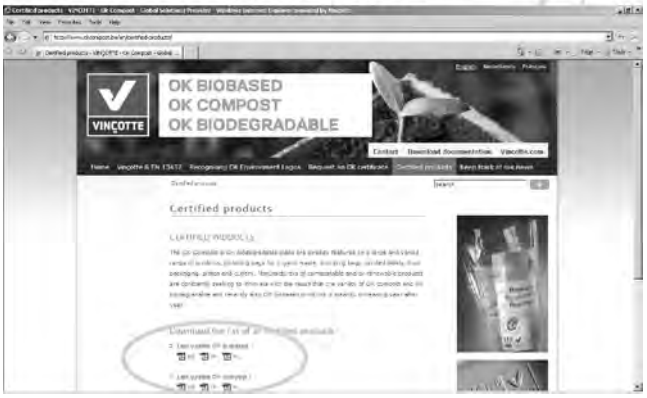
Certification of Compostable products and Biobased Products



Certification of Compostable products and Biobased Products

The **list** of certified products

The **website**

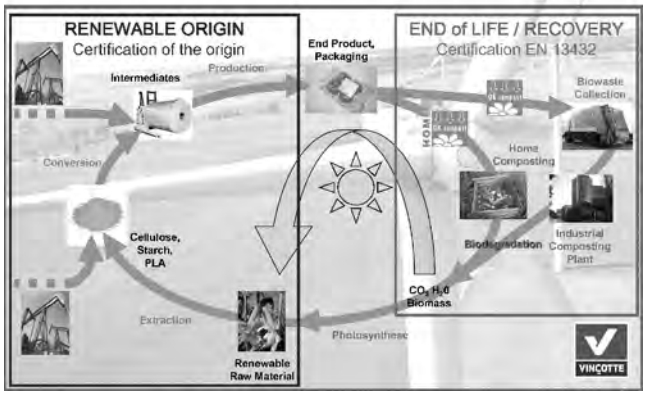


And tomorrow ?

Update of the Vinçotte's programs

- 4 programs have been updated (OK compost, OK compost HOME, OK biodegradable SOIL and WATER)
- Submitted to an Advisory Committee (Oct / Nov)
- Validation end 2011,
- Publication : January 1st, 2012
- OK biobased under revision (2012)

LCA ?



Contact

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Certification of Compostable products and Biobased Products

工作坊 5

「環球環保標籤」工作坊

Certification of Compostable products and Biobased Products

Presented by Mr. Philippe Dewolfs, Manager Labs & CERTEST Products of Aib Vincotte

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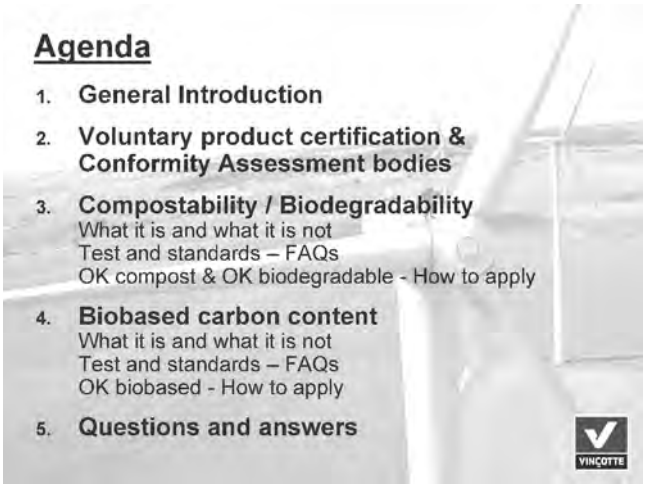
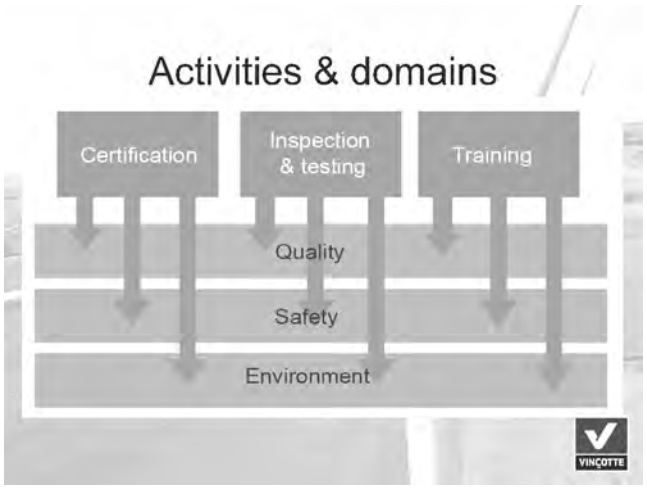
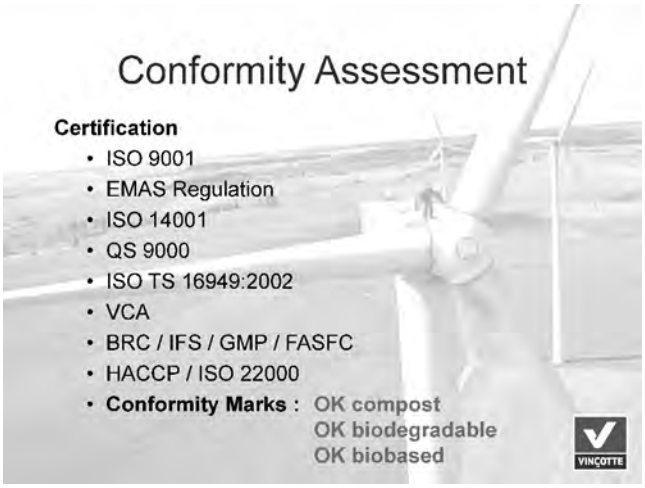
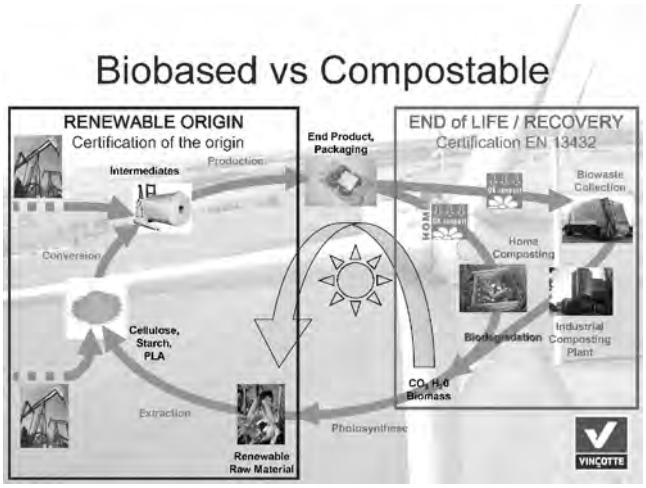
Certification of Compostable products and Biobased Products

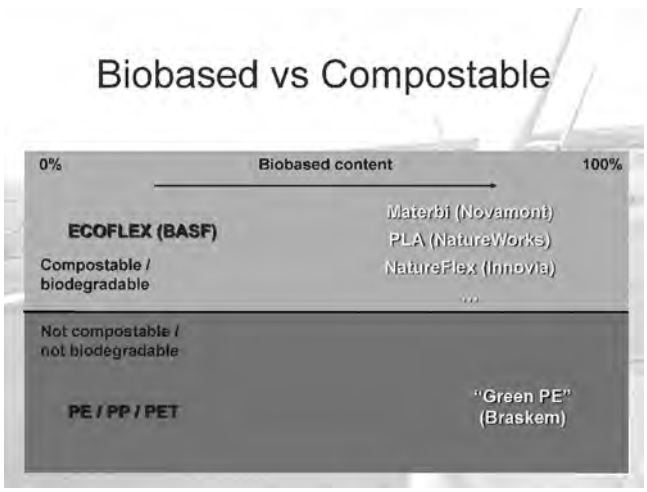




Certification of Compostable products and Biobased Products







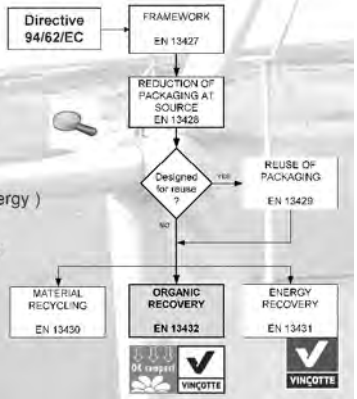
Certification of Compostable products and Biobased Products

Agenda

- Some of the drivers for "voluntary" product certification
- The three necessary components for a successful scheme
- Practical effects for countries outside the EU.
- OK compost conformity mark as a guideline

OK compost as a guideline

- Packaging directive :
  - REDUCE
  - REUSE
  - RECYCLE
  - RECOVER (organic / energy)
- Conformity to EN 13432
  = organic recovery
  = industrial compostability
  no more, no less



Drivers

- **Authorities**
- **Market** : retailers - brands - users
- **Industry** : Innovation / new product

Drivers : Authorities

- Need for independent & competent **assistance** in some very **specific sectors**
- "Privatisation" of the inspection / assessment & monitoring

conformity mark = a priori assessment	⟺	a posteriori inspection = market monitoring
Who makes the mistakes pays : manufacturer		Taxpayer : everybody pays *Privatisation of the bene socialisation of the cos*

Drivers : Authorities

- City of Antwerp (Belgium),
  - Tender for bags for the green waste collection
  - Many competitors, many "compostable" bags, no method to evaluate the products

  ⇒ Need help to make a selection and eliminate the black sheep

  ⇒ Asking Vinçotte to develop a certification scheme specific for compostable bags.
  = tests + certification + market monitoring

Drivers : Market (retailers – brands – users)

- Externalisation of the conformity assessment
  = **competent** third party
- Product **specification** easier
- Retailers / Brands : **Communication** to customers easier
- Users : need for **confidence** in the products
  safety ⇒ quality ⇒ environment ⇒ ethic

Certification of Compostable products and Biobased Products

Drivers : Market

- A lot of retailers requires OK compost conformity mark to **demonstrate** the compostability of the products
  - Tax reduction
  - Internal / external Green Policy
- Some use the logo (B2C), some other don't use it (B2B).

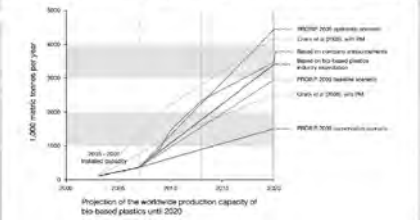
Drivers : Industry - Innovation

- Promote innovation by **giving confidence** in new products and/or new concepts

- Gives the innovators the possibility to demonstrate the compliance of their products with existing standards while **keeping the know-how confidential** = **independent & competent** third party

Drivers : Industry - Innovation

- Bioplastic industry is very new
- OK compost increases the confidence in these products, and participates in the development of this industry



Projection of the worldwide production capacity of bio-based plastics until 2020

Role of a CAB

- A Conformity Assessment Body is an **independent & competent intermediate** (third party) between the **manufacturers** and the (end-)**users**
- A conformity mark is the **visible sign** (logo) of the **conformity** of the product, to a **specific requirement**, assessed by an **independent & competent** body

The tools

	Technical content	Easy to understand
Mark - Logo (B2C)	-	★★★★
Certificate (B2B)	★★	★★★
Assessment report	★★★	★★
Test report	★★★★	★

A conformity mark translates complex technical matters in an easy-to-understand message

The 3 necessary components for a successful scheme

- **No general model** : there is a strong sectorial / geographical / economic dependence
- **Necessary components**
  - **Credibility / Competence** of the CAB
  - **Visibility** of the mark : people know what it means
  - **Credibility** of the mark : people believe the assessments are relevant and valid = credibility of the CAB

Certification of Compostable products and Biobased Products

Credibility of the CAB

- Ethical behaviour : a very sensitive issue at all levels
  ⇒ Bears out the need for **independent** CAB's
- Real & visible **competence** :
  more and more an absolute necessity
- **Credibility** = Adequacy of the conformity assessment tool
  ⇒ conformity, no more, no less

Competence of the CAB

- Accredited / Agreed / Certified / Notified, but
  - Low visibility of accreditation for the customers
  - Lack of awareness of the market with regard to the differences between the requirements
- The **reputation** of the CAB is still the major element
  - Network (other CABs, authorities, social groups)
  - Participation to standardisation workgroups
  - Neutrality
- Need for **fair competition** between CABs

Competence of the CAB

- Competence
  - in conformity assessment
  - in the related standards
  - In the bioplastic sector
- Consultant for national authorities
  (Belgium (Royal Decree), Australia, UK, Romania, …)
- International agreements and network

Visibility of the mark

- People know what it means
- Basic requirement =
  adequate design of the logo
- To increase visibility

Credibility of the mark :

- People believe the assessments
  are relevant and valid
  => credibility of the CAB
- People know who is behind the mark
  => Google "OK compost"
  => easy to contact Vinçotte
  => market monitoring / traceability !
- Effective market monitoring
  + actions in case of non-conformity or misuse of the mark

Credibility : Assessment & Market monitoring

Certification of Compostable products and Biobased Products

Mark with slow acceptance

Belgian Consumers Association identifies 4 reasons :

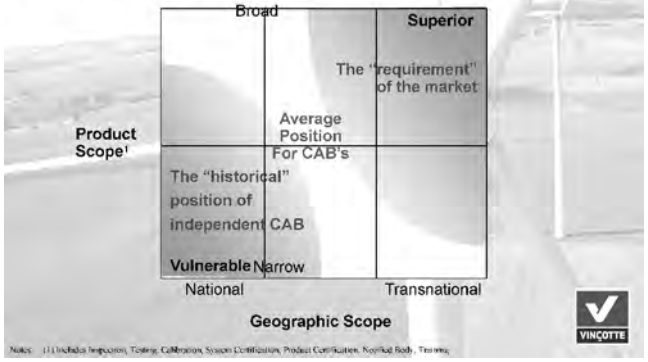
- **Cumbersome** procedure
- **Cost** of procedure
- **Lack of clarity** (label covers a product but sometimes only a component)
- Some countries have **already** implemented an efficient **national certification scheme**

CABs : Expectations from the market

The needs of the market appear to be contradictory

- **High level** of competence induces a need for **selectivity**
- "One-stop assessment" induces a **wide technical and geographical coverage**

CABs : Expectations from the market



Practical effects for countries outside the EU.

