27 April 2020

Methacrylates (~ MFMAs)

Multi-functional methacrylate portfolio

allnex Radcure Business Unit

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The Coating Resins Company

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Acrylate versus Methacrylate technology

Acrylates	Methacrylates
UV curing speed	
• Very fast	• Moderate
Viscosity	
• Higher	• Lower
Curing method(s)	
• Mainly UV and EB curing	• UV, EB and peroxide curing
Stability	
• Less stable	• More stable
Applications	
• Inks, varnishes, wood coatings, plastic coatings, paper upgrading …	• Adhesives, rubber vulcanization, PCBs, optical clear resins, casting

Why methacrylates?

- **in UV/EB curing***, methacrylates are slower and less flexible than their acrylate counterparts. Hence, acrylates are preferred.

- However,
  - Methacrylates are **more thermally resistant**, **harder**, generate **less odor**, are **less toxic**, and **more abrasion resistant** than equivalent acrylates
  - Methacrylates are **more stable**, have **higher Tg** and are **lower viscous** than their acrylate alternatives.

- **For radical curing**, such as peroxide curing, methacrylates are preferred over acrylates.

Ultraviolet Light (UV) and Electron Beam (EB)

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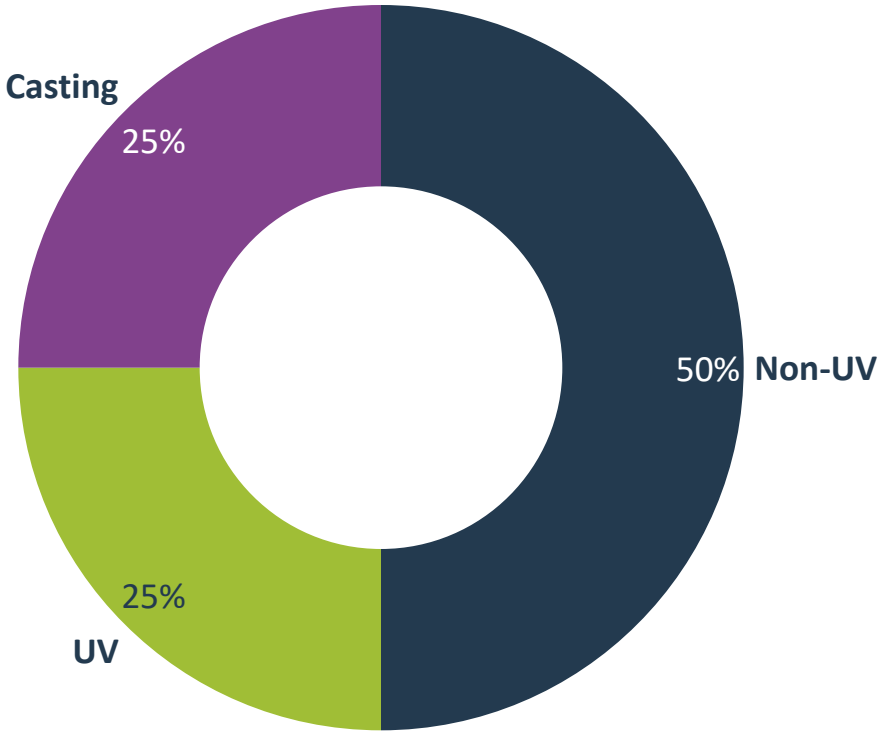
Market overview

- The majority of the MFMA market are **non-UV** applications, the **UV** market is runner up and third is **casting**:



- **In UV,** the majority is in electronic applications, such as PCB Screen Printing
- **In non-UV**, the big application fields are adhesives, rubber vulcanization and flooring
- **In Casting**, the lion share is for lens casting

