

CYTEC

Surface Specialties



UVACURE[®]

Cationic UV-Curable Resins

Cytec Industries Inc.

Cytec Industries is a specialty chemicals and materials technology company with sales of about \$ 3 billion. Its growth strategies are based on developing technologically advanced customer solutions for global markets including: aerospace, coatings, mining, plastics and water treatment.

Cytec Surface Specialties

Cytec Surface Specialties manufactures and markets a broad range of technically innovative products for applications in key coating markets such as architecture and construction, automotive and transportation, graphic arts, wood and paper, plastics and general industries.

A leader in environmentally-friendly coatings technologies, we are a total solution provider – offering an extensive range of high-performance products, supported by a deep level of technical expertise.

Product Range

Cytec Surface Specialties offers a comprehensive product range, including many world-class technologies that have earned leading positions in their target markets. These are divided into three main groups:

- Liquid Coating Resins and Additives
- **RADCURE**[®] and Powder Resins
- Adhesives, Bonding and Formulation Resins

Cytec Surface Specialties leads in

- UV/EB curable systems
- Powder coating resins
- Waterborne alkyds
- Waterborne epoxies
- Waterborne resin systems in primer surfacer, base and clear coats for automotive OEMs
- Adhesives, Bonding and Formulating Resins (ABF)

Global Presence

Headquartered in Brussels (Belgium), Cytec Surface Specialties operates ISO-certified manufacturing facilities.

Our ten technology centers – located in Europe, Asia and North America – offer customers ready access to world-class technical support and applications research.

We also have sales offices in more than 30 countries, enabling us to provide responsive service around the globe, and to help our customers identify and profit from emerging opportunities.



Introduction

Cationic UV cure technology is used to produce solvent-free, environmental friendly lacquers, inks, coatings and adhesives, offering unique film properties. Typical applications for cationic UV cure technology are metal decoration on cans, packaging inks (including aluminium laminating adhesives and overprint varnishes). As the ionic polymerization reaction continues during the post curing process (also called dark cure effect) practically all of the reactive species are incorporated into the final polymer matrix.

Benefits:

- High conversion
- Low shrinkage
- Excellent adhesion
- Good flexibility
- Low odor
- Low toxicity and skin irritation
- No oxygen inhibition
- Excellent gas barrier properties
- High chemical and solvent resistance

Product Range

Products	Description	Application Properties
<i>UVACURE® 1500 resin</i>	Cycloaliphatic di-epoxide, high purity.	Primary component of cationic UV-curing formulations giving a hard and tough film.
<i>UVACURE 1530 resin</i>	Modified cycloaliphatic di-epoxide, OH-functional.	High cure speed, strength, hardness, solvent resistance and crosslink density.
<i>UVACURE 1533 resin</i>	Acrylic modified cycloaliphatic epoxide.	Soft, flexible, exceptional adhesion in coatings and laminating adhesives.
<i>UVACURE 1534 resin</i>	Modified cycloaliphatic di-epoxide, OH-functional.	Good flexibility, good water resistance and excellent toughness.
<i>UVACURE 1561 resin</i>	Epoxide/acrylate for hybrid cationic/free radical curing.	Faster initial cure, increased strength, improved chemical resistance.
<i>CAT 006 resin</i>	Modified low viscosity cycloaliphatic di-epoxide.	Viscosity reducing diluent leading to flexible films.
<i>CAT 012 resin</i>	Cationic reactive diluent, OH-functional (cyclic ether).	High cure speed, low viscosity diluting agent leading to a flexible film.

Typical properties

Products	Viscosity mPa.s at 25 °C	Colour ⁽¹⁾	EEW ⁽²⁾ g/mol	HEW ⁽³⁾ g/mol	Density at 25 °C (kg/l)
<i>UVACURE 1500 resin</i>	275	100 A	134	n. a.	1.17
<i>UVACURE 1530 resin</i>	400	100 A	184	370	1.14
<i>UVACURE 1533 resin</i>	310 000	2 G	262	n. a.	1.10
<i>UVACURE 1534 resin</i>	2 300	1 G	268	375	1.10
<i>UVACURE 1561 resin</i>	150 000	5 G	451	n. a.	1.18
<i>CAT 006 resin</i>	85	1 G	157	n. a.	1.12
<i>CAT 012 resin</i>	25	1 G	116 ⁽⁴⁾	484	1.02

(1) A = Apha, G = Gardner, (2) Epoxy Equivalent Weight, (3) Hydroxyl Equivalent Weight, (4) Expressed as Cyclic Ether Equivalent Weight.

Tensile Properties of *UVACURE*[®] Resins (ASTM D882 Norm)

Products	Tensile strength (MPa)	Elongation (%)	Young Modulus (MPa)	Toughness (MPa)
<i>UVACURE 1500 resin</i>	41	7	1048	2
<i>UVACURE 1530 resin</i>	60	8	1379	3
<i>UVACURE 1533 resin</i>	4	230	6	4
<i>UVACURE 1534 resin</i>	25	135	331	24
<i>UVACURE 1561 resin</i>	77	8	1669	4

Considerations for formulating Cationic UV Systems

Epoxy / Hydroxyl Ratio (EHR)

The cure speed of cationic UV systems can be optimized by modifying the Epoxy Hydroxyl Ratio (EHR). An EHR between 2 and 6 gives acceptable cure rates, the optimum reactivity is around 3.

