



## Ovante, LLC's MMA Adhesive

Storm Greeter can be applied as a liquid coating and as a pre-cured sheet. When using the pre-cured sheet, a strong adhesive is needed that will bond the coating to steel.

Methyl-Methacrylate (MMA) has long been used for bonding dissimilar materials in the following industries:

- Marine
- Transportation industry (panels of aluminum to other panels)
- Trucks and Construction Equipment (side and roof panels, door panels, aerodynamic components)
- Plastic bonding (large solar cell collector panels)
- Electric motor manufacture, involving the bonding of ferrite magnets to metal housing of steel or aluminum
- Bonding loudspeaker magnets to back plates, sweep transformer core sections
- Composite bonding of truck trailer beds using aluminum structural elements, composite parts such as fenders, stiffeners to door panels, sliding roofs
- Medical/Orthopedic use as grout for hip and knee replacements. Typically, the lifespan of methyl-methacrylate as bone cement is 20 years in a semi-corrosive environment, enduring vibration and pressure, before revision surgery is required<sup>1</sup>

The MMA used with Storm Greeter is a 1:1 mix ratio that cures in ambient temperatures in about 15 minutes. Our MMA has a tested adhesive tensile lap shear ranging from 1,300 to 3,000 psi. Other MMAs have mix ratios ranging from 100:3 down to 1:1. The worktime window is much larger than with other adhesives because the two components can be applied separately to the materials being bonded. The curing process doesn't begin until the two surfaces come into contact.

MMAs can withstand paint bake cycles, including powder coating and electron coating, at typically 220 to 230°C (428 to 446 F) for up to 35 minutes with no loss of strength<sup>2</sup>. They can withstand prolonged exposure to temperatures ranging from -60F (-50C) to 200F (95C)<sup>3</sup>.

### The Ford - Aston Martin Test<sup>4</sup>

Portions of the Aston Martin Vanquish, especially the front-end assembly and crash structure, are made of composite materials bonded to steel structures. Ford conducted testing on 2

(specimens A & C in the test) polyurethanes and one MMA adhesive (specimen B) to evaluate their suitability for bonding these dissimilar materials for hi-stress use.

“Short (56mm) bonded test coupons with a 25.4mm by 12.7mm overlap area were produced with a 2mm bond gap. Six bonded samples were bolted together in series and subjected to a constant tensile load according to Ford. The pre-stressed samples were then exposed to Ford’s Arizona’s Proving Ground Equivalent (APGE) corrosion test cycle: 15 minute immersion in 5% (by weight) salt water, followed by a drip dry for 1 hour 45 minutes at room temperature. For the remaining 22 hours of the 24-hour cycle, the coupons were held at 50°C (122 F) and 95% relative humidity. The number of APGE cycles to failure was recorded for each coupon.”

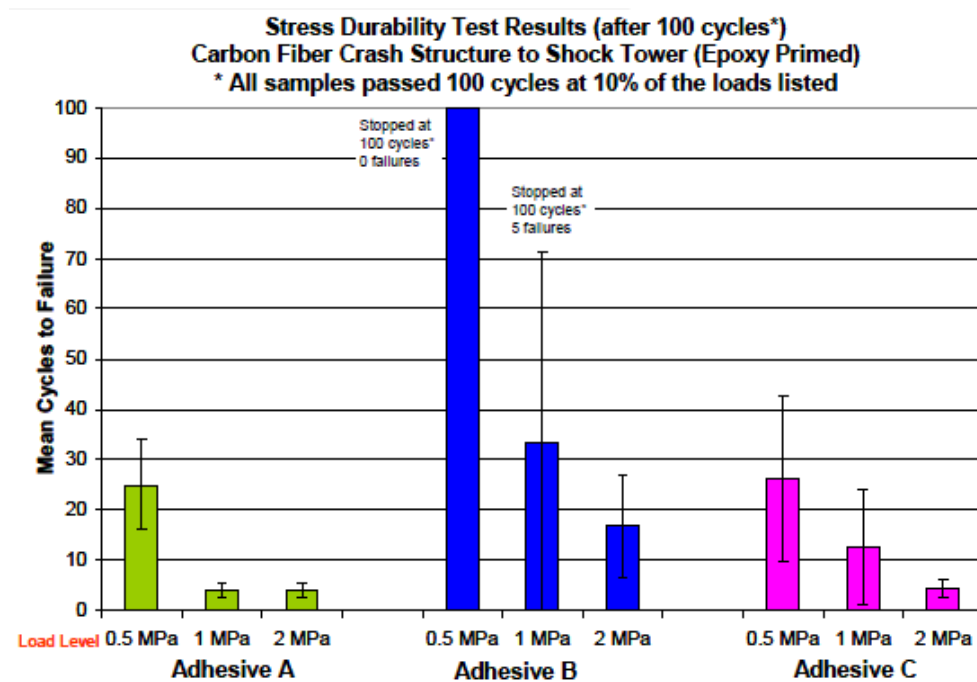


Figure 1.

