MOMENTIVE™

Versatic Acids and Derivatives

# Solutions for Superior Clear Coat Appearance

CARDURA™
GLYCIDYL ESTER

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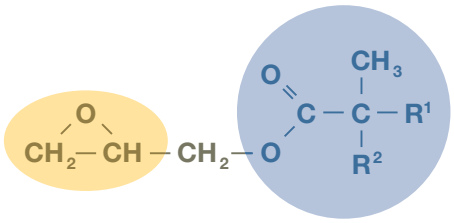
Clear coats for Automotive OEM and Refinish applications must exhibit superior appearance. This translates into a set of complex requirements including high gloss, outstanding DOI (Distinctness of Image) and low orange peel. The correct balance of these properties maximizes the wet look of the finished coating. Automotive coatings must also be very durable and resistant to maintain its appearance after exposure to various chemicals and environmental conditions. In addition to automotive applications there are many other industrial coating end-uses such as non automotive transportation, motorcycles or plastic coatings where these properties are also critical.

The ability to balance these different needs has been further complicated by environmental regulations which require reductions in solvent usage. Not only does this increase the viscosity of the coatings systems, but it also has a detrimental effect on flow and leveling which can be directly correlated to the appearance of the finished film. Cardura has the ability to address all these issues simultaneously because of its alkyl group and unique physical properties.

**Our Answer**




**Glycidyl Ester** **of Versatic 10**
$R^1 + R^2 =$
7 carbon atoms

## Benefits of Cardura™

- **A Cardura containing resin imparts a superior appearance** to formulated automotive clear coat. Cardura's alkyl group improves appearance by improving flow and leveling.
- An additional benefit of Cardura is that it also opens up an **easier to control process route to manufacture high solid content low viscosity Acrylic Polyols**, without resorting to using special additives nor special pressurized reactor.

### Cardura™ Glycidyl Ester

- Cardura is the glycidyl ester of Versatic™ Acid 10, a highly branched carboxylic acid containing 10 carbon atoms.
- Cardura is a bulky and hydrophobic monomer which is easily incorporated into resins via its reactive epoxy group.

### Characteristics:

- Average epoxy group content 4100 mmol/kg
- Boiling range: 251 – 278 °C (5 – 95%)
- Low viscosity (23 °C): 7 mPa·s
- High flame / flash point
- Low colour
- Low vapour pressure

**Your Options**

Monomer
Reaction Medium
Building Block
Reactive Diluent
Process Aid
Acid Scavenger
Additive
Grinding Vehicle

**Your Systems**

Waterborne
High Solids
Radiation Cure
100% Solids
Solventborne

## Cardura monomer is a very versatile building block enabling a broad spectrum of potential solutions for your challenges.

