VISIOMER® HEMA-P

Resin strength promoter for glass fiber composites

VISIOMER® HEMA-P products demonstrate improved adhesion to glass fibers (GF) and an increase of total resin strength when combined with vinyl ester (VE) and unsaturated polyester (UP) resins.

The total increase in resin strength of glass fiber laminates due to inclusion of **VISIOMER® HEMA-P** was determined by different mechanical tests: the interlaminar shear strength test (ILSS), the tensile test and the compression test. Performance was measured in resin load direction using unidirectional (UD)-laminates:

MECHANICAL TEST	PERFORMANCE OF VISIOMER® HEMA-P ADDITION
ILLS	Up to 35% increase in strength
Tensile Test	Up to 31% increase in strength
Compression Test	Up to 41% increase in strength

Table 1: Strength improvement in mechanical tests by **VISIOMER® HEMA-P**

LIGHTWEIGHT STRUCTURAL COMPOSITES

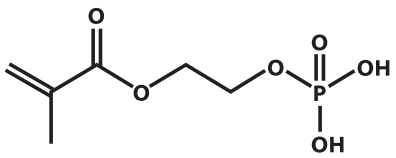
Higher performance composite parts are possible when using VE/UP resin technology. Table 1 shows improvement of mechanical properties of glass fiber laminates caused by incorporation of **VISIOMER® HEMA-P.**

Higher ILSS prolongs the fatigue life of the composite part. Increased durability of composite material may be realized in ship or yacht body parts that can withstand higher water impact. Alternatively, it is possible to reduce the overall amount of composite material. Wind turbine blades can become lighter without sacrificing service life.

VISIOMER® HEMA-P can significantly improve the strength-to-weight-ratio in glass-fiber reinforced VE/UP composites.

VISIOMER® HEMA-P: AN OVERVIEW

Figure 1: Structure of the active ingredient in **VISIOMER® HEMA-P**



2-Hydroxyethyl-Methacrylate-Phosphate (HEMA-P) is a well-known adhesion promoter in applications like adhesives or coating resins, enabling superior adhesion to polar surfaces like minerals, glass, and metals. Evonik Operations GmbH offers this chemistry in two versions—**VISIOMER® HEMA-P 70 M** and **VISIOMER® HEMA-P 100**—for polymer design flexibility.

	VISIOMER® HEMA-P 70M	VISIOMER® HEMA-P 100
Supply	In 30% MMA	Pure, MMA-free
Viscosity	40-75 mPa•s	3000-7000 mPa•s
Phosphorous content	10.6%	15%

Table 2: Comparison of **VISIOMER® HEMA-P 70M** and **VISIOMER® HEMA-P 100**

ADHESION PROMOTION

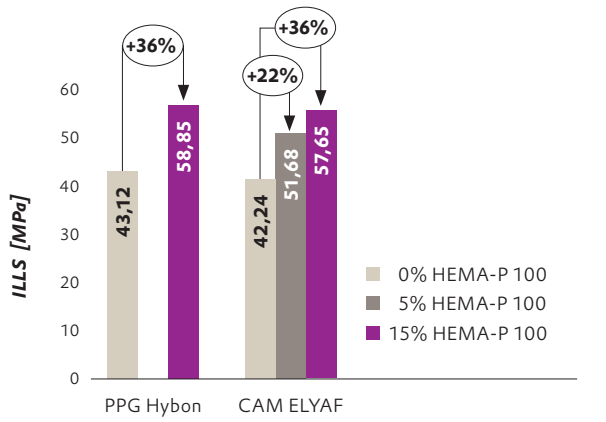
VISIOMER® HEMA-P products can be used as functional co-reactive diluent for VE or UP resins.

In this study two different GF types (PPG Sizing Hybon 2002 and Cam ELYAF Sizing WR6) were used to produce four-layer UD glass fiber laminates by vacuum infusion. **VISIOMER® HEMA-P 100** was added as co-reactive diluent to a standard styrene containing unsaturated polyester resin. Resin strength improvement in the glass fiber laminates was determined by three different mechanical tests.

The interlaminar shear strength (ILSS) was measured using a three-point bending test to provide information on the resin-fiber adhesion strength.