- Newcomer (manufacturer) obtains the **same level of credibility** as well-established manufacturer (*if the products comply to the requirements*) ⇒ eliminate black sheep
- **Differentiation** in quality, price or service, not in compliance ⇒ opportunity to distinguish from the others
- Harmonisation of the market
- Conformity mark **is not** & **may not be** a barrier to free circulation of goods

Certification of compostables products

3

The OK compost approach

Hong Kong Productivity Council
Sept. 23, 2011

Vinçotte
Philippe DEWOLFS

16

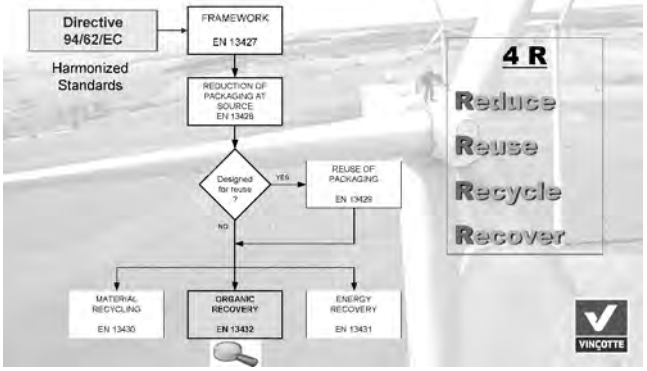
OK compost

Certification of Compostable products and Biobased Products

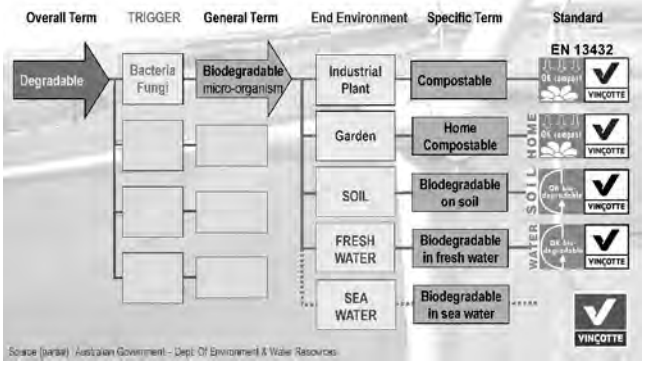
Packaging directive 94/62/EC

- The Directive on Packaging and Packaging Waste (94/62/EC)
  - Defines requirements for the manufacturing and composition of packaging.
    - reduction of **packaging**
    - reduction of **waste** by reuse / recycling / recovery
  - Obligation for the Member States to organize
    - waste collection
    - recycling / recovery

Packaging directive 94/62/EC

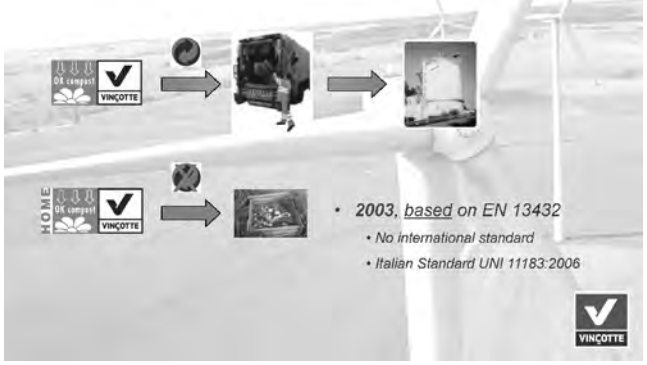


Compostable ? Biodegradable ?



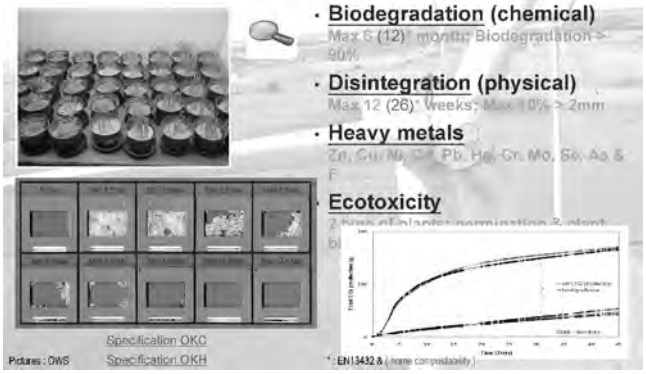
Source (partial) : Australian Government - Dept Of Environment & Water Resources

Environmental Conformity Marks



- *2003, based on EN 13432*
  - *No international standard*
  - *Italian Standard UNI 11183:2006*

OK Compost (HOME) = 4 tests



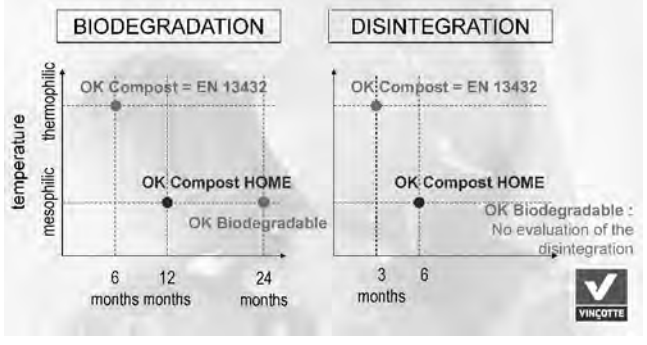
- **Biodegradation (chemical)**
  Max 6 (12)* month: Biodegradation > 90%
- **Disintegration (physical)**
  Max 12 (26)* weeks: Max 10% > 2mm
- **Heavy metals**
  Zn, Cu, Ni, Cr, Pb, Hg, Cr, Mo, Se, As & F
- **Ecotoxicity**
  2 kinds of plants: germination & plant b

Specification OKC
Specification OKH

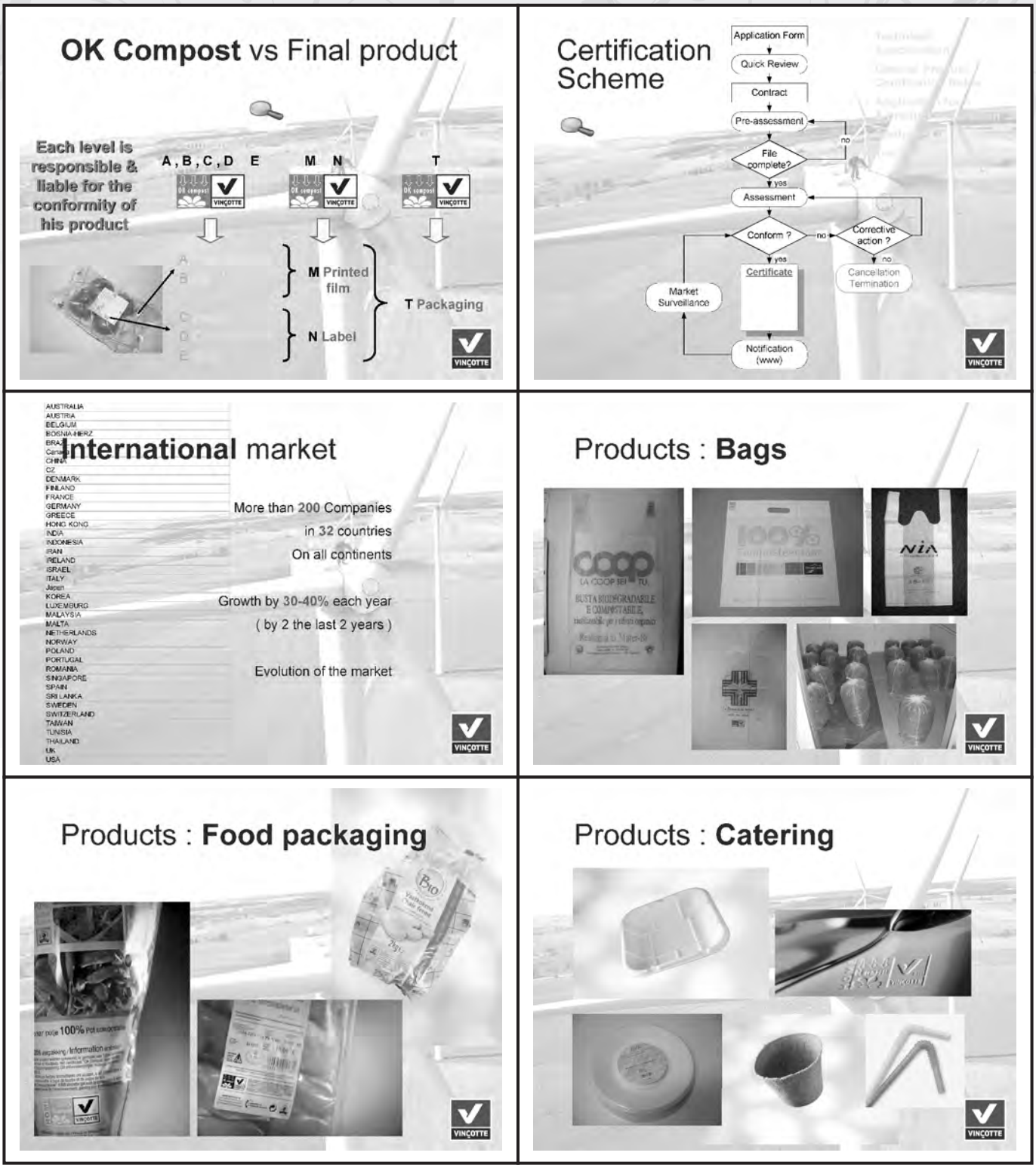
Pictures : OWS

*: EN 13432 & (home compostability)