**Structural Features:**

- Epoxy group

**Performance Characteristics:**

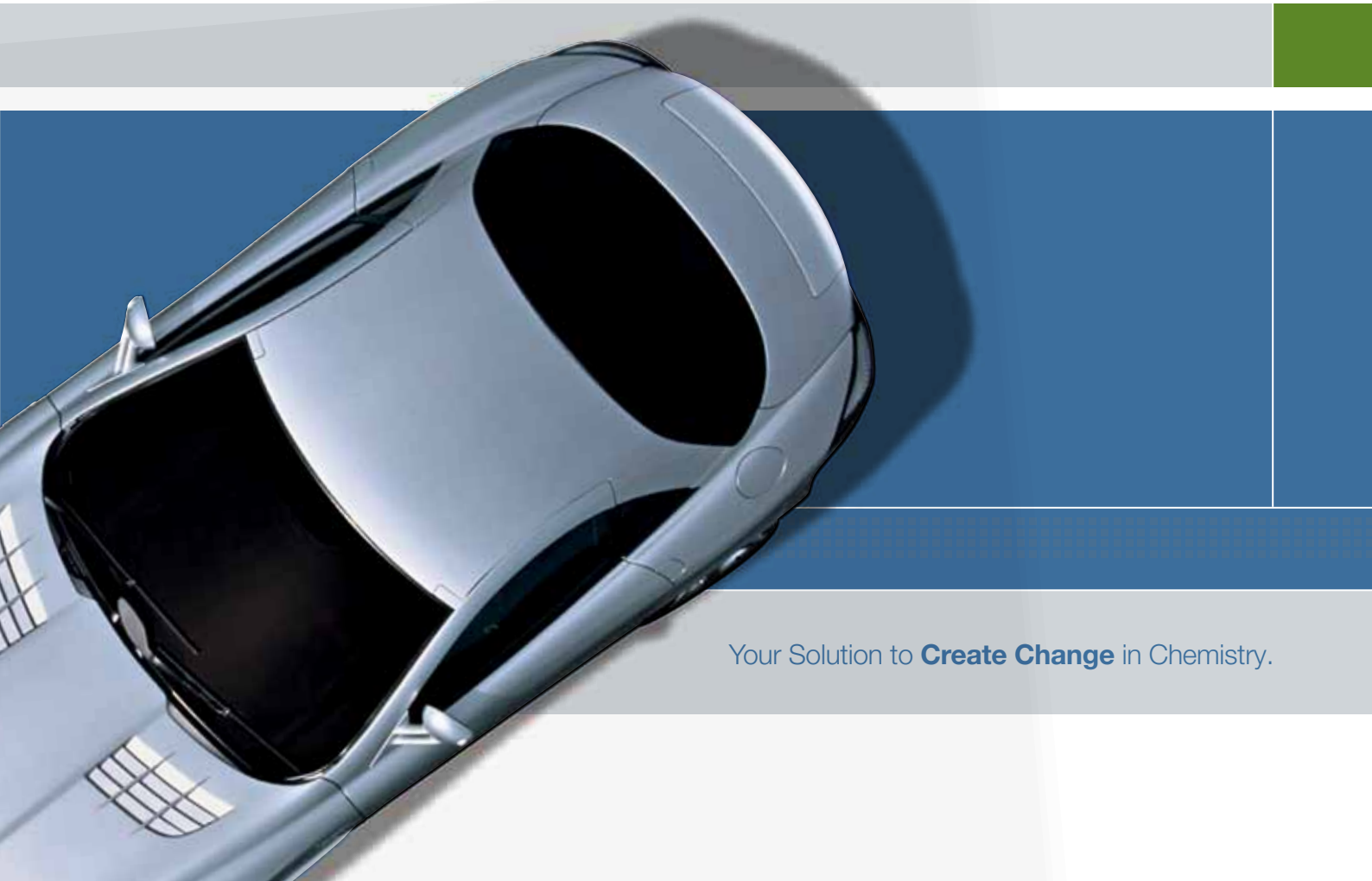
- Highly reactive towards amines, acids, alcohols
- Enhanced metal adhesion

**Structural Features:**

- Sterically protected ester group
- Bulky structure

**Performance Characteristics:**

- Water resistance
- Excellent acid and alkali resistance
- Superior outdoor durability
- Improved gloss
- Improved pigment utilization
- Low solution viscosity
- Improved polar solvent resistance
- Excellent solubility in aliphatic solvents
- Excellent compatibility with polar solvents



Your Solution to **Create Change** in Chemistry.

CARDURA™
GLYCIDYL ESTER

## Cardura™ Based Resin Imparts Superior Appearance to Automotive Clear Coats.

High performance clear coats are typically urethane systems formed through the reaction of acrylic polyol resins with isocyanate curing agents.

Appearance is a very important aspect in clear coat performance. Good appearance is described as a combination of different aspects: gloss, DOI, wet-look, etc. A dull or hazy appearance is something that clear coat manufacturers want to avoid in their product.

One common approach to improve the appearance is to blend in a small amount of polyester resin. A more convenient approach is to incorporate Cardura into the acrylic polyol thus avoiding the polyester resin blending step.

