TECHNICAL BULLETIN

EBECRYL® UV/EB Energy Curable Resins

UV/EB INKJET INKS

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allnex
The Coating Resins Company

INTRODUCTION

UV/EB inkjet inks can provide significant advantages when compared to non-UV/EB based inkjet inks. Among these are ultralow volatile organic content (VOC) inks that are non-flammable, highly durable, one-pack systems with extended pot-life and good adhesion to plastic substrates. UV/EB inkjet inks do not dry unless exposed to UV light or EB energy, minimizing issues with clogged nozzles. Energy cured coatings polymerize in milliseconds upon exposure to ultraviolet light (UV) or electron beam (EB) energy to enable high productivity and energy efficiency.

GENERAL CONSIDERATIONS

The low viscosity of inkjet inks combined with the complexity of the printing head means that pigment particles need to be ground to sub-microns sizes (average size of ≅ 0.1 micron). This fine pigment dispersion is comparable to a nano-particle dispersion and is the highest level of dispersion used in the printing, coating, and materials coloring industries. Bead mills equipped with ceramic beads of ≅ 0.2mm are used to achieve this level of dispersion.

Special pigment grades with specific primary particle size, good dispersant possibility, and light fastness are suggested for use in this area. The use of pigment dispersions prepared in UV resins is recommended.

One of the most important properties of the pigment dispersion is the stability against flocculation during production and storage. This is only achieved when the resin layer containing the dispersing agent is strongly adsorbed to the pigment surface. Therefore, the balance between pigment, dispersing agent, and binder is of primary importance.

UV/EB inkjet inks have several characteristics not found in solvent and water based inkjet inks.

- Inks will not dry by evaporation and/or absorption into the substrate. They must be polymerized by exposure to UV or EB in order to form a cured ink film. The polymerization will not continue after UV/EB exposure. If inks are not properly cured, the residual monomer components could produce a strong odor, or the ink could be tacky or “wet”.

- If the ink penetrates into the substrate, as is possible for some papers and cardboards, the component that has penetrated into the substrate will not be polymerized by the UV lamp. This can generate an unpleasant odor. Printing with UV ink is therefore not possible on some absorbent substrates. EB cure can be used to eliminate this problem, as the electron beams can penetrate the substrate.

- The film thickness of UV/EB inkjet inks is generally higher than those of solvent and water based inks. Indeed, all of the applied UV/EB inkjet ink will form the “dry” ink film, whereas in water and solvent based inks, the solvent or water will be evaporated, leaving a thinner film. Thicknesses between 5 and 40 µm are realistic for UV inkjet prints.

The reactivity or cure speed of UV/EB inkjet inks is linked to the binder composition, the level and quality of the photoinitiator, and the color intensity. See below for binder considerations.

- Mono-acrylated monomers (diluting acrylates) have the lowest viscosity (5 to 10 cP). Unfortunately, their reactivity is also the lowest.
- Di-acrylate monomers have a higher viscosity, but also a higher reactivity than the mono-acrylates. They constitute the major part of the binder.
- Tri-acrylate and higher functionality monomers are highest in reactivity, but will be used in smaller proportions in the formulation, as they also increase shrinkage and brittleness.
- Oligomers are used in small amounts to provide important properties, such as toughness and flexibility, which are not achievable with just monomers.

RAW MATERIALS FOR UV/EB INKJET INKS

Materials used in UV/EB inkjet inks are usually low viscosity diluting acrylates (monomers) and oligomers because of the low viscosity requirements of inkjet inks. Materials recommended for UV/EB inkjet inks are shown in the following tables.