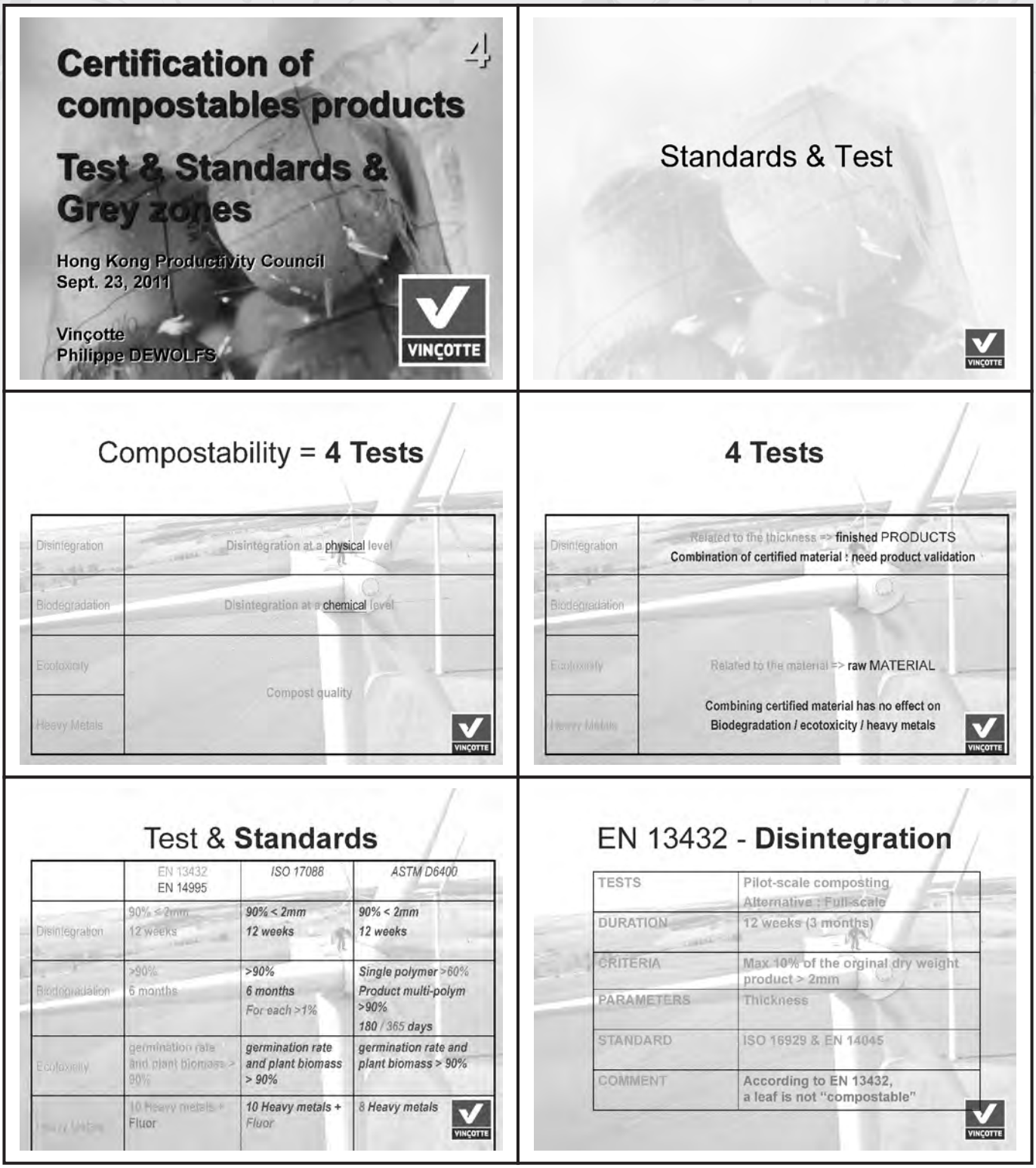
Temperatures & Delays



Certification of Compostable products and Biobased Products

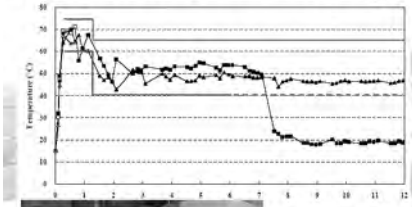


Certification of Compostable products and Biobased Products



Certification of Compostable products and Biobased Products

Quantitative Disintegration Test



12 weeks,
90% of disintegration

ISO 16929 or
EN 14045

4 vessels
-2 reference (biowaste)
-2 test (biowaste + 1-10 % material)

VINÇOTTE

Qualitative Disintegration Test

ISO 20200
30 slides

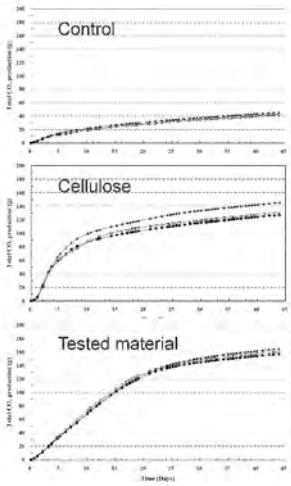
VINÇOTTE

EN 13432 - **Biodegradation**

TESTS	Preferably ISO 14855 (Controlled composting) or ISO 14851 or ISO 14852
DURATION	Maximum 6 Months
CRITERIA	90% (absolute or relative to reference)
VALIDITY	- 3 replicates with in 20% - >70% after 45 days
CONDITIONS	3 x 3 = 9 vessels , at 58 ± 2 °C
COMMENT	Not applicable if : - Natural material Non chemically modified material - Not significant (< 1%, tot max 5%

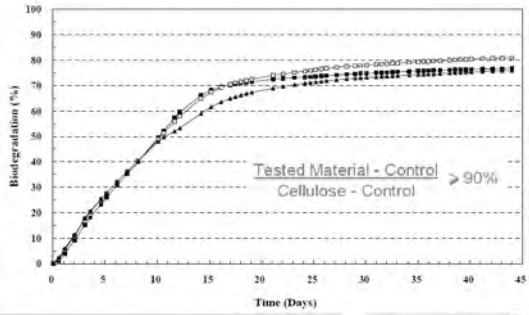
VINÇOTTE

EN 13432 **Biodegradation**



VINÇOTTE

EN 13432 - **Biodegradation**



VINÇOTTE

EN 13432 – Compost Quality
Material characteristics

Packaging, packaging materials and packaging components shall contain a minimum of 50 % of volatile solids which exclude largely inert materials.

Element	ASTM D 6400		EN 13432 [F]	Japan [J]
	US [A]	Canada [D]		
Zn	1 400	463	150	160
Cu	750	189	50	50
Ni	210	45	25	30
Cd	17	5	0,5	0,5
Pb	150	125	50	10
Hg	8,5	1	0,5	0,2
Cr	—	265	50	50
Mo	—	5	1	—
Se	50	4	0,75	—
As	20,5	19	5	5
F	—	—	100	—
Co	—	38	—	—

Certification of Compostable products and Biobased Products

EN 13432 – Compost Quality
Ecotoxicity

TESTS	2 plants OECD 208 & EN 13432
DURATION	2 weeks
CRITERIA	Germination & Growth > 90%
COMMENT	4 replicates of 2 mix for 2 plants + references

VINÇOTTE

EN 13432 – Compost Quality
Ecotoxicity

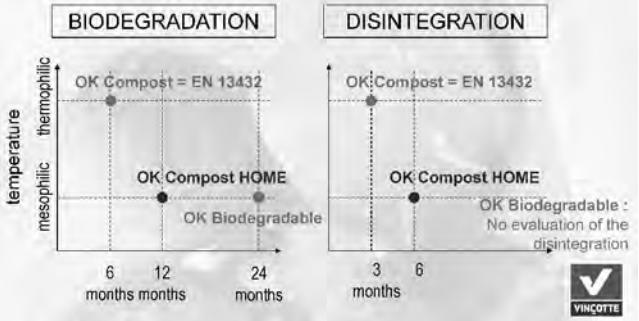
VINÇOTTE

OK compost
OK biodegradable

Temperatures & delays

VINÇOTTE

Temperatures & Delays



VINÇOTTE

Temperatures & Delays

	OK compost EN 13432	OK compost HOME	OK biodegr SOIL	OK biodegr WATER
Disintegration	12 weeks 70-65-40 °C	6 months 25 ± 5 °C	no	no
Biodegradation	6 months 58 ± 2 °C	12 months 25 ± 5 °C	24 months 20-25 °C	6 weeks 20-25 °C
Ecotoxicity	OECD 208 + EN 13432	Same as OK compost	Same as OK compost	Same as OK compost
Heavy Metals	EN 13432	Same as OK compost	Same as OK compost	No (local regulation)

How to understand the standard ?

VINÇOTTE

Certification of Compostable products and Biobased Products

Combination of constituents / components

Some "grey areas" in the standard => **Need for interpretation** !

How to use the standard for complex, multicomponent products ?

EN 13432 – Combination of constituents / components

EN13432 Scope

In case of a packaging formed by different components, some of which are compostable and some other not, the packaging itself, as a whole is not compostable.

However, if the **components can be easily separated** by hand before disposal, the compostable components can be effectively **considered and treated as such**, once separated from the non compostable components.

EN 13432 – Combination of constituents / components

Definitions

constituent **of a packaging material (EN 13432)**

all pure chemical materials and substances of which a packaging material is composed

chemical

packaging component (EN 13432)

part of packaging that can be separated by hand or by using simple physical means

physical

Integrated **component (Vinçotte)**

part of product that can be (easily) differentiated but not (easily) separated by hand or by using simple physical means.

EN 13432 Biodegradation : **Exemptions**

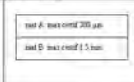
Biodegradation

Exemption (= no test) if :

- Non-significant component/constituent (means < 1%) & for a maximum of 5 % (*A.2.1 Significant organic constituents*)
- Non chemically modified natural material (*4.3.2 Materials of natural origin*)

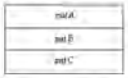
Vinçotte Disintegration : **Multilayers** (1/2)

The following multilayers are be accepted as meeting the disintegration requirements of the test program based on the determinations in the table below :

	Multilayers of two layers thickness of each layer is not exceeding 50 % of its specific maximum certified thickness	Multilayers of three layers total thickness of the multilayer is not exceeding 50 % of the lowest maximum certified thickness of all used materials
Example		
Multilayer without glue	accepted without disintegration testing	
Multilayer with glue	accepted after positive result of qualitative disintegration testing	

Always assessment and certification of the new multilayer by Vinçotte

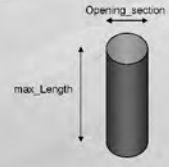
Vinçotte Disintegration : **Multilayers** (2/2)

The originally accepted multilayer	The modified multilayer:
	
The original multilayer has already been accepted for the disintegration requirements.	The modified multilayer (modification: replacing of a layer) will be accepted for the disintegration requirements without additional testing on the complete multilayer on the condition that all following requirements are met: √ the original multilayer is accepted to meet the disintegration requirements √ the replacing layer (symbolized as "mat D" below) is already certified √ the thickness of the replacing layer is not exceeding 50 % of its maximum certified thickness √ the replacing layer (in its applied –or higher than applied-thickness) shows equal or better disintegration properties than the replaced layer (in its applied –or lower than applied-thickness) in a qualitative comparative disintegration test.

Certification of Compostable products and Biobased Products

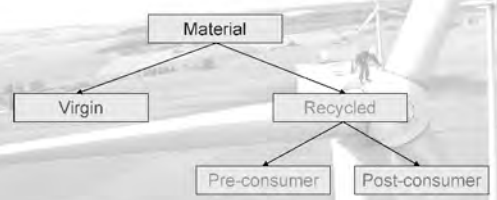
Vinçotte Disintegration : **Hollow bodies**

- The allowed thickness for the straw is max 50% of the certified thickness of the material.
- max_Length / Opening_section ≥ 1 cm^{-1} => hollow body



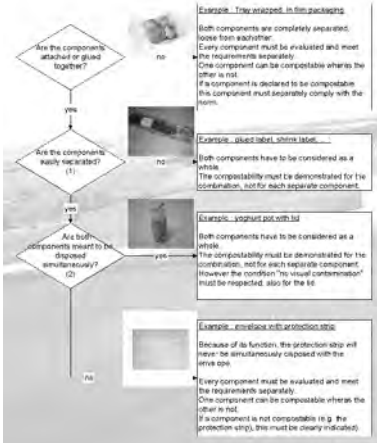
- ! If 2 openings !

Vinçotte– **Recycled material**



Periodical analyse of the material
(heavy metals content)

Combination of constituents / components



Vinçotte – **Combination** of constituents / components

Fruits or vegetables packaged with a tray and a film.

- Both components are completely separated, loose from each other.
- Every component must be evaluated and meet the requirements separately.
- One component can be compostable whereas the other is not.
- If a component is declared to be compostable, this component must separately comply with the norm.

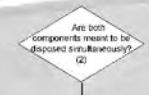
Vinçotte – **Combination** of constituents / components

Fruits or vegetables packaged with a film.
A label is affixed on the film

- The label is not an component but an integrated component
- Both components have to be considered as a whole.
- The compostability must be demonstrated for the combination, not for each separate component.

Vinçotte – **Combination** of constituents / components

Pot with a shrink label and a lid.



- The shrink label is not an component but an integrated component
- Both components have to be considered as a whole.
- The compostability must be demonstrated for the combination, not for each separate component.
- However the condition "no visual contamination" must be respected, also for the lid.

Certification of Compostable products and Biobased Products

Vinçotte – **Combination** of constituents / components

A letter with a protection strip

- Because of its function, the protection strip will never be simultaneously disposed with the envelope.

no

- Every component must be evaluated and meet the requirements separately.
- One component can be compostable wheras the other is not.
- If a component is not compostable (e.g. the protection strip), this must be clearly indicated).

Vinçotte – **Combination** of constituents / components

Compostable bags (for green waste collection) packaged in PE packaging.

- In this case, these bags (for waste collection) are not to be considered as packaging.
- However, the information printed on the packaging (claiming that the packaged bags are compostable) may not confuse the end user. The claim (red circle) as on the picture is not allowed.
- This is also true for other compostable items (plates, cutlery, ...) packaged in a not compostable packaging.

Agreement of Labs

OK compost **Agreement** of labs

Quality standard for labs (ISO 9000)

3 possibilities :

- agreed by **Vinçotte** (via audit by Vinçotte, based on ISO 17025) => official **list**
- **accredited** ISO 17025 for EN 13432 by National Accreditation Board
- agreed by other **Certification body**

But

- if the lab is not agreed by Vinçotte (1st case), always contact us **before** starting the tests ....

The case of the oxodegradable plastics

EN 13432 – **Oxodegradable**

- Additivated PE

  PE + pro-oxydantia
- Does not fullfill ASTM D 6400 nor EN 13432

  (ASTM D 6954 is a test method)
- Is not certified

工作坊 6

「RoHS 2及其他環保法規」工作坊

The Impact of Key Global Environmental Directives on Manufacturers

Presented by Mr. Bijan Dastmalchi,
The Principal of Symphony Consulting, Inc.

The Impact of Key Global Environmental Directives on Manufacturers

Presented by Mr. Bijan Dastmalchi who is the Principal of Symphony Consulting, Inc.

