Packaging design and cationic curing materials

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Presented by Paul Kelly
Introduction

Background

- 35 years in Radiation Cured coatings and Inks since 1981

Previous experience

- 19 Years Formulator
  Radcure coatings and inks
  (Coates, Manders, Sericol, Sun)
- 12 Years Resins
  Technical, sales + market development
  (Akzo, Sartomer, SI Group, AGI)

Speaker, Paul Kelly
Technical Development Manager at Perstorp
Perstorp at a glance

- World leader in several sectors of the specialty chemicals market
- Pioneer in formalin chemistry, plastics and surface materials
- Founded in 1881 in Perstorp, Sweden
- 135 years of winning formulas
- 1,500 employees in 22 countries
Everywhere you need us
Introduction to the Webinar

Range of packaging requirements and materials.
- Eg Food / non-food
- Flexible plastics – labels, pouches, bags
- Metal containers and closures
- Glass
- Carton board and laminates
- Rigid / semi-rigid plastics

Range of technologies available for print and decoration.
- Solvent based coatings and inks
- Water-based coatings and inks
- Radiation cured coatings and inks

Suitability of cationic cured UV inks and coatings.
- Focus on food packaging and Metal decorating

How cationic cured inks and coatings offer solutions to problems
Packaging types and materials

- Metal containers & closures
- Plastics
- Glass
- Cartons & laminates
Packaging types and materials

**Plastics**
- Polyethylene (PE, HDPE, LDPE)
- Oriented Polypropylene (OPP, BOPP, TCPP)
- Polyester (PET, Mylar)
- Polyacrylates (Acrylics)
- Polycarbonate (PC)
- Polystyrene (PS)
- Polyvinyl Chloride (PVC)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Thermoplastic Polyurethanes (TPU)
- Polyamides (Nylon)
- Akestra

** Metals**
- Aluminium
  - Vacuum deposited (Caps, cosmetics)
  - Anealed (tubes)
  - Foils (laminated packs, yoghurt pots, pharmaceuticals)
  - Drawn containers (drink containers, pet food, ROPP)
  - Monobloc (aerosols)
- Tin-plate (Biscuit tins, twist-off, aerosols)
- Tin-free steel (crowns, can ends)
Requirements of packaging decoration

Packaging decoration should be considered an integral part of package design and ideally enhance properties of the package.

Categories of requirements

- Adhesion
- Gloss / Clarity / Colour
- Mechanical properties
- Chemical Resistant
- Safety + Integrity
- Environmental
Choices for decoration

In all cases, the decoration is generally coated and printed by one of the following technologies.

1. Solvent based and traditional oil based
2. Water based
3. Radiation cured
# Advantages & Disadvantages

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<tr>
<th>Technology</th>
<th>Advantages</th>
<th>Disadvantages/myths</th>
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| Solvent and oil based    | 1. Long history and experience  
2. Low cost  
3. Variety of materials | 1. High VOC  
2. Slow drying  
3. Mostly fossil based  
4. Migration |
| Water based              | 1. Seen as “safe”  
2. Low VOC  
3. Migration | 1. Low solids (typically 60% water)  
2. Slow drying  
3. Limited suitability on impermeable substrates  
4. Migration |
| Radcure                  | 1. Space saving  
2. Production speed  
3. Versatile  
4. VOC-free  
5. Low energy  
6. Low migration  
7. Enhanced print quality | 1. Wrongly perceived as hazardous  
2. Acrylates can have poor adhesion (Cationic has excellent adhesion to difficult substrates)  
3. Curing conditions must be carefully controlled  
4. Seen as high cost |
Reduction in traditional printing Inks, increase in Electronics, Digital 3D and Others.
Two types of **Radiation cure**

**Free radical curing**
The dominant technology >95%

Curing by use of a radical generating photo-initiator or electron beam, typically using acrylate, UPE or other unsaturation.

**Cationic curing**
<5% of Radcure market

Curing by use of a “Lewis acid” generating photo-initiator, typically using epoxy, vinyl ether, oxetanes or caprolactones.
Cationic Cure - history
Checkered history and tarnished reputation

- Original patents of 3M and GE
- Single supply of epoxides and patent licence complication led to slow uptake and limited development of materials.
- A series of “scares” (e.g., Antimony, Benzene) and the exit of Dow as a supplier created a climate of uncertainty and a tarnished reputation.