An experiment was conducted with 3 different resin compositions formulated into similar clear coat formulations. All resins and formulations were designed to have a solids content of 50 % at a spray viscosity of 20 sec DIN Cup 4 (at 23 °C). Other than the type of binder/resin used, all 3 formulations contain the same additives and catalyst levels. The formulations are:

1. Clear coat formulated using reference acrylic polyol.
2. Clear coat formulated using reference acrylic polyol mixed with 10 % by weight of a commercial polyester resin.
3. Clear coat formulated using an acrylic polyol that contains 30 % Cardura™.

### Conclusion

Cardura based polyols clearly exhibit superior appearance in automotive clear coats. Compared to the alternate approach of blending polyester and acrylic polyols, Cardura in acrylic polyols offer better hardness and an improved balance between pot-life and drying time.

- State of the art wavesacan dual measurement apparatus has confirmed that clear coats based on Cardura have a better appearance when compared to systems based on acrylics or blends of polyester and acrylic resins.
- In addition to offering the best appearance, clear coats based on Cardura will have a higher hardness than blends of polyester acrylic systems and similar hardness to straight acrylic clear coats.
- While Cardura-based resins result in longer dust free times, their use significantly increases the pot life. Further paint and resin formulation optimization can be achieved to get the right balance of property.

## Performance Benefit

- Cardura™ enables the development of coatings with a **superb wet look** while making it easier to offer a more **environmentally friendly product by reducing the demand of solvents.**

| Recipes (parts weight) | 1. Clear coat formulated using reference acrylic polyol | 2. Clear coat formulated using reference acrylic polyol mixed with 10 % by weight of a commercial polyester resin | 3. Clear coat formulated using an acrylic polyol that contains 30 % Cardura™ |
|---|---|---|---|
| **Resins** | | | |
| Acrylic Polyol (APO) | 49.65 | 46.09 | 51.72 |
| Polyester Polyol | – | 4.42 | – |
| **Crosslinker** | | | |
| HDI Isocyanurate | 13.75 | 15.30 | 14.07 |
| **Additives** | 0.71 | 0.76 | 0.64 |
| Flow Agent | 0.34 | 0.34 | 0.35 |
| Catalyst - organotin (DBTDL) | 1.48 | 1.48 | 1.52 |
| **Thinner** | 34.06 | 31.61 | 31.60 |
| **Total** | **100.00** | **100.00** | **100.00** |
| **Paint Recipe Characterization** | | | |
| OH% of APO (on solids APO) | 3.00 | 3.00 | 3.00 |
| DBTDL% (on solids APO) | 0.03 | 0.03 | 0.03 |
| NCO/OH Ratio | 1.05 | 1.05 | 1.05 |
| Ratio of fast/slow solvents | 80 / 20 | 80 / 20 | 80 / 20 |
| Solid content (% weight) on application | 49 | 52 | 49 |
| Pot life | 1h45 | 1h51 | 3h26 |
| Spray viscosity (DIN cup 4) sec. at 23 °C | 20 | 20 | 20 |
| Film thickness (microns) | 80 | 80 | 80 |

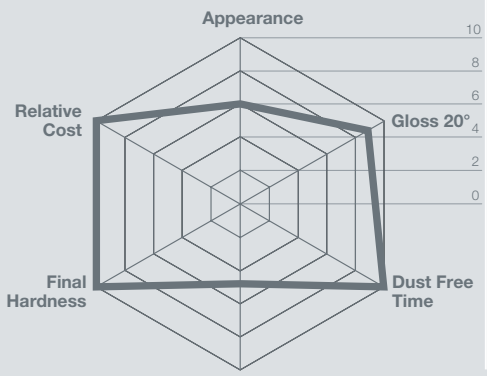
All resins are with Tg of 39 °C. Paint formulations are designed to have the same additives and catalyst levels.
Further paint and resin optimization can be achieved to get the right balance of properties.