The Impact of Key Global Environmental Directives on Manufacturers

Symphony Consulting

The Impact of Key Global Environmental Directives on Manufacturers

December 8, 2011

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Symphony's Areas of Practice

- **Supply Chain and Mfg. Outsourcing**
  - Reducing inventory exposure in the supply chain
  - Sourcing: EMS qualification, selection, and audit
  - Cost modeling on-shore vs. off-shore mfg.
  - Contract drafting and negotiations
  - Transition from internal to outsourced manufacturing
- **Global Environmental Compliance (RoHS / REACH / WEEE)**
  - Policy and strategy definition
  - Development of a conformance assurance system
  - Cost effective due diligence
  - Supplier data collection
- **IT Procurement and Contract Negotiations**
  - Hardware
  - Software
  - Services

Disclaimer

- The material in this webinar is...
  - Intended to provide some insight into key issues surrounding REACH / RoHS II
  - To be used as a guideline along with other key considerations that may not be covered in this webinar
- The material in this webinar is not...
  - A guarantee of any kind in regards to financial performance, success, results, or compliance with the REACH Regulation / RoHS II directive
  - Intended to cover all issues that need to be considered in transitioning your supply chain for REACH / RoHS II compliance
- Symphony accepts no liability or responsibility for the manner in which a company chooses to utilize the material offered in this webinar.

Workshop Purpose

The purpose of this workshop is to provide you with information on the most relevant global environmental risks, how they are enforced, and what you can do to mitigate risks to your business

Agenda

- **Morning**
  - Introductions
  - Importance of a Robust Compliance Program
  - RoHS II
  - PoHS
  - China RoHS
  - Battery Directive
  - Packaging Directive
- Afternoon
  - REACH
  - BPA, Formaldehyde and other restricted substances
  - Enforcement in the EU
  - Conformance assurance and testing

Introduction

- Your Name
- Your Company (if you wish to disclose)
- Your role / job title
- What you would like to get from today's session

The Impact of Key Global Environmental Directives on Manufacturers

Why Is a Robust Compliance Program Important

- Non-compliance can impact revenue due to stopped shipments
  - Customers
    - Contracts
    - PO's
  - Enforcement authorities
- Lead to fines, unwanted publicity
- Can force mid-product lifecycle redesigns

Risks of Poor Supplier Compliance

- Hundreds of Millions of Dollars of product withdrawals in Britain, Netherlands & Sweden alone in 2009 and 2010 for RoHS violations
- Penalties included fines, missed shipments, risk of negative publicity
- Enforcement methods:
  - Focused product category audits
  - Initial consumer product focus but now industrial also
  - Nearly half of the enforcement actions came from "whistler blowers"
- Enforcement approach varies among EU member states
  - UK: Documentation
  - Netherlands / Sweden: Product

Evidence of RoHS Enforcement

UK, Netherlands, Sweden enforcement officials report:

- 25% of all products tested in 2009 still non-RoHS compliant
- The Swedish Chemical Agency (KemI) found lead in concentrations exceeding the legal limit in 22% of consumer products tested. This constituted 17 electrical toys out of 79 tested, eight out of 29 electronic products and two out of 21 lamps. KemI has reported the companies responsible for the import of these products to the police – **Chemical Watch News - Mar 15, 2011**
- $30 million/yr in products sequestered in each country

"A Roundtable with EU RoHS Enforcement Authorities" TechAmerica / Symphony Consulting, Inc webinar with Chris Smith (UK), Roel Feijen (NL), Christina Larsson (SW)

"The product needs to comply, not the documentation" –Roel Feijen VROM-Inspectorate Netherlands

"In order to satisfy the [due diligence] defense you have to show that you created a **control system**, that it worked and that you operated that system" Official U.K. RoHS website

Overview of EU RoHS Directive

- RoHS: "**R**estriction **o**f **H**azardous **S**ubstances"
- Took effect July 1, 2006
- Elimination of two families of brominated flame retardants and several heavy metals from electronics

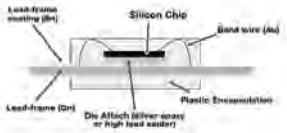
Lead (Pb)	<0.1%
Mercury (Hg)	<0.1%
Hexavalent Chromium (CrVI)	<0.1%
Polybrominated Biphenyls (PBBs)	<0.1%
Polybrominated Diphenyl Ethers (PBDEs)	<0.1%
Cadmium (Cd)	<0.01%

- Exemptions granted if strong technical case made that there is no other way & use is vital to commerce
- Applies at "homogenous" level: each layer of each component of each assembly

RoHS Overview

"Homogeneous Material"

- Material that cannot be mechanically disjointed into other materials through unscrewing, cutting, crushing, grinding, and abrasive processes



RoHS Overview

- "Producer" defined as any person who
  - "Manufactures and sells electrical and electronic equipment under his own brand;
  - Resells under his own brand equipment produced by other suppliers;
  - Imports or exports electrical and electronic equipment into a Member State."
- "Put on the market" means the initial action of making a product available for the first time in the EU
- Effective date: all shipments on or after July 1, 2006
- Proof of compliance within 28 days after request

The Impact of Key Global Environmental Directives on Manufacturers

RoHS Exemptions

Exempts materials in *specific applications*

- 4(e) – Mercury in metal halide lamps (MH)
- 5(a) - Lead in glass of cathode ray tubes
- 6 - Lead as an alloying element in steel, aluminum and copper alloy containing up to 0.35%, 0.4% and 4% lead by weight, respectively
- 7(a) - Lead in high melting temperature type solders (i.e. lead- based alloys containing 85 % by weight or more lead)
- 7(b) - Lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signaling, transmission, and network management for telecommunications

13

RoHS Exemptions (con't)

Expired & Expiring Exemptions...

- 9(a) - DecaBDE in polymeric applications (Expired 6/30/2008)
- 22 - Lead as impurity in RIG (rare earth iron garnet) Faraday rotators used for fibre optic communication systems (Expired 12/31/2009)
- 11(a) - Lead used in C-press compliant pin connector systems (Expired 9/24/2010)
- 7c(ii) – Lead in dielectric ceramic in capacitors for a rated voltage of less than 125 VAC or 250 VDC (Expires on 1/1/2013)
- 8(a) - Cadmium and its compounds in one shot pellet type thermal cut-offs (Expires 1/1/2012)
- 11(b) - Lead used in other than C-press compliant pin connector systems (Expires on 1/1/2013)

14

EU RoHS Recast (RoHS II)

- Entry force date: July 21, 2011 and becomes national EU Law on January 2, 2013
- Same six banned substances and maximum concentration values
- Inclusion of
  - Category 8 - medical devices (7/22/2014)
  - Category 8 – in-vitro medical devices (7/22/2016)
  - Category 9 - control/monitoring instruments (7/22/2014)
  - Category 11 - Other EEE not covered by any of the categories in Annex I (7/22/2019)
- RoHS II - RoHS Directive mandates review & improvement be done every four years
- Exemptions require renewal every 5 years (Categories 1-7, 10, 11) and 7 years (Categories 8, 9)to stimulate substitution
- Compliance must be an on-going process not an event (i.e. is each manufacturing lot compliant? – not just one time collection of CoCs)
- "Producer" will be replaced with "Economic Operators" (includes manufacturers, distributors, importers, and authorized resellers)

15

EU RoHS Recast (con't)

- Requires **Technical Document** (Kept 10 years after EEE is put on the market)
  - Product description
  - Bill of Materials
  - Examinations carried out
  - **Test Reports**
- Provide signed CE Declaration of Conformity (DoC)
- CE marking will be required for compliant products
  - batch / serial number
  - manufacturer name / trade mark
  - manufacturer contact information
- Risk based approach backed up by test data (i.e. certificates of compliance alone is no longer sufficient in all cases)

16

RoHS Recast: What to expect

- Increased enforcement efforts
- Audits by certification bodies due to CE marking link
- More scrutiny by other "economic operators" (e.g. distributors, retailers, customers)
  - Contract terms vis-à-vis compliance
  - Declarations of conformity
  - Site audits
- Perceived more as an "ISO" type exercise rather than one time effort
- More robust due diligence requirements
  - Differentiated approach to components and suppliers based on risk
  - Verification testing

17

RoHS Recast - Document

18

The Impact of Key Global Environmental Directives on Manufacturers

PoHS

- Prohibition on Hazardous Substances (PoHS)
- Applies only to Norway
- Very similar to RoHS Directive and homogenous layer concept but more stringent in maximum concentration values – as low as 5ppm
- Any consumer products that do not fall into categories 1 to 8 and 10 of the RoHS Directive. Examples:
  - Test equipment (smoke detectors, thermostats, etc.)
  - Clothing
  - Bags
  - Toys
  - Paint
- Do not apply to:
  - Food and packaging
  - Fertilizers
  - Medical equipment
  - Tobacco
  - Transport equipment
  - Auxiliary equipment

PoHS (con't)

- Was due to come into force on January 1, 2008 with 18 restricted substances but reduced to 10 restricted substances in August 2008 after evaluation suggestions from stakeholders
  - Arsenic and arsenic compounds (0.1% w/w)
  - Bisphenol A (0.005% w/w)
  - Lead and lead compounds (0.01% w/w)
  - Hexabromocyclododecane (HBCDD) (0.1% w/w)
  - Cadmium and cadmium compounds (0.01% w/w)
  - Chlorinated paraffins (0.1% w/w)
  - Musk xylene (0.05% w/w)
  - Pentachlorophenol (0.1% w/w)
  - Perfluorooctanic acid (PFOA) and individual salts and esters of PFOA (0.005% w/w)
  - Triclosan (0.001% w/w)
- The Norwegian Pollution Control Authority wishes to evaluate the stakeholder replies properly and has decided to defer entry into force until further notice
- Due to Norway's inclusion into REACH, being an EEA country, they are pushing new restrictions under the auspices of the REACH Regulation's methodologies

RoHS I, RoHS II & PoHS

RoHS I	RoHS II	PoHS
Came into force on July 1, 2006	Came into force on July 21, 2011. National EU Law by January 2, 2012 and later dates depending on Categories	January 1, 2008; rescheduled to August 2008, but delayed until further notice
Scope: Categories 1 - 7, 10	Scope: Categories 1 - 11	Scope: Consumer products not in Categories 1 - 7 and 10 (i.e. including Category 9)
6 Banned Substances at homogenous layers (Pb, Cd, Hg, Cr6+, PBB, PBDE)	6 Banned Substances at homogenous layers (Pb, Cd, Hg, Cr6+, PBB, PBDE)	10 Banned Substances at homogenous layers (Only Pb and Cd from RoHS)
Max Concentration Value at 1000ppm, except Cd at 100ppm	Max Concentration Value at 1000ppm, except Cd at 100ppm	More stringent, as low as 5ppm
No reference to REACH	Review and Amendment of Annex II must be coherent with REACH	Pushing new restrictions under the auspices of the REACH Regulation's methodologies

RoHS I, RoHS II & PoHS (con't)

RoHS I	RoHS II	PoHS
Exemption Annex	Exemption Annex III (Existing) and Exemption Annex IV (Category 8, 9)	Exemptions listed in draft
No defined process and timeline for exemption renewal process	Defined process and timeline for exemption renewal process	No defined process and timeline for exemption renewal process
Self declaration	Signed Declaration of Conformity	Self declaration
CE Marking as official EU declaration was not required	CE Marking as official EU declaration required	CE Marking as official EU declaration was not required
Testing not required - due diligence	Testing is now required - risk based approach	Testing not required - due diligence
Technical documents not required	Require technical documents, and retained for 10 years	Technical documents not required
No Defined Obligations For Manufacturers, Distributors, Importers	Defined Obligations For Manufacturers, Distributors, Importers	No Defined Obligations For Manufacturers, Distributors, Importers

Overview of China RoHS

- Effective March 1, 2007
- Same substances and MCV as EU RoHS, but without exemptions
- Carried out in two phases
  - Phase 1: Documentation and labeling March 2007

  - Phase 2: Restriction of substances based on a catalog
    - **First items published – cell phones / printers**
    - **10-12 "EU exemptions" permitted for phones / printers**
    - **Testing at an approved Chinese lab (in China)**
    - **CCC (China Compulsory Certification) required within 10 months of promulgation in catalog**

Battery Directive (26 September 2006) — Basics

Scope: All batteries but distinctions made based on type

Requirements:

- **Prohibited substances**:
  - Mercury (≥ 2.0% wt) button cells
  - Mercury (≥ 0.0005% wt) (all other batteries)
  - Cadmium (≥ 0.002% wt) (all batteries)
  - Military / aerospace are exempted from prohibition
- **Must be designed for easy battery removal:**
  - Generally batteries must be secured with clips not soldered onto PC board
  - Instructions for removal must accompany unit
  - Exemptions for safety or data reliability (but will be required to prove this.)
- **All batteries must be recycled at no cost to consumer:**
  - Portable batteries (All producers/importers/Distr must have free take back program)
  - Industrial batteries – must still have instructions for safe removal & recycle
- **Marking**
  - "Don't dispose of in trash" Trash bin with X across it (size: 3% of cell or 1.5% cm)
  - Type of battery; if it contains Pb, Cd, Hg, etc must be marked on battery
  - Capacity of battery must be marked on unit but rules aren't finalized yet.