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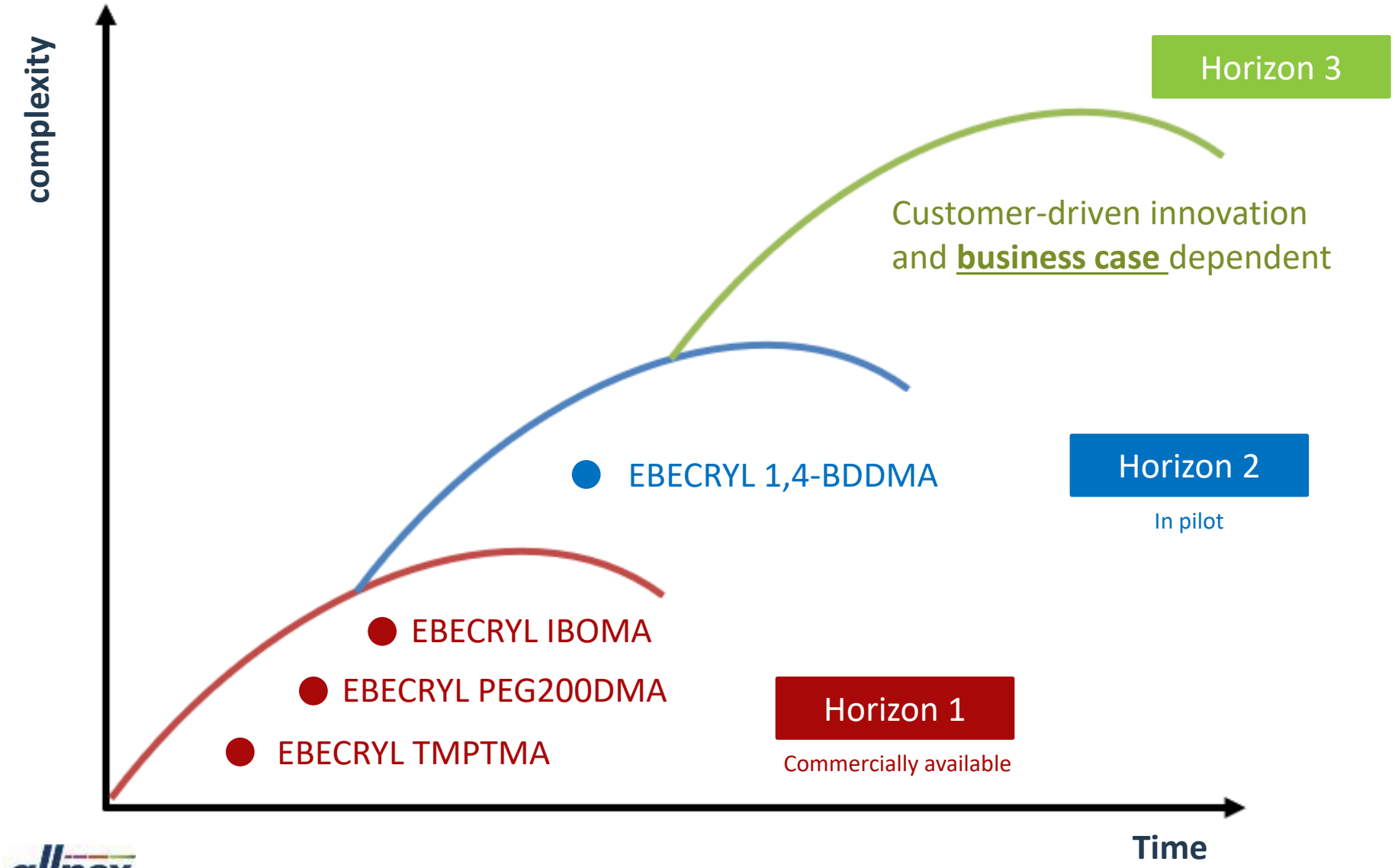
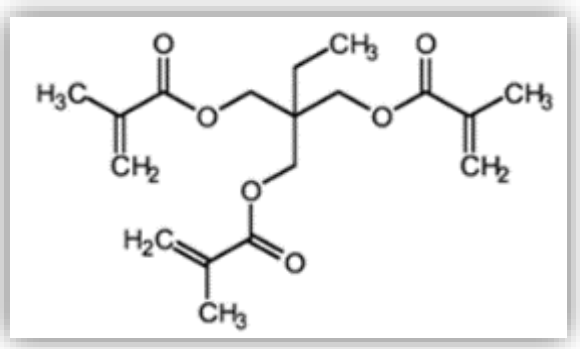
Our Portfolio Extension development

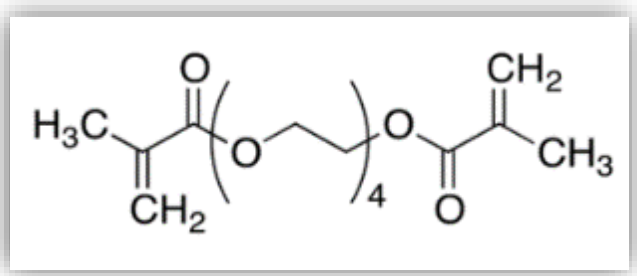


EBECRYL TMPTMA



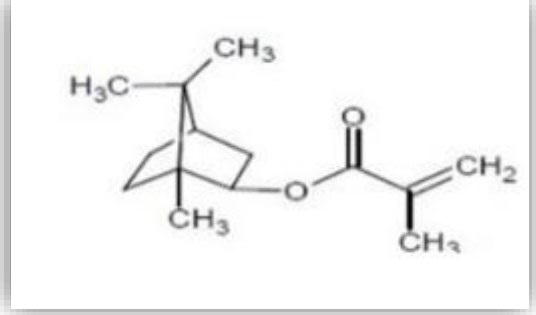
- EBECRYL TMPTMA
  - Trimethylolpropane Tri-methacrylate
  - **Tri**-functional monomer
  - CAS N°: **3290-92-4**
- Properties:
  - High methacrylate density leading to high reactivity and hardness
  - Low viscosity, hydrophobic and
  - Outdoor weatherability
- Pricing & sampling:
  - Target pricing: ask your representative
  - Samples via CMC