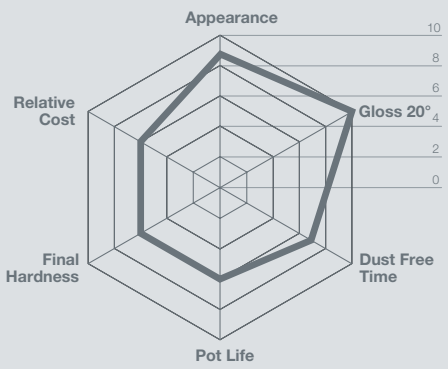
## Performance comparison summary of clear coats

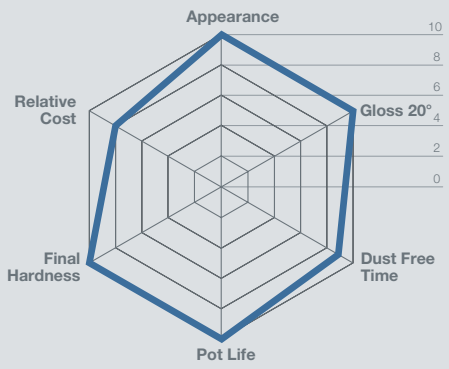
1. Clear coat formulated using reference acrylic polyol

2. Clear coat formulated using reference acrylic polyol mixed with 10 % by weight of a commercial polyester resin

**3. Clear coat formulated using an acrylic polyol that contains 30 % Cardura™**




Scale from 1 (poor) to 10 (excellent)

Your Solution to Superior **Appearance and Performance.**

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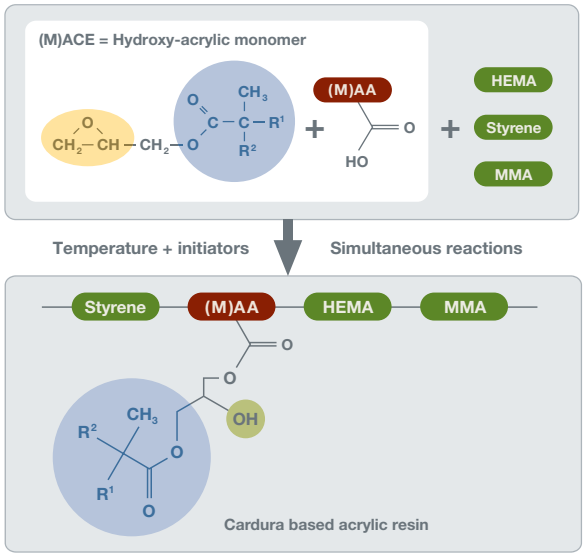
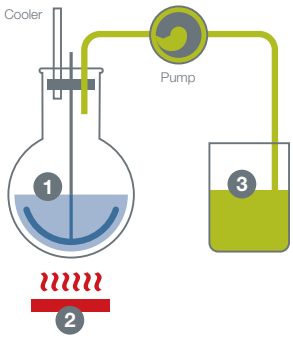
## Chemistry

Cardura can easily be incorporated into acrylic polymers by the reaction of its epoxy group with the carboxylic group of (meth)acrylic acid to form a hydroxyl (meth) acrylate monomer called (M) ACE. (M)ACE reacts with the other monomers via a radical polymerisation reaction. The epoxy acid reaction and the radical polymerization proceed simultaneously. The hydroxyl groups can be used, in combination with other hydroxy-functional intermediates, for reaction with the cross-linker, e.g. melamine formaldehyde and polyisocyanate resins.




## Effect of Cardura™ on the Process for High Solids Resins

Cardura is used as a reactive solvent for the preparation of acrylic resins. Because of its high boiling point, it is often used as part of the initial reactor charge. This allows for the reduction or elimination of solvent during the polymerization process which results in higher solid resins.