The Impact of Key Global Environmental Directives on Manufacturers

Packaging Directive—Basics

Scope: All product packaging

Requirements:

- **Total weight of the following heavy metals cannot exceed 100 ppm by wt:**
  - Lead (Pb)
  - Cadmium (Cd)
  - Mercury (Hg)
  - Hexavalent chromium
- **Packaging material must be labeled to facilitate recycling**

>PET<

- **EU member states were required to establish recycling programs & significant recycling goals were established**
  - 25 EU countries have producer "takeback" laws or producer taxes to ensure recovery of used packaging. These involve producer tracking, reporting and payment of fees.
  - Packaging volume and weight must be the minimum necessary to adequately protect the product (no small part in big box with foam peanuts)
  - Packaging must be designed to permit reuse or recovery

25

Agenda

- Morning
  - Introductions
  - Importance of a Robust Compliance Program
  - RoHS II
  - PoHS
  - China RoHS
  - Battery Directive
  - Packaging Directive
- **Afternoon**
  - REACH
  - BPA, Formaldehyde and other restricted substances
  - Enforcement in the EU
  - Conformance assurance and testing

26

REACH: What is it?

Registration **E**valuation **A**uthorization of **Ch**emicals
(Reg. No. 1907/2006)

- REACH is a regulation not a Directive like RoHS
- Effective as of June 2007
- A process where most chemicals must be **Registered** for specific applications prior to use in EU
- Chemicals are being **Evaluated** for health & environmental hazards
  - Beginning with those considered most hazardous
  - Eventually thousands of chemicals over the next 10-15 years
- Highly toxic or environmentally damaging chemicals require **Authorization** for use:
  - Some will be authorized only for certain uses
  - Will be taxed based on tons/yr – some will be heavily taxed
  - Substances may be tracked from chemical manufacture up to the supply chain through to **manufacturer/importer**

27

REACH: What is it?

- REACH is a European Union Chemical Regulation that:
  - Profoundly effects companies that make or sell chemicals / substances in the EU
  - Significantly effects companies that use chemicals / substances to manufacture products or as intermediates or preparations in the EU
  - Leads to reporting requirements for anyone importing goods / articles into the EU supply chain through to manufacturer/importer
- The Purpose of REACH:
  - To create a single, uniform chemical management policy for EU Countries
  - Move responsibility for chemical hazards assessment onto chemical companies and away from government
  - Ensure industry adequately handles the risks of hazardous chemicals throughout life cycle
  - Risk = Hazard x Exposure Opportunities rather than unilateral bans on substances

28

REACH: Terms you need to know

- **Substance**: Any chemical such as iron, lead, polypropylene, benzene
- **Preparation:** Mixtures made from Substances such as **ink** or **PVC resin** used to make wire insulation (mixture of Polyvinylchloride, DEHP plasticizer, colorants, stabilizers and other additives)
- **Article:** Any manufactured item where the shape, surface or design causes it to be more important than its chemical make up. In other words, nearly all hardware, components, modules and finished goods
- **Downstream User**: Anyone who uses Substances commercially in the EU such as formulators (resin mfrs, flux suppliers, etc), OEMs (adhesives, paints, flux, etc), importers of products that contain these substances.
- **Substance of Very High Concern (SVHC)**: Most dangerous substances as determined by ECHA (Article 57)
- **ECHA: E**uropean **Ch**emicals **A**gency
- **Only Representative**: A European entity who acts as an agent to register substances for non EU Companies

30

REACH: Registration requirements

- Substances must be registered to import into the EU whether in:
  - raw chemical form,
  - preparations or
  - a manufactured article **if intentionally released**
- Registration requires submission of detailed toxicological and exposure data for evaluation by ECHA:
  ("No Data; No Market")
- Non EU Companies must use an "Only Representative" to Register (Article 8)
- Before Nov 2008, substances could be pre-registered but now, all new substances require extensive toxicity testing and approval by ECHA before being placed on the market

31

The Impact of Key Global Environmental Directives on Manufacturers

REACH: Substances, Preparations & Articles

Copper ore:	Substance	
Copper concentrate:	Substance	
Smelted Copper:	Substance	
Copper Alloy:	Preparation	
Bare copper wire:	Article	
Copper wire with insulation:	Article	

31

Additional examples of Articles – Laser Printer

- Enclosure
- Power Cord (Spare?)
  - Connector
  - Copper wire
  - Insulation
- PCBA
  - PCB (Spare?)
  - Components
- Power Supply
  - PCBA (Spare?)
    - Components
    - PCB
  - Sheet metal

32

REACH: Substances of Very High Concern

- Candidate List of 53 SVHCs have been released with the latest on June 20, 2011.
- Article 33: Notification of a substance to the EU Chemicals Agency is mandatory if SVHCs are present in:
  - Substance Shipments ≥ 1 metric ton / year ***AND***
  - Concentration in article is ≥ 0.1Wt%
- Must be prepared to notify requestors (mostly B-to-C products) within 45 days of the date of request if Article contains an SVHC that is > 0.1% by weight of the Article
- Must proactively notify downstream users (mostly B-to-B products) if Article contains an SVHC that is > 0.1% by weight of the Article
- General Criteria for Inclusion (Article 57):
  - Carcinogens (Categories 1 or 2 per Directive 67/548/EEC)
  - Mutagens (Categories 1 or 2 per Directive 67/548/EEC)
  - Reproductive Toxins (Categories 1 or 2 per Directive 67/548/EEC)
  - Persistent, Bioaccumulative or Toxic per (Annex XIII) (e.g. PolyChlorinatedBiphenyls, perfluorooctanic acid)
  - Endocrine Disruptors (phthalates, etc.)

33

REACH: Substances of Very High Concern

Substances of Very High Concern (SVHC)	Date of Inclusion
Anthracene	28-Oct-08
4,4'-Diaminodiphenylmethane (MDA)	28-Oct-08
Dibutyl phthalate (DBP)	28-Oct-08
Cobalt dichloride	28-Oct-08
Diarsenic pentaoxide	28-Oct-08
Diarsenic trioxide	28-Oct-08
Sodium dichromate	28-Oct-08
5-tert-Butyl-2,4,6-trinitro-m-xylene (musk xylene)	28-Oct-08
Bis (2-ethyl(hexyl) phthalate) (DEHP)	28-Oct-08
Hexabromocyclododecane (HBCDD) and all major diastereoisomers identified: α-hexabromocyclododecane, β-Hexabromocyclododecane, γ-hexabromocyclododecane	28-Oct-08
Alkanes,C10-13, chloro(Short Chain Chlorinated Paraffins)	28-Oct-08
Bis(tributyltin)oxide (TBTO)	28-Oct-08
Lead hydrogen arsenate	28-Oct-08
Triethyl arsenate	28-Oct-08
Benzyl butyl phthalate (BBP)	28-Oct-08
2,4-Dinitrotoluene	13-Jan-10
Aluminosilicate Refractory Ceramic Fibres	13-Jan-10
Anthracene oil	13-Jan-10
Anthracene oil, anthracene paste	13-Jan-10
Anthracene oil, anthracene paste, anthracene fraction	13-Jan-10
Anthracene oil, anthracene paste, distillation lights	13-Jan-10
Anthracene oil, anthracene-low	13-Jan-10
Dibutylbyl phthalate	13-Jan-10
Lead chromate	13-Jan-10

34

REACH: Substances of Very High Concern

Substances of Very High Concern (SVHC)	Date of Inclusion
Lead chromate molybdate sulphate red (Color Index Pigment Red 104)	13-Jan-10
Lead sulfochromate yellow (Color Index Pigment Yellow 34)	13-Jan-10
Pitch, coal tar, high temperature	13-Jan-10
Tris(2-chloroethyl) phosphate	13-Jan-10
Zirconia Aluminosilicate Refractory Ceramic Fibres	13-Jan-10
Acrylamide	20-Mar-10
Sodium chromate	18-Jun-10
Potassium chromate	18-Jun-10
Ammonium dichromate	18-Jun-10
Potassium dichromate	18-Jun-10
Tetraboron disodium heptaoxide, hydrate	18-Jun-10
Disodium tetraborate, anhydrous	18-Jun-10
Boric acid	18-Jun-10
Trichloroethylene	18-Jun-10
Chromic acid, Oligomers of chromic acid and dichromic acid; Dichromic acid	15-Dec-10
Chromium trioxide	15-Dec-10
2-Ethoxyethanol	15-Dec-10
2-Methoxyethanol	15-Dec-10
Cobalt(II) diacetate	15-Dec-10
Cobalt(II) carbonate	15-Dec-10
Cobalt(II) dinitrate	15-Dec-10
Cobalt(II) sulphate	15-Dec-10

35

REACH: Substances of Very High Concern

Substances of Very High Concern (SVHC)	Date of Inclusion
Cobalt dichloride	20-Jun-11
1,2-Benzenedicarboxylic acid, di-C6-8-branched alkyl esters, C7-rich	20-Jun-11
1,2,3-Trichloropropane	20-Jun-11
1-Methyl-2-pyrrolidone	20-Jun-11
Hydrazine	20-Jun-11
1,2-Benzenedicarboxylic acid, di-C7-11-branched and linear alkyl esters	20-Jun-11
Strontium chromate	20-Jun-11
2-Ethoxyethyl acetate	20-Jun-11

36

REACH VI and the Future

- 20 new substances are being evaluated (Oct 2011) and expected to be authorized by early 2012
- 91 substances under evaluation (2012 – 2014)
- Substances of concern for electronic industry:
  - Silicon Dioxide – ceramics, optical glass, dies
  - Silver – solder, terminations, plating
  - Gallium Arsenide – dies
  - Titanium Dioxide – capacitors

37

REACH: Impact on Non-EU manufacturers

- Know the chemicals used in the products you import into the EU
- Be prepared to report information about the presence of toxic substances in your products
- Unlike RoHS, the list already has 53 substances – more will be added semi-annually or annually
- Unlike RoHS there are no product category exemptions (e.g. medical devices, control and monitoring instruments)
- In cases where substances are "intentionally released",
  - you will need to "Register" and
  - receive "Authorization" prior to shipping into the EU (e.g. inkjet cartridges)

38

REACH: How to get started

- Training— Know the basics of REACH for Article Manufacturers
  - **Internally**
  - **Suppliers**
- Know What's In Your Products— Like RoHS, you will need detailed data from suppliers and to evaluate its authenticity:
  - **Full (or partial) materials declarations** with SVHCs disclosed
    and/or
  - **Surveys disclosing absence/presence of substances** in current SVHC list, including amount of SVHC (Weight in component)
- Document— Materials Declarations/survey information in database format to allow manageable Wt% calculations for each "Article" that uses that component.
- Report—Be prepared to:
  - Report SVHC levels of substances as they are added to REACH SVHC list
  - Provide adequate "safe handling and Use" information if SVHCs present
  - Report to ECHA if you shipping more than 1 metric tonne/year of an SVHC into EU across your entire product line

39

REACH: How to get started

(Knowing what's in Your "Article")

- Catalog & triage components in your product: Plastics, Glass, lubricants, etc.
- Most plastics are mixtures of polymers and other substances (Most polymers are exempt but not other substances in plastic)

  Examples:
  - PVC plastic: polyvinylchloride (polymer), plasticizer, colorants, fillers such as silica, etc.
  - Epoxy: Polymerized Bisphenol A -TBBPA (co-polymer), residual monomers of TBBPA, epichlorhydrin etc; silica filler, colorants, etc.
  - ABS: Acrylonitrile butadiene styrene (polymer) + brominated flame retardant + fillers + colorants
- By cataloging the types of materials in your products, you can react quickly to new additions to the SVHC list by:
  - Researching where the SVHC is used: PVC, optical glass, polystyrene
  - Searching your database for suspect materials
  - Querying your supplier if any SVHC is in the suspect material

40

REACH: How to get started

(Collect 100% Materials Declarations from Suppliers)

Homogeneous Material Composition Declaration for Electronic Products

Item	Weight (mg)	Component	CAS#	Weight (mg)	Item-ppm	Part-ppm
Plastic	35.10	SiO2	60676-86-0	29.601	844,300	525,424
		Epoxy Resin	25928-94-3	5.265	150,000	93,159
		Sb2O3	1309-64-4	0.123	3,500	2,175
		Brominated Epoxy	40039-93-8	0.081	2,300	1,432
Leadframe	18.48	Cu	7440-50-8	17.778	962,150	315,228
		Ni	7440-02-0	0.554	30,000	9,831
		Si	7440-21-3	0.120	6,500	2,130
		Mg	7439-95-4	0.028	1,500	492
Ext. Lead Finish	1.39	Sn	7440-31-5	1.390	1,000,000	24,645
Chip	0.72	Si	7440-21-3	0.716	994,000	12,743
		Al	7429-90-5	0.004	6,000	77
Int. Lead Finish	0.31	Ag	7440-22-4	0.310	1,000,000	5,497
Wires	0.30	Au	7440-57-5	0.298	1,000,000	5,284
Die Attach	0.09	Ag	7440-22-4	0.071	750,000	1,263
		Epoxy Resin	25928-94-3	0.024	250,000	417

41

REACH: How to get started

(What if you can't get a 100% Materials Declaration)

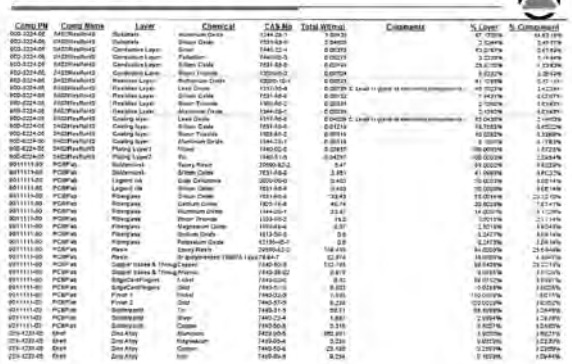
- Special RoHS/REACH surveys sent to selected suppliers based on "triage" of the materials in your Article
  - Request weight of SVHC if present – not just yes/no
  - Must survey suppliers each time new substances are added to SVHC list.
- Generic information:
  - Use datasheets & other supplier information to learn general type of material (i.e. ABS, PPS, PVC, etc.)
  - Assume typical (worst case) additives are present. (i.e. PVC contains about 40-60% plasticizer – assume it is DEHP)
  - Determine the weight of DEHP by Weight of plastic x % DEHP.
  - Use this DEHP weight to determine % in article
- Chemical Lab Testing:
  - Use sparingly – in general, it will be too expensive for REACH reporting.
  - May need to verify whether suspected item is present in certain samples. (I.E. Is HBCDD present in my article's polystyrene?)