Monofunctional Diluting Acrylates		
	Viscosity, cP @ 25°C	Key Features & Benefits
IBOA	9.5	• Isobornyl acrylate. Provides hardness after cure. • Moderate diluting properties. Flexibility without softening. • High Tg = 75°C
EBECRYL 114	10	• 2-Phenoxyethyl acrylate. • Good reactivity. Lowest shrinkage and favorable adhesion on plastic substrates. • Tg = 7°C.
EBECRYL 113	120	• Hydroxyl functionality. • Very good film flexibilizer. Very good reactivity. Low odor. Improved adhesion. • Low Tg = - 6°C
EBECRYL 117	70	• Hydroxyl functionality • Low Tg = -50°C • Low odor

Difunctional Diluting Acrylates		
	Viscosity, cP @ 25°C	Key Features & Benefits
HDDA	6.3	• 1,6-Hexanediol diacrylate. • High diluting power and excellent adhesion properties. Weatherable.
DPGDA	9.2	• Dipropylene glycol diacrylate. • Good cure speed and better flexibility than HDDA.
TPGDA	11.8	• Tripropylene glycol diacrylate. • Good cure speed and slightly better flexibility than DPGDA and HDDA.
EBECRYL 130	171	• Tricyclodecanediol diacrylate. • Excellent reactivity and good hardness. • Barrier properties. Low shrinkage.
$NPG(PO)_2DA$	15.9	• Propoxylated neopentyl glycol diacrylate. • Good pigment wetting and flow. • Low surface tension.
EBECRYL 152	21	• Let down for inkjet inks. • Good flow, leveling, and adhesion to wide range of plastic substrates

Higher Functionality Diluting Acrylates		
	Viscosity, cP @ 25°C	Key Features & Benefits
TMPTA	115	• Trimethylolpropane triacrylate. • Good reactivity and good hardness. Chemical resistance.
TMPEOTA	70	• Ethoxylated trimethylolpropane triacrylate. • Good compatibility with pigment dispersions. Flexibility.
OTA-480	88	• Propoxylated glycerol triacrylate. • Good reactivity, good hardness/flexibility compromise. Low irritancy. • Good pigment wetter.
EBECRYL 895	7600	• Dipentaerythritol penta/hexa-acrylate. • Low migration resin. • Use to increase cure speed and hardness of inks. High reactivity
EBECRYL 40	148	• Alkoxylated tetra-acrylate. • Good compatibility with pigments (often used in the letdown of liquid inks). • Good hardness/flexibility compromise. • High gloss and high cure speed. • Low irritancy.
EBECRYL 140	979	• Di-trimethylolpropane tetra-acrylate. • Very good compatibility with pigments. • Low irritancy. • Good hardness and solvent resistance. • Very high cure speed.

Amino Acrylates		
	Viscosity, cP @ 25°C	Key Features & Benefits
EBECRYL 81	92	• Amino modified polyether acrylate. • Low viscosity. • High reactivity when used as main binder.
EBECRYL 83	515	• Amino modified polyether acrylate. • High reactivity when used as main binder. • Low irritancy.
EBECRYL 85	150	• Amino modified polyether acrylate. • High reactivity when used as main binder. • Highest in reactivity. • Low migration resin.
EBECRYL 7110	1200	• Amine functional acrylate. • Use at 10-15% levels to improve the surface cure of the ink. • Film flexibilizer and adhesion promoter. • Possible competition with the dispersing agent with flocculation consequences.
EBECRYL P115	22	• Highly efficient co-initiator used at 5-15% levels to increase surface cure. • Low viscosity

Adhesion Promoter		
	Viscosity, cP @ 25°C	Key Features & Benefits
EBECRYL 303	900	• Excellent adhesion to a wide range of plastic substrates. • Good exterior durability. • 45% HDDA.

Pigment Wetting Resins for Use in Pigment Paste Preparation		
	Viscosity, cP @ 25°C	Key Features & Benefits
EBECRYL 151	125	• Low viscosity acrylate for pigment grinding of inkjet inks.
EBECRYL 452	769	• Polyester acrylate for organic pigment grinding on pearl mills. • Excellent pigment wetting in presence of dispersing agents.
EBECRYL 820	580	• Polyester acrylate with good organic pigment wetting properties. • Excellent pigment wetting in presence of dispersing agents. • Low migration version of EBECRYL 452.
EBECRYL 3203	1000	• Modified epoxy acrylate for carbon black pigment grinding on pearl mills. • Excellent pigment wetting of oxidized carbon blacks in presence of dispersing agents.