**Step 1:** Use Cardura as reactive solvent

**Step 2:** Heat to 140 – 170 °C

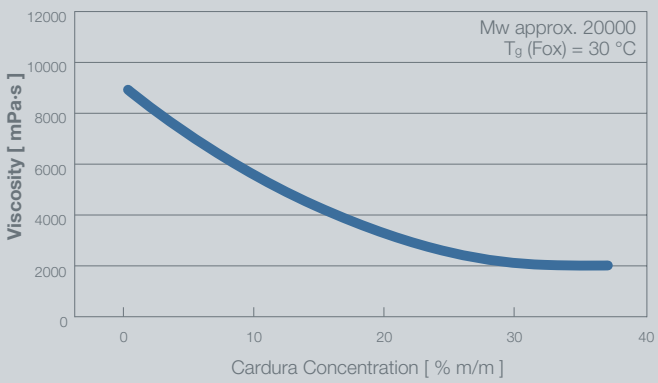
**Step 3:** Add gradually Monomers
+ (meth)acrylic acid
+ initiator

## Effect of Cardura™ on Solution Viscosity

Cardura produces lower viscosity acrylic resins which can be used for making high solids resins for low VOC applications. Cardura reduces the resin viscosity because its bulky structure also limits the chain interactions limiting hydrogen bonding.

## Processing Benefit

- Cardura™ is used as a high boiling point reactive solvent. This allows for a reduction in solvent used during the polymerisation step. Which in turn results **in higher solids resin with intrinsically lower viscosity.**



**High Solid Resins Manufacturing Routes Comparisons**

| Parameters / Routes | Conventional Cooking | Pressure Reactor | Chain Transfer Agent (CTA) | Cardura™ in Input Reactor Charge |
|---|---|---|---|---|
| **Reaction Temperature** | A very high temperature is required which demands high boiling point solvents, creates safety issues and leads to color development. | Low molecular weight resins are obtained through the use of high temperature. | A low molecular weight can easily be obtained at conventional cooking temperature. | The same resin viscosity can be achieved with a higher molecular weight as compared to the other resins, hence a lower polymerization temperature can be used. |
| **Reaction Pressure** | Atmospheric. | High pressure will need very expensive pressure cookers. | Atmospheric. | Atmospheric, but Cardura can also be used in high pressure systems to improve overall resin performance. |
| **Type and Amount of Initiator** | The most common approach in conventional resins, but requires high level, or use of expensive speciality initiators. | Not required. | Not required. | Not required as the use of Cardura gives lower molecular weight resin. |
| **Type of Solvents** | High boiling solvent are mandatory. These solvents need to be stripped in an additional process step at the end of the polymerization reaction. | Pressure reactor provides the option to use low boiling point solvent. | Normal. | Cardura will act as a high boiling point temperature solvent when used in the input reactor charge. It also introduces freedom of choice for using additional co-solvents. As it is built into the resin there is no need for an expensive extra solvent stripping step. |
| **Amount of Hydroxyl-Functional Monomer** | Standard level. | Standard level. | Standard level. | Hydroxyl groups introduced by using Cardura lead to a reduced amount of hydroxyl-functional monomers that is required. |
| **Operation Costs** | High energy consumption for heating and for possible stripping of high boiling solvents. | High costs for investment in pressure reactor and safe operation. | Normal. | Normal. |
| **Resin Features** | Difficult to achieve low molecular weight - Narrow molecular weight distribution. | Normal. | Odor issue. Some color issue. | Easiest process to make high solid resins. Color can develop if high temperature is used. |
| **EHS Concern** | High temperature control is difficult. | Safety of pressurized operation. | CTA is toxic and needs specialized import and handling permit in some countries. | None. |

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**Reach our Global Customer Service network at:**

**U.S. and Canada +1 866 443 9466**
**Email: 4information@momentive.com**

**Europe and all Others +31 10 295 4179**
**Email: 4information.eu@momentive.com**

**Please refer to the literature code MSC-600 when contacting us.**

For further information visit us
at **momentive.com/versatics**

MOMENTIVE™

**World Headquarters**
**Momentive Specialty Chemicals Inc.**
180 East Broad Street
Columbus, OH 43215-3799

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