UVACURE 1500 resin is used as the main component in a formulation. OH functionality can be incorporated by adding polyols, *UVACURE 1530 resin* and/or *UVACURE 1534 resin*, alcohols (ethanol, isopropanol) or glycol ethers (diethylene glycol, tripropylene glycol).

Film properties with different EHR

EHR 3 > Improved through cure; high toughness; good flexibility; excellent adhesion.

EHR 6 > Better surface cure; higher hardness; improved chemical resistance.

Viscosity Modification

Several groups of reactive diluents are used to decrease the viscosity of cationic UV-systems and each one will influence the final film properties accordingly.

- Cyclic ethers, such as *CAT 012 resin* (Oxetane) are an excellent balance between diluting power, reactivity and low odor.
- Vinyl ethers are good diluents which reduce viscosity while maintaining adhesion, however, they lack solvent resistance and often have a pungent odor.
- Alcohols increase reactivity and significantly decrease the viscosity, however, due to the poor solvent resistance, their use is limited to a few percent in a formulation.
- Glycidyl ethers are less efficient in reducing viscosity but improve solvent resistance, while maintaining elasticity.

Flexibility Modifiers

The following materials improve film flexibility:

- Modified cycloaliphatic epoxides:
UVACURE 1533 resin, UVACURE 1534 resin
- Epoxidized polybutadiene:
e. g. Poly BD 600 and 605 polybutadiene resin (Arkema)
- Polyols

Water Resistance

Cationic UV-curing systems are affected by moisture and amines.

Some selected additives can be added to improve the water resistance such as Silwet L-7604 additive, Silquest A-186 and A-187 additives (Witco) or vinyl trimethoxy siloxanes.

Hardness, Improved Surface Cure

Hybrid UV systems (blends between cationic and free radical curing resins) can improve the surface cure, impart higher hardness and better solvent resistance than 100% cationic cure systems. Suitable oligomers/monomers from Cytec Surface Specialties e.g. **EBECRYL® 3700 resin**, **EBECRYL 3420 resin**, **EBECRYL 436 resin**, **OTA 480** and **TMPTA**. For all hybrid formulations, shelf life should be tested.

Increased hardness can also be obtained with blends of epoxy novolac resins or trifunctional glycidyl ethers.

Photoinitiators

Iodonium and triarylsulphonium salts are widely used as photoinitiators for cationic UV-curing. They are available from several suppliers such as Ciba Specialty Chemicals, Lamberti, GE Silicones.

Pigments and Pigment wetting

Pigments for cationic UV inks must be carefully selected, because basic surface functionality will decrease cure speed and may negatively influence adhesion to the substrate.

CAT 012 resin at a maximum level of 25 %, in combination with small amounts of an epoxidized polybutadiene resin, together with Solsperse 26 000 (Lubrizol), improves favourably pigment wetting.

Matting Agents

Non basic matting agents, such as some types of Syloid matting agent (Grace Davison), waxes and co-polymers may be used for gloss reduction. Low gloss values are difficult to achieve. The viscosity increases rapidly as the concentration of the matting agents increases.

Additives

Most cationic UV formulations contain some selected additives, such as slip agents (e.g. **EBECRYL 350 resin**), to control the coefficient of friction values, wetting and flow agents, adhesion promoters (**UVACURE® 1533 resin**), surfactants, defoamers etc.

Care has to be taken to avoid basic materials, because the acid formed upon irradiation is neutralized and the curing process is inhibited.

Contact

Cytec Surface Specialties SA/NV

Anderlechtstraat, 33
B-1620 Drogenbos
Belgium

Tel: + 32 (0) 334 5602

Fax: + 32 (0) 334 5995

E-Mail: tsd.radcure@cytec.com

Trademark notice:

The ® symbol indicates a Registered Trademark in the United States and the TM or * indicates a Trademark in the United States. The mark may also be registered, the subject of an application for registration or a trademark in other countries.

Notice: Cytec Industries Inc. in its own name and on behalf of its affiliated companies (hereinafter 'Cytec Industries') decline any liability with respect to the use made by any third party of the information contained herein. The information contained herein represents Cytec Industries' best knowledge thereon without constituting any express or implied guarantee or warranty of any kind (including, but not limited to, regarding the accuracy, the completeness or relevance of the data set out herein). Cytec Industries is the sole owner or authorized user of the intellectual property rights relating to the information communicated.

The information relating to the use of the products is given for information purposes only. No guarantee or warranty is provided that the product is adapted to the client's specific use. The client should perform its own tests to determine the suitability for a particular purpose. The final choice of use of a product remains the sole responsibility of the client.

Pub. No. 210122 E, Version A

www.surfacespecialties.com