42

The Impact of Key Global Environmental Directives on Manufacturers

REACH: How to get started

Develop a Database of Materials Declarations that can be quickly searched for new SVHC REACH suspects



Evidence of REACH Enforcement

Email dated May 15, 2011 from Swedish Enforcement Authority:

dear Bijan,

Article 33 is a demand for information if an article contains more than 0,1% of a SVHC substance publicated on the Candidate list under Reach. If a company don't give information about content of a SVHC substance and we as an enforcing authority find out, we have to report this to the police due to our legislation. Then it is up to the cort if they want to press charges or not.

In Sweden we have enforced this information request in art 33 of Reach. We did send products for analysis for ftalates. In the articles where DEHP was found in levels above 0,1 % we asked the supplier of what information he had been given on content of DEHP and what information he gave to his customers.

If thecompany did not give informationabout SVHC content to their customers we reported this to the police. We do not know yet if the police will react on this reports or not.

kind regards

Christina Larsson

REACH: Useful websites

General website for REACH Guidance documents
http://guidance.echa.europa.eu

REACH Guidance for downstream users
http://guidance.echa.europa.eu/docs/guidance_document/dui_en.pdf

SVHC Candidate List
http://www.echa.europa.eu/chem_data/candidate_list_en.asp

45

Bisphenol-A (BPA), CAS #: 80-05-7

- Is an endocrine disruptor that may interfere with the hormone system
- Tolerable Daily Intake (TDI) level for BPA of 0.05 mg/kg bodyweight
- Added to many types of clear, hard plastics to make them more shatterproof (mainly polycarbonate and epoxy resins)
- 8 Billion pounds used by manufacturers worldwide annually
- Epoxy resins containing Bisphenol A are as coatings on the inside of almost all food and beverage cans
- Bisphenol A is a preferred color developer in carbonless copy paper and thermal paper used in sale receipt paper
- The 2003-2004 National Health and Nutrition Examination Survey (NHANES III) conducted by the Centers for Disease Control and Prevention (CDC) found detectable levels of BPA in 93% of 2517 urine samples from people six years and older.
- Human exposure sources:
  - Leached from the plastic lining of canned foods
  - Leached from polycarbonate plastic bottles
  - Leached from food plastic packaging

46

Bisphenol-A (BPA), CAS #: 80-05-7

- Health risks:
  - Adults - accelerating puberty, increasing the risk of cancer, heart disease and diabetes
  - Affects brain development and behavior in infants and fetal growth
- Canadian (2010), European (2011), United Arab Emirates (2010) and Chinese (2011) leaders have already banned BPA for use in baby bottles
- United States:
  - Currently banned in 11 states, with California as the latest addition
  - Prohibits manufacture, sale or distribution of bottles or cups designed for children three years old and younger that contain BPA at a level above 0.1 ppb)
  - Introduce BPA ban to establish a federal ban in all food and beverage containers
  - The legislation has not yet been debated or subjected to a vote

47

BPA legislation

Country	Conditions of Restriction	Date of Entry Into Force
US	Banned in "recycling food containers" and "other food containers"	March 2009
EU	Banned in plastic baby bottles	2011
Canada	Added into the Toxic Substances List	Oct 2008
Norway	Banned in consumer products (BPA is one of the 18 hazardous substances that are proposed to be restricted in PoHS)	Jan 2008

The Impact of Key Global Environmental Directives on Manufacturers

Formaldehyde, CAS#: 50-00-0

- Common building block for the synthesis of more complex compounds and materials
- Widely used in pressed-wood products glues and adhesives; permanent-press fabrics; paper product coatings; and certain insulation materials; hair products
- Classified as a known human carcinogen (cancer-causing substance) by US EPA and Canadian EPA
- Recently added into California Proposition 65
- Proposed to be evaluated as a REACH SVHC by 2013

49

Other Hazardous Substances

Substance Name	Materials with potential chemical risks
Halogen	PVC panel, plastics, plastic cement, printing ink, product additives, plasticizing agent, etc.
Phthalates	Plastics, plastic cement, lubricating oil
Tetrabromobisphenol A	PCB panel, plastic cement, plastics, ABS panel, rubber, resin, textiles, fibers, paper, etc.
PAHs	Rubber, tire, oil paint, plastics and other non-metal materials
Polychlorinated Biphenyls (PCB)	As cooling agents used for transformers and as insulating oil used for condenser, etc.
Polychlorinated Naphthalene(PCN)	Electric wires, timber, mechanic lubricating oil, galvanized decoration compounds, condenser manufacturing, testing oil, raw materials for dye products, etc.
Short chain paraffin chloride	Glass, cable materials, plasticizing agent, lubricating oil, oil paint additives, industry flame retardants, decoagulant, etc.
Organic tin compounds	Antifoulant, deodorant for textiles, antimicrobial agent, wood preservative, polymer materials such as intermediates in PVC composition stabilizer, etc.
Ozone Depleting Substances(ODC/HCFC/Halon)	Cooling agent for refrigerator and air-conditioner, aerosol products, etc.
Azo compounds	Textiles, plastics, printing ink, oil paint, coating, ink, varnish, adhesive, etc.
Asbestos	Construction materials and oil paint filler, heat insulating fillings, electric wire insulation, filler fillings, fire protection suit, asbestos gloves, experiment headscarf and asbestos mat, etc.

50

Enforcement

- Country specific approach
  - Penalties
  - Importance of documentation
- Database for information sharing since 2010
- Implications with other government agencies (e.g. taxation)
- Whistle-blower
- Non-Governmental Organizations (NGOs)

51

National Measurement Office

Enforcement Authority

NMO Environmental Enforcement

Chris Smith

Technical Enforcement Manager

52

National Measurement Office

Enforcement Authority

NMO Enforces

- RoHS
- Batteries (content, removability and labelling)
- EuP (ERP)
- Energy Labelling

53

National Measurement Office

Enforcement Authority

Enforcement Policy

- Enforcement Based on Intelligence and Risk
- Compliance Through Co-operation
- UK Producer Only
- Compliant UK
- Proportionate Enforcement Actions
- Meeting the Compliance Code

54

The Impact of Key Global Environmental Directives on Manufacturers

National Measurement Office | Enforcement Authority

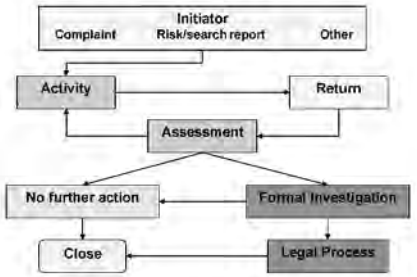
Proportionate Enforcement Action

- Positive Solutions
- Level and Scope of Breach
- Response from the Producer
- Cooperation
- Fair Markets

55

National Measurement Office | Enforcement Authority

General Approach

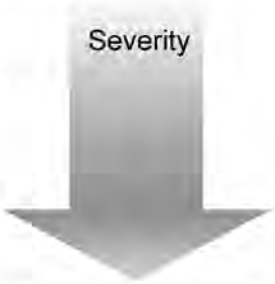


56

National Measurement Office | Enforcement Authority

Tools

- Education
- Informal Warning
- Improvement Plan
- Compliance Notice
- Enforcement Notice
- Formal Caution
- Civil Sanctions
- Product Withdrawal
- Court Action
- Remedial Action
- Publicity



57

National Measurement Office | Enforcement Authority

RoHS

58

National Measurement Office | Enforcement Authority

UK Requirements

- The Product Complies if Within Scope
- Compliance Information is Prepared Before Placing on the Market
- Information is Supplied Within 28 Days of Request
- Information is Kept for 4 Years After Last Product is Placed on Market

59

National Measurement Office | Enforcement Authority

Activities

- Over 800 investigations
- Intervention with circa 200 organisations
- Over £40M product withdrawal
- 2 Cases brought to justice

60

The Impact of Key Global Environmental Directives on Manufacturers

National Measurement Office

Enforcement Authority

Working with Industry to Ensure UK Compliance

61

RoHS enforcement in Sweden

Swedish Chemicals Agency
Christina Larsson

KEMI

Swedish Chemicals Agency

✓ National authority under the Ministry of Environment

✓Responsible for the Governmental goal "a non-toxic environment"

✓ Work with chemical substances and products (eg. paint, petroleum based products)

✓ Also chemicals in articles (eg. Restrictions of specific substances e.g. softeners in toys) and RoHS directive

KEMI

Essential legislation

EU requirements regarding hazardous substances in electronics:

- RoHS Directive (Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment, 2002/95/EG)
- REACH regulation (Registration, Evaluation, Authorisation of CHemicals, EG 1907/2006)

KEMI

REACH

- Article 33: information of SVHC above 0.1%

SVHC

- Are substances that are CMR, PBT or vPvB
- List is published at ECHAs webpage

KEMI

Enforcement for RoHS compliance

Analysis and on site inspections

www.kemi.se

KEMI

The Impact of Key Global Environmental Directives on Manufacturers

What products are of interest?

- ✓ inexpensive "no-name" products competing on price
- ✓ Big international brands (for comparance)
- ✓ Short-lived products (becomes waste quickly)
- ✓ Small products (likely to end up in household garbage)
- ✓ Products must comply - not only documentation

Example of analysed products

Product type	Preference
Mp3 player	Inexpensive no-name products
Rechargable Screwdriver	Major brand and inexpensive no-name products
Portable cd-player with radio	Major brand
Remote handcontrol	Major brand
Flat screen tv	Inexpensive no-name product
hairdryer	Major brand and inexpensive no-name products
Remote controlled helicopter	Major brand and no-name products
Christmas light	Major brand and no-name products
Stepmachine	Inexpensive no-name product
Toaster	No-name product

Procedure if non-compliance

- Companies are contacted about the results from analysis
- Company can choose to withdraw product from the market vountary
- Or product is forbidden to be sold by authorithy
- If product is imported from outside EU, company is reported to the police (maximun fine is 2 years in prison)

www.kemi.se

RoHS enforcement

In 2009

- ✓ 41 products tested
- ✓ 11 of 30 toys were not compliant due to lead in solder

In 2010

- ✓ Sweden participates in a joint EU project were EE toys will be tested
- ✓ Also EE-products from cat. 1-7 will be tested

www.kemi.se

Results

- ✓ Lead (Pb) is the most common reason for failure of RoHS-compliance
- ✓ Pb is mostly found in solders and plastic cables
- ✓ Cadmium (Cd) was found in plastic details from 6 products
- ✓ Cd was banned in Europe before RoHS
- ✓ Mercury (Hg) was found in a switch to a step-machine
- ✓ Hg is totally banned in all articles put on the Swedish market from 1 of June 2009

Conclusion

- ✓ Analysis and documentation do not always agree
- ✓ Many companies trust in documentation only
- ✓ 30% of companies had knowledge of spot-checks within the company
- ✓ Companies also has to consider REACH legislation (SVHC on candidate list)

The Impact of Key Global Environmental Directives on Manufacturers

Inspectorate of Housing, Spatial Planning and the Environment
Ministry of Housing, Spatial Planning and the Environment

RoHS Enforcement in the Netherlands

TechAmerica

March 15 - 2010

Roel Teijen
National Project Manager RoHS

Implementation RoHS/WEEE in the Netherlands

The Netherlands implemented these with
- WEEE management decree
  (Besluit beheer Elektrische en Elektronische Apparatuur)

Enforcement by VROM-Inspectorate

NL Agency (SenterNovem)
- Advising authorithies and companies
- http://www.senternovem.nl/Waste_Management_Department/index.asp

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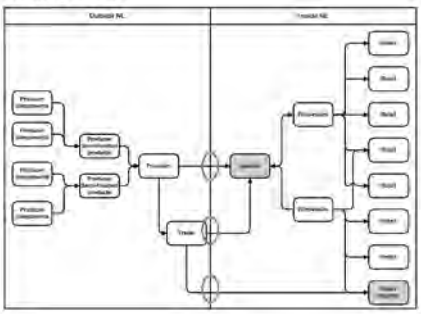
Where to enforce?

