

# Exceptional Options for Engineering Resins

Dow Plastic Additives



**DOW**



***We Make Plastics Work. Better.***

Dow is a global supplier of plastics additives, operating within a multi-regional supply chain network and offering experienced technical support both online and offline. Plastics additives are used in a wide range of applications, from consumer appliances and electronics to 5G base stations and new energy vehicle parts, and it plays an important role in many fields. Whether it's resins such as polycarbonate, epoxy, polylactic acid, or other engineering plastics and blends, Dow offers customers with differentiated, high-quality additives designed for use in these materials.

With nearly 70 years of experience, Dow has established itself as a trusted manufacturer of acrylic processing aids and core-shell rubber tougheners, consistently ensuring the safe production of high-quality plastic additives.

### Product configuration and mechanism

A core-shell rubber impact modifier has a multi-layer structure. The core is a cross-linked rubber, generally a butadiene, or butadiene styrene copolymer, or acrylic rubber. This core offers stress-induced toughening. The outer shell is a methacrylate

which is grafted onto the rubber core. The design of the product has two main purposes:

- Separation of rubber particles to minimize agglomeration and adhesion, making them easy to handle during processing.
- Compatibilization with plastic substrates, helping rubber particles to be dispersed evenly in plastics.

Unlike linear elastomers or bulk rubber which have been dispersed in the plastic phase, and are greatly influenced by shear during melt processing, core-shell rubber impact modifiers have dimensions that are already determined during manufacture and are therefore largely unaffected by the melt process.

### Product performance and features

A core-shell rubber impact modifier absorbs energy by inducing deformation within the resin under stress. It changes the stress field through stress concentration, thereby enhancing the resin's ability to yield under stress and exhibit crazing which results in improved toughness through minimized crack propagation.

Using a core-shell rubber impact modifier facilitates improvements in:

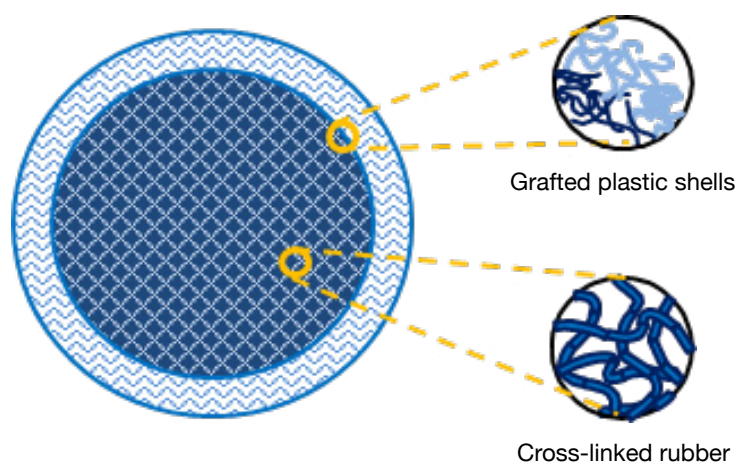
- Impact strength of resins
- Impact strength of filled resin formulations containing fillers such as pigments, mineral powders, glass fibers, and flame retardants
- Impact strength of aged plastics
- Impact strength of recycled materials
- Stress crack resistance of resins

Dow's core-shell rubber impact modifiers predominantly use an acrylate shell component, which has good compatibility with Polycarbonate (PC), Polyester resin, PC/Acrylonitrile Butadiene Styrene (ABS) alloys, PC/Polybutylene Terephthalate (PBT), Epoxy resin, etc. When the shell is grafted with functional groups, its compatibility with PC/PBT alloys, PC/ Polylactic Acid (PLA), or Nylon is further improved.

The refractive index of a specific transparent resin can be matched through design of the impact modifier and therefore maintain the transparency of the resin.

A distinct cross-linked structure means Dow's core-shell rubber impact modifiers have a lesser effect on modulus and heat resistance of the resin versus linear elastomers.

Through sophisticated process control and formulation, Dow has developed specialty core-shell rubber impact modifiers that exhibit lower impact on polyester hydrolysis properties and Polyoxymethylene (POM) degradation.

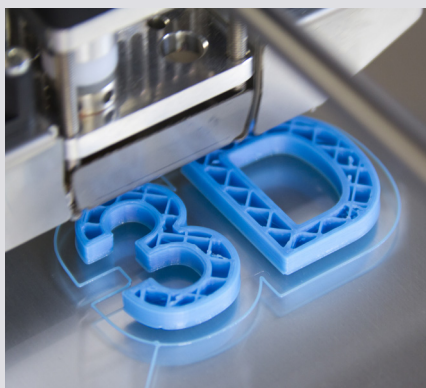
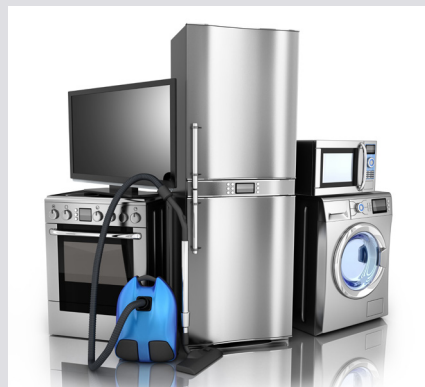




## Applications

Dow's plastics additives improve the impact strength, chemical and heat resistance, optical properties, weatherability and color retention of base polymers. They also aid plastics processing by improving melt strength, thermal stability, and lubricity, allowing plastics processors to achieve higher productivity without sacrificing quality.