Limited supply led to high prices, that has come down again Cationic curing has been missed as the good option

But Cationic UV has very big advantages and can solve many packaging design problems
# Comparison of UV technology

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| Radcure Free radial >95% | 1. Space saving  
2. Speed – full cure in seconds  
3. Versatile  
4. VOC-free  
5. Low energy  
6. High quality / high resolution | 1. Often perceived as unsafe  
2. Acrylates can have poor adhesion  
3. Curing conditions must be carefully controlled  
4. Curing is affected by atmospheric O2. |
| Radcure Cationic <5% | 1. All of above  
2. Exceptional adhesion on difficult substrates  
3. No “Oxygen inhibition”  
4. High chemical resistance  
5. Exceptional flexibility  
6. Low migration | 1. Process is affected by amines and high humidity  
2. Limited range of available raw materials |
Why cationic is great

**Tetra Recart**
- Flexo printed
- Carton packaging used for packing retorted food
- Alternative to traditional cans

**Decorative Sleeves**
- Shrink sleeves for the cosmetics, food and drink industries
- "Gravure quality" print
- High degree of shrinkage
- Superior scuff resistance

**Beverage can base**
- Cationic cure widely used.
- Cationic cured coating gives long term resistance and fast process.
- Designed for slip and resistance

Find these examples reported in "Packaging-Gateway.com"
http://www.packaging-gateway.com/features/feature58/
Radcure value chain

Radiation curing of acrylates/free radical systems, >95% total Radcure market

- Raw materials
- Resin maker: Acrylate resin and monomer manufacturer
- Formulator: Industrial coatings, Graphics, Electronics, Adhesives
- Fabricator: Application

Radiation curing of cationic coatings and inks, <5% total Radcure market

- Raw materials
- Formulator: Industrial coatings, Graphics, Electronics, Adhesives
- Fabricator: Application

Different position depending on chemistry
Food Packaging
EU and US. Regulations

2004
Food contact approval in EU

2006
EU Regulation on good manufacturing practice are set

Future
“German ordinance”

2005
• Fabes demonstrate testing methodology.
• ITX initiator news in Italy.
• Nestle introduces “Guidance document”.

Now – Swiss ordinance
Nestle guidance refers to “Swiss list”

US.
• FDA approval and guidance
• Awaiting the new improved TSCA
Cationic formulation

- **Cyclo-aliphatic Epoxy**
  - CAS No. 2386-87-0 UVR6105
  - CAS No. 3130-19-6 UVR6128

- **Reactive Diluent**
  - TMPO
  - CAS No. 3047-32-3

- **Initiator**
  - Irgacure 270

**Modifiers - Polyols**
- Polyether polyols
- Caprolactone polyols
- Dendritic “Boltorn” polyols

**Modifiers - Additives**
- Additives
- Pigments
- Fillers
Our offer for Cationic formulation

**Reactive diluent:**

- TMPO
  - High reactivity
  - Enhancing performance
  - Chemical resistance
  - High flexibility
  - Low odor
  - Safe

**Modifiers – Polyols:**

- **Boltorn™**
  Multifunctional and highly branched dendrimers

- **Alkoxylates**
  High reactivity and safe polyethers

- **Capa™ Polyols**
  Cross-linkers and flexibilisers with high reactivity
Forward looking

- Methodical application lab study, finding synergy between ingredients in cationic inks and coatings. Early results show very clear effects.

- Looking at ways to optimise cationic formulation in order to reduce initiator content, while increasing cure speed of the formulation.

- Comparison of commercially available “resins” and diluents in order to characterise relative advantages and weaknesses.
References

- Nestlé Guidance Note on Packaging Inks – version 02-2014
- Critical photoinitiators for LED curing - E. V. Sitzmann (Radtech 2015)
- Reduction of photoinitiator migration through control and optimization of the UV-curing process – Studer et al
- Applications of uv cationic coatings for food metal packaging - Dr Gianni Mirone & Dr Francesco Veltri
- UV Coatings Basics, Recent developments and new applications – Reinhold Schwalm (Elsevier 2006)

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