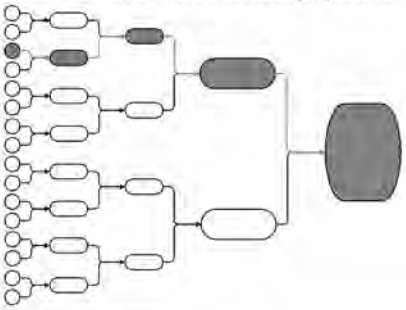


Taking samples & documentation

Equipment measurement with XRF
- Indicative
- If positive then to a recognized laboratory

In addition also documentation
- Conditions of purchase
- Declaration of conformity
- Test reports
- Number of bought and sold items

Chain electrical and electronic equipment



Not compliant

The product must comply, not the documentation

The Impact of Key Global Environmental Directives on Manufacturers

Administrative law

Stop sales / neutralize infringement
Not allowed to sell inside EU

If possible, replace non-compliant part of sold items

Give insight in the chain
Tell how to reduce recurrence

Possible penalty and or compulsion

Criminal law

By every infringement a report

- goes to the Ministry of Justice
- Public Prosecutor makes a financial proposal
- heavier penalties for recidivism
- company can go to court

Minor offence	Penal offence
– Max. € 19.000,= – Max. 1 year imprisonment – Alternative punishment	– Max. € 76.000,= – Max. 6 year imprisonment – Alternative punishment

Then what?

Equipment which has not been sold is waste
(one has to dispose of.....)
(EC/2006/12; Annex 1; Q2: Off-specification products)

Some possibilities:
Fix the equipment to RoHS-compliant
Ship equipment back to the original producer
(not for disposal)
Destroy equipment
WSR (EU 1013/2006)

Cooperation

Customs

- Starting up collaboration
- XRF-sampling before the EEE is entered

Food and Consumer Product Safety Authority

- Joint projects on Product Safety

European Member States

- The European RoHS Enforcement Network
- Exchange of knowledge
- Joint projects

Examples Enforcement actions

2008: 10%

- 24 companies visited
- 9 criminal reports
- 15 products withdrawn from market

2009: 20%

- some products 50% or even up to 100% not compliant
- 47 companies visited
- 30 criminal reports
- 90 products withdrawn from market

2010:

- EE toys (joint EU-project)
- Other EEE

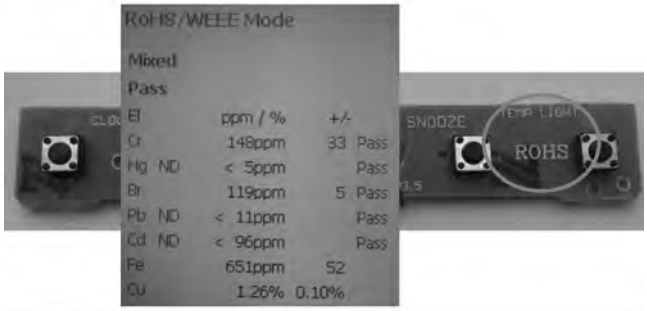
China RoHS labels

Worldwide declaration RoHS-substance is inside

- can be an exemption
- documentation is important

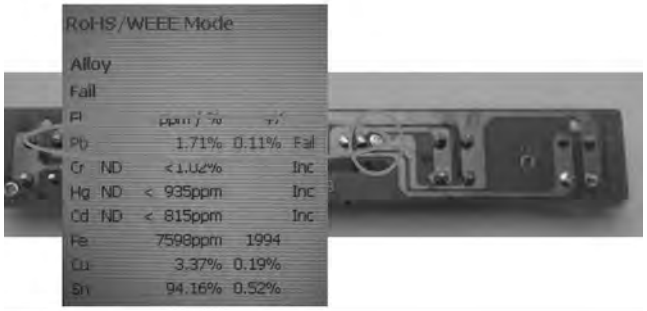
The Impact of Key Global Environmental Directives on Manufacturers

The Good..... or .....



85

the bad.....



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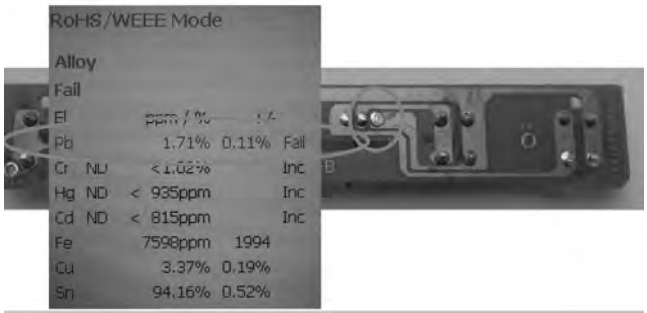
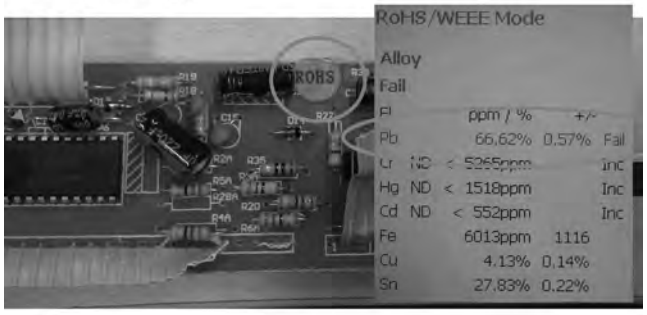
the bad.....



87

.....& the ugly



88

Compliance Assurance Systems: Key Features

- **A system which minimizes violations:**
  - Communication of supplier requirements
  - Contractual agreement with requirements
  - Preventative procedures & practices
  - Monitoring to confirm effectiveness of system
- **Documentation that:**
  - Demonstrates that "all reasonable steps" were taken to avoid violations should the system occasionally fail
  - Includes supplier Certificates of Compliance, evidence of engineering evaluation, process improvement efforts, auditing for effectiveness

89

Compliance Assurance Systems: More than Just an "Quality" Exercise

- **Conformance Assurance System Goals**
  - The goal should be to minimize the likelihood of non-compliant product reaching the market.
  - Should approach it with a systematic approach
  - Not seeking perfection but taking "all reasonable steps" to achieve compliance
- **Due Diligence Documentation**
  - "Due Diligence" documentation can help mitigate charges of gross negligence
  - Documentation is important but it may be of only limited help if your conformance system isn't effective
  - Some countries aren't that interested in documentation –only whether the product is compliant

90

The Impact of Key Global Environmental Directives on Manufacturers

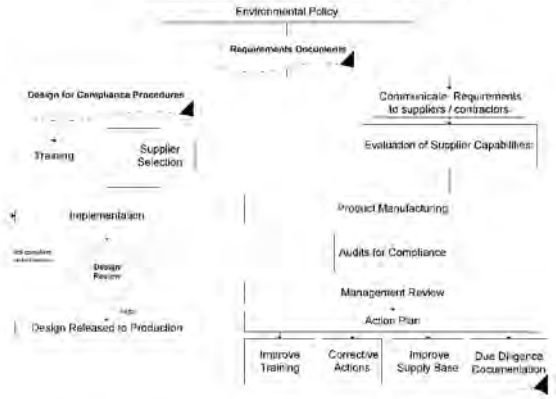
Conformance Assurance Systems

"...you have to show that you created a control system, that it worked and that you operated that system"--Official U.K. RoHS website

- **Corporate level policies and procedures** for RoHS, WEEE, REACH, etc. showing top down commitment
- **Procedures for ensuring conformance:**
  - Design for Conformance procedures
  - Official Requirements statements to your suppliers
  - Legal obligations in purchasing agreements
  - Proper controls in manufacturing facilities
  - Methods for determining effectiveness of your systems
    - Evaluating supplier conformance capabilities
    - Auditing
    - Verification testing strategies
- **Conformance Records**
  - Declaration of Compliance documentation from suppliers
  - Supplier survey and audit records
  - Chemical test data

91

Environmental Compliance System



Evaluating Supplier Compliance: Key to Compliance

You are only as compliant as your worst supplier

Each supplier should have:

- **A system which minimizes violations:**
  - Compliance agreements with their suppliers
  - Preventative procedures & practices
  - Monitoring to confirm effectiveness of system
- **Documentation that demonstrates:**
  - "All reasonable steps" were taken to avoid violations
  - Certificates of Compliance from their suppliers
  - Evidence of effectiveness through evaluation, process improvement efforts, auditing for effectiveness

93

Evaluating supplier compliance: Tools for Evaluating Supplier Compliance

- Supplier environmental compliance programs
  - Evaluation priorities
  - Surveys, on-site audits, third party certification
- Supplier conformance documentation
  - Certificates or Declarations of Compliance
  - Full (100%) Materials Declarations:
  - Third party chemical test data
- Your own verification testing

94

Evaluating Supplier Compliance: Environmental Compliance Programs

- Prioritize efforts:
  - Really understand module & systems suppliers:
    - Contains hundreds or thousands of parts
    - BOM / supplier selection not under your control
    - Any single layer of single part can contain a RoHS violation
  - Small custom & specialty parts / mechanicals suppliers
    - Frequently do not have support staff for RoHS / REACH
    - May not have good controls / practices
  - Major integrated circuit & passives suppliers
- *Use surveys to explore their compliance system*
  - *If possible use phone interviews / on-site audits*
  - *Don't "lead the witness" but do ask probing questions*
- Third party compliance certifications can be short cut to supplier selection

95

Evaluating Supplier Compliance: What is your level of trust?

- Does the supplier have the resources, knowledge and motivation to:
  - Investigate, analyze & supervise his own raw materials suppliers
  - Control the "Free Stock" materials used in his the processes
- Does the supplier live up to other commitments regarding technology, quality, delivery
- Are you convinced that their "testimony" in a Declaration of Compliance is reliable?

96

The Impact of Key Global Environmental Directives on Manufacturers

Evaluating Supplier Compliance: Component supplier RoHS audits

- Level of their compliance program
  - Do they stay ahead of new regulations
  - Top down management support
  - Knowledgeable RoHS / REACH specialist(s) with adequate resources
- Control of raw materials:
  - Do they get Certificates of Compliance or test data from their Suppliers
  - Do they test for RoHS violations themselves
  - Multiple source control
- Process controls during manufacturing
  - Free Stock items controlled
  - Segregation to avoid mix ups

97

Evaluating Supplier Compliance: Contract manufacturer RoHS audits

- Level of their compliance program
  - Do they stay ahead of new regulations
  - Top down management support
  - Knowledgeable RoHS / REACH specialist(s) - adequate resources
- Component control
  - XRF screening capability
  - Multiple source control for passives
- Free Stock Items
  - Solder paste
  - Label & ink
  - Hardware such as screws, nuts controlled for RoHS / REACH
- SMT processing
  - Oven reflow capability (thermal capacity, profile boards)
  - Inspection Criteria (less flow; grainy joints)
  - Rework machines (thermocouple, controlled heating profiles)
- Inventory Management
  - Keep RoHS and non-RoHS work separated on in inventory, processing, rework
  - Warranty repair work

98

Evaluating Supplier Compliance: Third party environmental assessments

- IECQ QC08000
  - Specifically designed around RoHS / REACH
  - Requires an effective compliance system
  - System must include factory controls
  - Annual audit for compliance
- ISO 14001: when RoHS / REACH compliance added to scope
  - ISO 14001 normally focused on hazardous materials management
  - RoHS/REACH compliance could be included in scope
  - Need to verify how substance compliance is incorporated into goals, procedures
  - Provides third party audit of documents / practices

99

Supplier Conformance Documentation

- Declarations of Compliance (RoHS / REACH SVHCs)
  - Supplier's pledge to deliver compliant product all the time
  - How they are worded can reveal level of commitment
- Materials Declarations:
  - RoHS Six substances (< 0.1% statements)
  - Lists of substances RoHS Six + JIG A & B
  - Listings of REACH SVHC present in product
  - 100% Materials Declared; Layer by Layer
- Third party chemical test data

100

Supplier Conformance Documentation: Evaluating Certificates of Compliance

- Is it a sworn statement by the supplier that the product is compliant? Or a collection of vague legal wording that is really meaningless?
- How well does it address RoHS Six Substances:
  - Explicitly states that RoHS 6 have been tested and are below levels
  - RoHS Six were not intentionally added
  - To the Best of our Knowledge, the RoHS six are absent
- Who Signed it?:
  - Signed by Officer of the Company
  - Signed by QA manager
  - Signed by Engineer
  - Not signed at all

GOOD ↓ POOR

GOOD ↓ POOR

101


RoHS Certificate of Compliance

Supplier Conformance Documentation: Example of a Poor Declaration

"....the following substances are not intentionally used or added:
- The heavy metals cadmium, lead, chromium (VI) and mercury
- Polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE)

"Since the presence of the above-mentioned substance(s) couldn't be expected under normal conditions, the absence has not been checked by tests."