Dow's plastics additives help to improve the performance of plastic materials and are widely used in many industries, including automotive, consumer electronics, semiconductor, electronic, energy, office automation, medical care, aviation, building and construction, and other fields.



## A Broad Range of Products for a Wide Range of Resins:

PARALOID™ MBS Impact Modifiers are highly effective tougheners developed by Dow. Their distinct core-shell structure allows them to improve the impact resistance of plastics with little to no impact on the modulus and heat deflection temperature, while providing excellent appearance, thermal process stability, static thermal stability, hydrolytic stability and easy colorability.

### PARALOID™ MBS Impact Modifiers for PC, PBT, PET and alloys

	PARALOID™ EXL-2616	PARALOID™ EXL-2620	PARALOID™ EXL-2650J	PARALOID™ EXL-2690	PARALOID™ EXL-2691J / EXL-3691J
Toughening efficiency/ Low temperature impact strength	+	++	+++	+++	++(+)
Thermal stability	++	++	++	+++	+++
Hydrolytic stability		+	++	+	+++
Colorability	+++	++	++	++	++

Key: +++: excellent, ++: very good, +: good, -: fair

Product names starting with “2” are in powder form and “3” in pellet form

These are typical properties, not to be construed as specifications.

PARALOID™ Acrylic Impact Modifiers have a core-shell structure that offers impact performance as well as excellent weather resistance and color retention. Without carbon-carbon double bonds they are less prone to thermal oxidation than MBS grades and offer better flame-retardant properties in most formulations.

### PARALOID™ Acrylic Impact Modifiers for PC, PBT, PET and its alloys

	PARALOID™ EXL-2311	PARALOID™ EXL-2313	PARALOID™ EXL-2314	PARALOID™ EXL-2315	PARALOID™ EXL-2330 / 3330	PARALOID™ EXL-2361 / 3361	PARALOID™ EXL-2388	PARALOID™ EXL-2390
Performance in PC, PC/ABS								
Toughening efficiency/ Low temperature impact strength	+	+		+	+	+	+	++
Thermal stability	+++	+++		+++	++	+++	+	++
Hydrolytic stability	++	+		+				
Colorability	+	+		+	++	+++	+	+
Performance in PBT, PET								
Toughening efficiency/ Low temperature impact strength	+	+	+++	++(+)	+	+	+	++
Low temperature impact strength	-	-	++	-	-	-	-	-
Melt Index	++	+	-	+	+	+	+	+

Key: +++: excellent, ++: very good, +: good, -: fair

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## Highlighting a few specific plastics additives from Dow

	Product name	Applicable resins	Characteristic
MBS Impact Modifiers	PARALOID™ BPM-520	PLA	High toughening efficiency, net-neutral on PLA compostability.
	PARALOID™ EXL-2600JE/3600JE	POM	Highly effective toughener with minimal effect on formaldehyde release.
	PARALOID™ EXL-2678	Transparent ABS, high-gloss ABS, PMMA/SAN alloy	Toughener without compromising transparency.
Acrylic Impact Modifiers	PARALOID™ EXL-2314	PBT, PET, Nylon and their alloys	Functionality improves compatibility and dispersibility, and thereby toughening efficiency.
Acrylic Microspheres	PARALOID™ EXL-5136	PC, PS, PC/ABS and other polar plastics	Light diffuser, matting and anti-blocking agent.
Flexible Acrylic Resin	VERSALOID™ 2308	PVC, PMMA, PVDF	Used as a weather-resistant transparent film or sheet, or as a blend with other plastics and resins.

- **Polylactic acid (PLA) Impact Modifier**

PARALOID™ BPM-520 Impact modifier exhibits good compatibility and excellent toughening efficiency in PLA and its alloys and can offer excellent impact strength at room temperature and below.

- **Polyoxymethylene (POM) Impact Modifiers**

POM offers excellent wear resistance, high modulus, chemical resistance, and dimensional stability, but suffers from poor low-temperature impact strength. It is also prone to degradation during melt processing, which can lead to formaldehyde release, a known health concern. PARALOID™ EXL-2600JE and PARALOID™ EXL-3600JE have been specifically engineered to enhance impact strength at room temperature and below, while having minimal effect on formaldehyde release during processing.