Low Viscosity Oligomers				
	Viscosity, cP @ 25°C	Oligomer Class	Acrylate Functionality	Key Features & Benefits
EBECRYL 810	453	Polyester Acrylate	4	• Low irritancy. • Hardness and Chemical resistance.
EBECRYL 5781	450	Polyester Acrylate	2	• Outstanding reactivity. • Bio-based. (57%) • High Tg (162°C).
EBECRYL 5850	5000	Polyester Acrylate	2	• High reactivity. • Bio-based. (56%)
EBECRYL 4100	6800 (23°C)	Aliphatic Urethane Acrylate	3	• Tough and flexible. • Good chemical and wear resistance.
EBECRYL 4200	8000 (23°C)	Aliphatic Urethane Acrylate	4	• Outstanding abrasion resistance. • Good chemical and mechanical resistance.
EBECRYL 4265	800 (23°C)	Aliphatic Urethane Acrylate	3.4	• Good chemical and wear resistance.
EBECRYL 4740	8000	Aliphatic Urethane Acrylate (Allophanate)	3	• Good weathering. • Fast cure.
EBECRYL 4857	2000	Aliphatic Urethane Acrylate	2	• Low Tg (4°C) • Flexible
EBECRYL 4858	7170	Aliphatic Urethane Acrylate	2	• Toughness and impact resistance. • Exterior durability.
EBECRYL 4859	9300	Aliphatic Urethane Methacrylate	2	• Toughness and impact resistance. • High Tg (124°C).
EBECRYL 5129	15780	Aliphatic Urethane Acrylate	6	• Fast cure. • Chemical, scratch, and abrasion resistance.
EBECRYL 8210	3750	Aliphatic Urethane Acrylate	3.5	• Hydroxyl functionality. • Excellent reactivity. Good scratch and abrasion resistance.
EBECRYL 8313	6000	Aliphatic Urethane Acrylate	2	• Flexible • Low Color
EBECRYL 8402	14800	Aliphatic Urethane Acrylate	2	• Outstanding exterior durability. • Good adhesion.
EBECRYL 4500	6000 (23°C)	Aromatic Urethane Acrylate	4	• Outstanding abrasion resistance. • Good chemical and mechanical resistance

STARTING POINT FORMULATIONS FOR UV/EB INKJET INKS

Pigment Paste	Yellow	Cyan	Magenta	Black
Grinding resin*	68.4	67.8	69	69
Stabilizer **	1.0	1.0	1.0	1.0
Solsperse 22000	0.6 – 1.0			
Solsperse 5000		1.0 – 1.5		
Solsperse 39000	5.0	5.0	5.0	5.0
Yellow pigment	25.0			
Blue pigment		25.0		
Red pigment			25.0	
Black pigment: SB 250				25.0
Total	100	100	100	100

* EBECRYL 151, 452, 3203.

** The use of a stabilizer is required in order to avoid the in-can polymerization of pigmented radiation curing materials caused by the complex interaction of pigment and acrylates. Example of commercial products: Florstab UV-1 from Kromachem.

Ink	Yellow	Cyan	Magenta	Black
Pigment paste	ca. 20	ca. 20	ca. 20	ca. 20
Diluent	60 -70	60 -70	60 -70	60 -70
PI system (UV cure only)	10 - 16	10 - 16	10 - 16	10 - 16

Note: The quantity of pigment depends on the type of pigment and the degree of dispersion.

PI System for UV Curing	
TPO or TPO-L	15%
ITX	35%
EDB	40%
Irgacure 369 or 379	10%

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