EBECRYL PEG200DMA



- EBECRYL PEG200DMA
  - Polyethylene Glycol 200 Di-methacrylate
  - **Di**-functional monomer
  - CAS N°: **25852-47-5**
- Properties:
  - Aliphatic, hydrophilic and good flexibility
  - Colorless, low viscous liquid
  - Acts as co-monomer to improve mechanical properties and chemical resistance
- Pricing & sampling:
  - Target pricing: ask your representative
  - Samples via CMC

EBECRYL IBOMA



- EBECRYL IBOMA
  - Isobornyl Methacrylate
  - **Mono**-functional monomer
  - CAS N°: **7534-94-3**
- Properties:
  - Good adhesion, toughness and high Tg
  - Excellent abrasion and heat resistance
  - Bio-based raw material
- Pricing & sampling:
  - Target pricing: ask your representative
  - Samples via CMC

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High level application overview

Anaerobic Adhesives

• Anaerobic Adhesives

Anaerobic adhesives are single component, solvent-free adhesives that cure in the absence of air and in the presence with metal ions. Anaerobic adhesives stay liquid until isolated from oxygen in the presence of metal ions, such as iron or steel. For instance, as soon as an anaerobic adhesive is sealed between a nut and a bolt on a threaded assembly, it quickly “cures” or hardens to form a tough cross-linked plastic.

The liquid adhesives are designed for use in challenging applications to fill the spaces and surface irregularities between tightly mated thread or cylindrical parts thus eliminating the need for washers and gaskets. Anaerobic adhesives are intended for metal-to-metal assemblies

➢Recommended methacrylate is **EBECRYL PEG200DMA**

In addition to our EAs such as EBECRYL 3720, 3600 and 3708

The reaction mechanism of anaerobic adhesives:

$$\underset{\text{(peroxide)}}{ROOH} + \underset{\text{(metal ion)}}{Fe^{2+}} \rightarrow \underset{\text{(initial radical)}}{RO\cdot} + Fe^{3+} + OH^{-}$$

MMA-based Structural Adhesives

• Structural Adhesives

Structural acrylic adhesives (MMA-based) are thermosetting adhesives which cure via a peroxide free radical mechanism and typically contain elastomers which are soluble in the uncured adhesive, but insoluble in the cured polymer matrix, resulting in a structural adhesives with more flexibility and impact resistance than would be expected in an acrylic polymer.

➢ Recommended methacrylate is EBECRYL **TMPTMA**

In addition to our vast portfolio of UAs such as EBECRYL 230, 210, 242N, 250, 4859 and so on.

Rubber Vulcanization

- Rubber is upgraded by vulcanization using elemental sulphur. This method uses retarders, peptisers and accelerators which are difficult to make, dangerous to use and environmental unfriendly.

- One of the technical routes is to involve coagents such as Triallyl cyanurate (TAC), Triallyl isocyanurate (TAIC) and mult-functional methacrylates (MFMs).

  - Main product recommendation is **EBECRYL TMPTMA**

Flooring and waterproofing

- In acrylic based flooring, the main element is MMA. However, next to MMA monomer the formulation is based
  - on solid acrylics,
  - flexible urethane acrylate (such as EBECRYL 230 and 250),
  - diluting, low shrinkage methacrylate monomers such as EBECRYL TMPTMA and PEG200DMA

➢ Our recommendation in flooring and waterproofing next to our UAs to flexibilize the system are our two diluting methacrylate monomers: **EBECRYL TMPTMA** and **PEG200DMA**

Composites

- **Composite Marble**

Solid surfacing refers to a class of building materials composed of acrylic polymer and inorganic filler used primarily for kitchen and bath countertops.

The acrylic polymer is composed primarily of MMA, with a small amount (~2%) of EBECRYL **TMPTMA** used as a crosslinker.

3D printing

- 3D printing monomers
  - Viscosity reducers
  - Low shrinkage
  - Higher toughness

➢EBECRYL **PEG200DMA** and EBECRYL **IBOMA**

- Additive Manufacturing Processes:
  - SLA: Stereolithography:
  - DLP: Digital Light Processing:

Light source

Plastic modifiers

- MFMAs are used as coagents in PVC systems to improve mechanical and heat resistant properties

- EBECRYL **TMPTMA** is common crosslinker to increase crosslink density

- Next to PVC, MFMAs are also used in PMMA sheets and Propylene plastics.

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Questions

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