- **Transparent ABS Impact Modifiers**

PARALOID™ EXL-2678 Impact Modifier is designed for use during the manufacture of transparent ABS. It can be used at a predetermined ratio in production of clear PMMA/SAN blends (also known as clear ABS) to improve toughness while maintaining the transparency of PMMA/SAN blends.

- **Functionalized Impact Modifiers**

PARALOID™ EXL-2314 is grafted with functional monomers on the shell, which can react with amine, carboxyl, and other groups in plastics such as polyester and Nylon, thereby improving compatibility. It is suitable for use in polyester, Nylon, and their alloys to improve impact strength.

- **Light Diffusing and Anti-Blocking Agent**

PARALOID™ EXL-5136 is a specially designed acrylic microsphere with light diffusion properties. It acts as a matting and anti-blocking agent. Its structure, shape and particle size are specially designed to reduce the surface gloss of plastic products, minimizing the need for special texturing or matte coatings, thus reducing overall costs, and reducing the impact on mechanical properties. PARALOID™ EXL-5136 can be used as a light diffuser in transparent plastics such as polycarbonate, polystyrene, etc. Where it offers a balance of efficient light diffusion and light transmittance at a very low dose (typically 1% or less).

PARALOID™ EXL-5136 can also be used as an anti-blocking agent. In polypropylene films, 0.2% loading of PARALOID™ EXL-5136 can reduce the coefficient of friction of polypropylene films to the requirements of use, and at the same time have little impact on the light transmittance, gloss, and mechanical properties of the film.

- **VERSALOID™ Flexible Acrylic Resin**

VERSALOID™ 2308 is a clear, weather-resistant resin developed for film and sheet applications with a multi-layered core-shell structure. It has good flexibility and offers a soft touch, and its high surface tension ensures excellent printability and sprayability. Its downstream applications include decorative films, building protection films, car wrap and ambient lighting.

## Impact Modifiers for Thermoset Resins

Thermoset resins, including epoxy and crosslinked acrylate, are extensively utilized across a wide range of industrial and consumer applications due to their exceptional chemical and thermal resistance, strong adhesion, and excellent electrical insulating capabilities. However, their inherent brittleness post-curing imposes limitations on their broader applicability. PARALOID™ Impact Modifiers improve the toughness of thermoset resins and their composites, allowing them to be used in a wide range of applications such as structural adhesives, composites, coatings and adhesives, wind power, automotive, aerospace, or electronics.

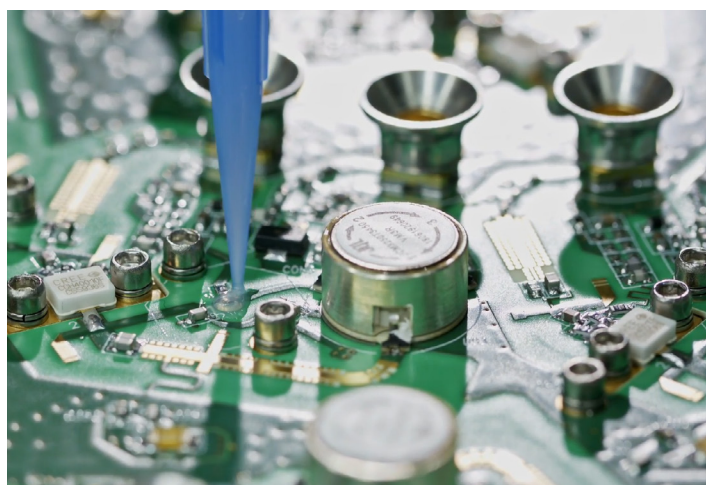
PARALOID™ Impact Modifiers can improve the following properties of thermoset resins:

- Improve product toughness at room temperature and low temperatures
- Increases elongation at break
- Improve the fatigue resistance of epoxy resins
- Improve the adhesion of epoxy resins to metal substrates

PARALOID™ Impact Modifiers are pre-crosslinked rubber tougheners that remain phase separated in the cured resin. Compared with plasticizers and thermoplastic ductile resin modifiers, PARALOID™ Impact Modifiers have little effect on the glass transition temperature and modulus of epoxy resins.

In addition, through some distinct designs, PARALOID™ Impact Modifiers exhibit good dispersion and low viscosity in thermoset resin monomers.

	Product name	Applicable resins	Characteristic
MBS Impact Modifiers	PARALOID™ TMS-2672	Epoxy, MMA	A new generation of high-efficiency tougheners with easy dispersion and low viscosity.
	PARALOID™ TMS-2670J	Epoxy, MMA	Next- generation workhorse toughener
	PARALOID™ EXL-2655	Epoxy	High purity toughener designed for low ionic content
Acrylic Impact Modifiers	PARALOID™ EXL-2314	Epoxy	Contains functionalized shell, which can participate in the curing reaction of epoxy resin and improve the adhesion to metal and inorganic substrates
	PARALOID™ EXL-2300G	Epoxy	High impact strength toughener with excellent thermal stability



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