Figure 2 shows that the addition of **VISIOMER® HEMA-P 100** (5-15wt%) significantly increases the ILSS up to 36% independent of the fiber type used.

Figure 2: Increase in interlaminar shear strength (ILSS) for **VISIOMER® HEMA-P 100** containing UP resins



The ILSS results prove that **VISIOMER® HEMA-P** as co-reactive diluent provides a superior fiber-to-resin adhesion.

Additionally, the GF laminates were subjected to tensile strength and compression tests to further evaluate mechanical properties in the presence of **VISIOMER® HEMA-P.**

Figure 3: Resin failure of tensile strength measurement (90° direction) for UP resin containing **VISIOMER® HEMA-P 100**

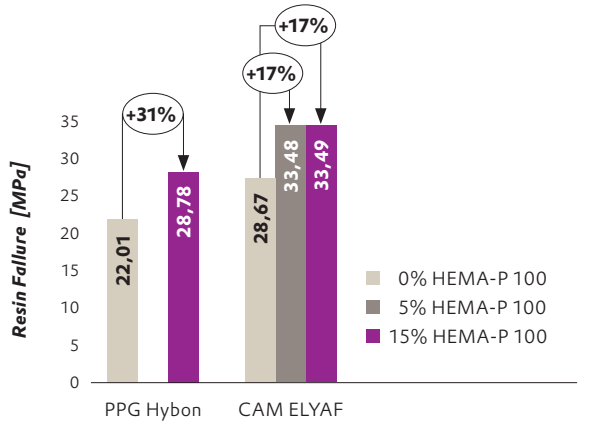


Figure 3 shows the resin failure of the different resin formulations taken from the 90° tensile testing. In contrast to the ILSS measurement, the increase in resin failure depends on the glass fiber type used. The maximum increase in resin failure is achieved by the addition of 15wt% HEMA-P and the use of the Hybon fiber.

Figure 4: Mechanical properties determined by compression testing (90° direction) for laminates prepared with a standard UP resin with and without 15wt% **VISIOMER® HEMA-P 100**

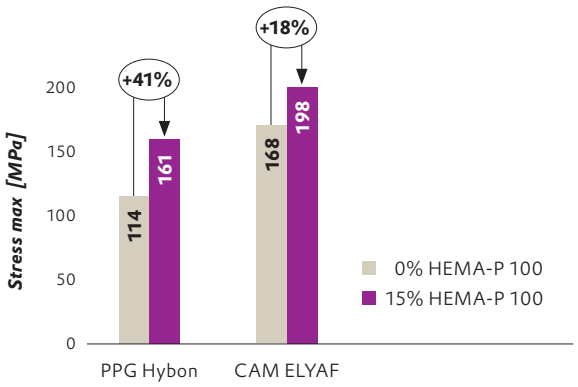


Figure 4 provides the results of the compression testing of laminates containing **VISIOMER® HEMA-P** as strength promoter versus the standard UP resin without strength promoter. The measurements confirm again the improvement of mechanical properties using **VISIOMER® HEMA-P.** The performance increase depends on the glass fiber type. The increase of compression strength in 90° direction for PPG HYBON 2002 is up to 41%, where the increase for CAM ELYAF WR6 is lower but still significant at 18%.

In conclusion, incorporation of relatively low proportions of **VISIOMER® HEMA-P** specialty methacrylate can significantly improve the total strength of glass fiber reinforced VE/UP composites. This improved mechanical strength allows to produce components with reduced weight and identical performance — creating possibilities for a sustainable world.

VISIOMER® METHACRYLATES — READY FOR THE NEXT LEVEL

Evonik Specialty Methacrylates looks forward to supporting you in finding the best solution for your next challenge in polymer design. Contact us for further information on our **VISIOMER® HEMA-P** products.

OUR PROMISE TO YOU

- We are your experts for Specialty Methacrylate monomers.
- We are at your service with a globally available sales and technology organization.
- We are your solution provider with tailor-made products and joint research & development projects.
- We support your growth through a reliable and flexible global production & technology network.
- We are looking for a long-term partnership and mutual value creation.

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