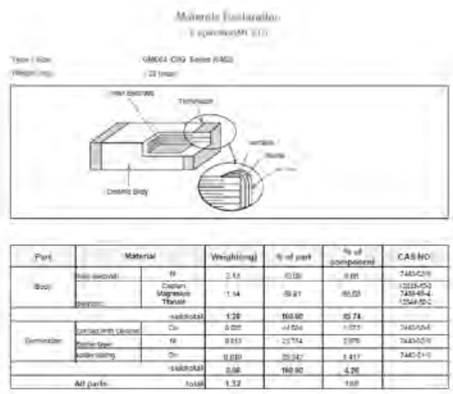
"Although the above-mentioned substance(s) is (are) not intentionally added, this does not exclude the presence of negligible traces due to (among others) impurities in the components supplied by third parties and used in our production facilities...However it is our opinion that the chemical composition is compliant"

103

Supplier Conformance Documentation: 100% Materials Declarations

- ☐ Demonstrates a high level of product evaluation
- ☐ Evaluation and analysis of each homogenous layer in the component
- ☐ IPC-1752 efforts to standardize this information in a computer friendly format
- ☐ Extremely valuable for dealing with the ever growing REACH SVHC lists

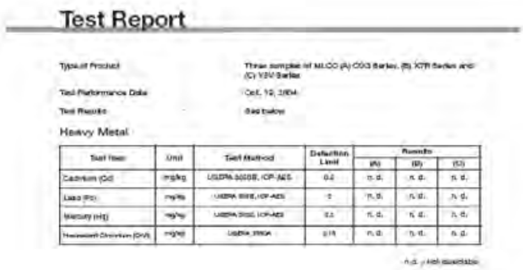
104



Supplier Conformance Documentation: Supplier provided third party test data

- ☐ Third party test data adds confirmation that substances of concern are absent.
- ☐ Keep in mind it is a snap shot in time—rarely is testing done lot after lot.
- ☐ RoHS – compliance of each homogenous layer is very difficult to determine by component testing

105



Supplier Conformance Documentation: Database-confirmation of absence/presence data

- ☐ Information should be stored in a database that references your part numbers to substance information
- ☐ Requires significant effort to build up
- ☐ Variety of software vendors and content providers

108

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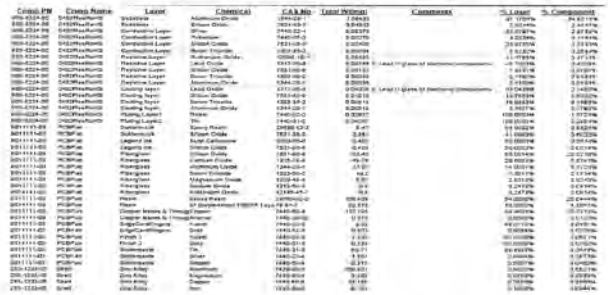
Supplier Conformance Documentation: Database – 100% materials declarations



109

Supplier Conformance Documentation: Using your own substance surveys

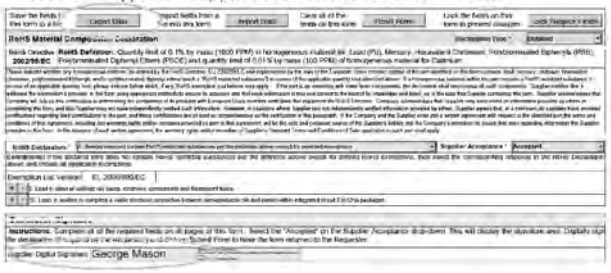
- Avoids long hours of piecing together complete picture from various supplier documents
- Provides structured document for suppliers who do not have complete information package
- Not all suppliers will be willing to complete such document
- Substance survey should provide path to storage in a database
- IPC-1752 provides flexible format
  - Allows for addition of REACH SVHC substances
  - Has XML export function

110

Supplier Conformance Documentation: Tour of a typical "Supplier Materials Disclosure" Form

111

Supplier Conformance Documentation: Tour of a typical "Supplier Materials Disclosure" Form



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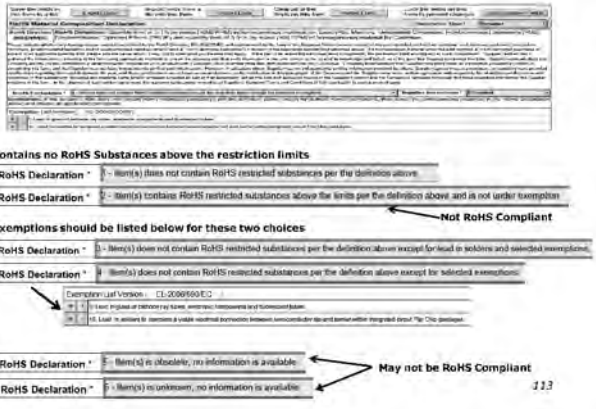
Supplier Conformance Documentation: Tour of a typical "Supplier Materials Disclosure" Form



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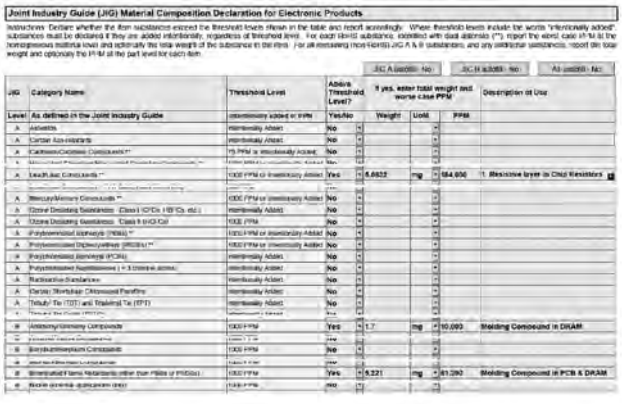
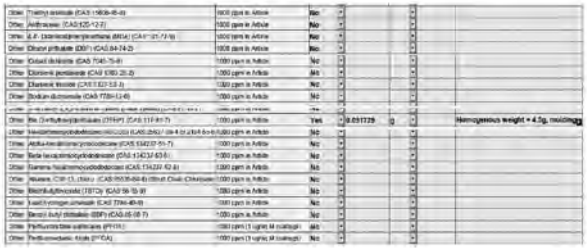


The Impact of Key Global Environmental Directives on Manufacturers

Supplier Conformance Documentation: Tour of a typical "Supplier Materials Disclosure" Form



115

Supplier Conformance Documentation: Trustworthiness of supplier information

- ☐ Does the supplier have the resources, knowledge and motivation to:
  - Investigate & analyze the chemistry of his own raw materials & subcomponents?
  - Does he control the "Free Stock" materials
  - Does "that's proprietary" mean "I don't know"?
- ☐ Is the supplier "top tier" in other features such as quality, delivery and technology?
- ☐ You need to be convinced that the supplier's "testimony" is true
- ☐ **Because you may need to convince an EU enforcement official it's true.**

116

Supplier Conformance Documentation: Validating the Supplier's Answers

- ☐ Is it a Legal Document?:
  - Signed by authorized representative or technical person with right knowledge
  - Includes your Part number and/or Manufacturers part number (traceability)
  - Declaration & exemptions area completed
  - All the substance boxes checked either "yes" or "no"
- ☐ Investigate Documents for trustworthiness
  - It's part of "Due Diligence" process—just filing them away is not enough
  - EU enforcement officials are well versed about electronic components & know how to find violations
  - Your suppliers providing documents need to be equally well-informed
  - Documents need to be legitimate, reasonably accurate

117

Supplier Conformance Documentation: Validating the Supplier's Answers

You may want to ask "are you sure" if:

- ☐ If all substance answers are "no":
  - Part would need to be "Halogen Free" if plastic, "Lead-Free" PCBA, "Green"
  - Believable if it's a relative simple part; not so believable for complex PCBA
- ☐ "No exemptions"
  - Many electronic components are not yet possible without using lead (Pb)
  - Believable if it's a plastic or metal part; not so believable for complex PCBA
- ☐ UL flame rated plastic part with "No" checked for "Other Brominated Flame Retardants":
  - Polycarbonates, nylon, epoxy with "no BRFs" listed; is it really Halogen free?
  - Believable if advertised as "Halogen Free" or made of LCP, PEI, PPS, PI
  - XRF test can validate; important to know whether "other BFRs" are used
- ☐ PVC insulatated cables with "no" for DEHP, BBP, DBP, or DIIP
  - Are they using a plasticizer not listed in either SVHC list?
  - Perhaps insulation is not Polyvinylchloride

118

Verification Testing

- ☐ Screening using X-Ray Fluorescence (XRF)
- ☐ Quantitative analysis using wet chemical testing
- ☐ Standardized test methods:
  - IEC 62321
  - China RoHS SJT 11365-2006
- ☐ Specialized Methods—small homogeneous layers
- ☐ Interpretation:
  - Exemptions List—legal or illegal lead (Pb)
  - Materials Declarations—legal or illegal BFRs
  - Electronic components vs. minimum sample sizes
  - Most components have many "homogeneous layers"

119

Test Sampling Strategies

- ☐ Enforcement Model–Where would I look if I were Customs?
- ☐ Environmental Model—Largest Environmental Impact?
- ☐ Bookkeeper Model—All homogenous layers of every part!
- ☐ Reasonable Person Model—Balance risk vs. reward
- ☐ Raw Materials Model—Have suppliers test raw materials

120

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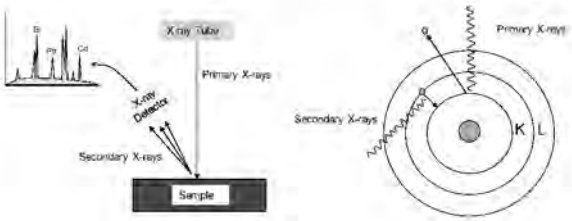
X-Ray Fluorescence (XRF)

- Handheld units
  - Postage stamp sample area
  - User Friendly
  - Screening of large, homogeneous objects
  - $45-55 K
- Benchtop Units (Pin Diode Detectors)
  - Many were designed for use with powder substances
  - Some have X, Y stages suitable for electrical components
  - Some have capability analyze RoHS elements on multiple plating layers
  - Require training to do program setup
  - $60-70K
- Laboratory Units (Silicon Detectors liquid nitrogen cooled)
  - Greatest range of elements detected; best accuracy
  - Need trained Scientist to operate / interpret
  - $100 K or more

121

X-Ray Fluorescence (XRF)



122

Screening Using XRF

- Very useful for detecting lead (Pb) containing terminations
- Useful in detecting percentage levels of lead, cadmium in plastics
- Without extensive calibration standards, not accurate enough to certify RoHS levels near 1000 ppm level.
- Not accurate enough to detect 100 ppm levels of cadmium

123

Wet Chemical Analysis

- Sample Size (Depending on Lab, 1 gram – 10 grams minimum of sample)
- Sample preparation (Isolating homogeneous layers then dissolving or vaporizing)
- Test Instruments (Large collection of Instruments required)

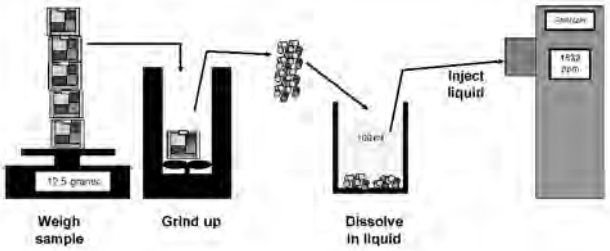
124

Sample Preparation

- Must turn sample into a liquid and/or gas for instruments
- Best way to get things to dissolve quickly is to grind into a powder
- With heterogeneous materials, you end up with an average answer.
- Separating various layers can be difficult and expensive.
- Separation of layers is impractical on very small parts.

125

Sample Preparation



126

The Impact of Key Global Environmental Directives on Manufacturers

Wet Chemical Analysis Instruments

- Pb, Cd, Cr, Hg
  - ICP-AES, ICP-AA: (~$30-40K)
- Cr^{+6} Identification
  - UV Vis + Diphenylcarbazide Dye: (~$7K)
- PBB, PBDE
  - FTIR (~$30K)
  - ICP-MS, GC-MS (~$100K)
  - Need to be able to distinguish between legal & illegal Brominated Flame Retardants
- Must have chemistry lab (~$100K+) & chemist

Key Steps for Risk Mitigation

1. Make environmental compliance part of your supplier selection and supplier management process
2. Incorporate liability language into your contracts
3. Implement a robust data management system that with real-time reporting capabilities
4. Listen to your customers and use this as an opportunity to win more business
5. Keep up to date with the latest legislation

Summary

- RoHS II CE marking has important implications which shouldn't be overlooked
- RoHS II accountability extends beyond the manufacturers, impacting suppliers, distributors, and importers
- REACH is being enforced and requires a robust data collection and reporting tool
- EU is enforcing RoHS and REACH, but more importantly, customers are beginning to ask for evidence
- Any company's ability to comply is as good as their worst supplier
- Compliance is a process, not an event

Questions & Answers

Thank you

如你對此講義匯集的內容或是對此專業服務發展資助計劃有任何查詢，請聯絡
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