“Figure (1) shows the results of the Ford stress durability test described in the previous section. The coupons were initially loaded to produce a stress of 0.05, 0.1 and 0.2 Mega-Pascals (7.25, 14.5, and 29 psi) within the bond, which bracketed the peak predicted stress from the full vehicle FE analysis of 0.11MPa. After 100 APGE cycles, none of the joints had failed. After 100 cycles the loads were increased by a factor of 10 in order to try and discriminate between the adhesives (72.5, 145, and 290 psi). As can be seen from Figure (1), there was a considerable difference in performance, particularly at the lower load levels. The test was stopped after 200 cycles with none of the 0.5MPa loaded MMA samples having failed. In contrast the PU adhesives failed after 26 cycles once the load had been increased from 0.05 to 0.5MPa. The main conclusion from these trials is that the MMA adhesive appeared to have much better, long-term corrosion durability than the two PU adhesives tested.”

## Interboat NL Engine Foundation Test<sup>5</sup>

“Interboat annually produces around 220 high-quality fiberglass cruisers, tenders and sloops in a range of sizes from 5.7 to 10.5 m. The head office and main showroom is located in Loosdrecht (approximately 20 km southeast of Amsterdam), and production operations are located in Zwartsluis.”



This test involved using an MMA adhesive to mount the motor foundation of an 18' fiberglass sloop to the hull. Figure 2.

“Following a simple solvent wipe surface preparation, the engine section was positioned in the hull and a bond line drawn around it. With the engine part lifted clear, the (MMA) was applied with an air-assisted, 380-ml cartridge gun. The engine section was carefully dropped into place onto the (MMA) adhesive and accurately positioned in the hull. Any gaps were filled, and a small brush was used around the edges to smooth any excess adhesive.” Figure 3.

Figure 2.



Figure 3.

After 70 minutes, ballast was added to the hull, bringing the total weight up to 500 Kg, or 1,100 lbs. A hoist was attached to the engine foundation and the sloop was lifted, using only the strength of the MMA adhesive to hold the 1,100 lb. weight.

## Tougher and Stronger Glue (Machine Design Magazine- 2007)<sup>6</sup>

“A key to performance for any adhesive is its ability to withstand force. In one test, researchers compared the ultimate strength of a cold-rolled steel assembly joined using adhesives (MMA, epoxy, and two-part acrylic), mechanical fasteners ( $\geq$ 8-in. bolt and three POP rivets), and welding (butt weld and two spot welds). All three adhesive technologies were stronger than the mechanical methods and similar in strength to the thermal assembly methods.” Figure 4.

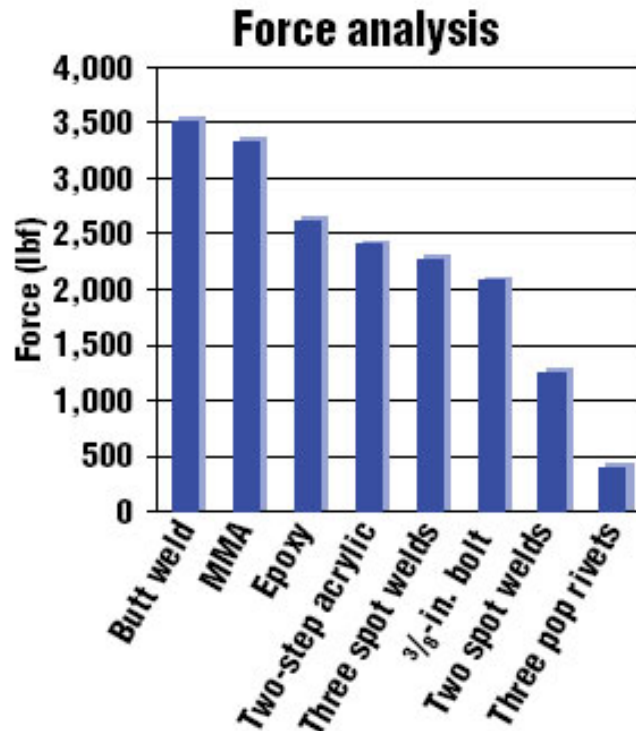


Figure 4.

“Environmental considerations can also greatly affect the long-term performance of an assembly. A two-part MMA, for example, was exposed to salt fog and humidity for 1,000 hr. Here the adhesive maintains more than 95% of its strength when compared to the control sample.”

### Storm Greeter Pre-Cured Sheets & MMA

Everyone says “coating is a pain in the ...”. We see that as a challenge.

- Storm Greeter prevents corrosion in even the most aggressive environments
- Storm Greeter has performed well through two rounds of testing at EPRI
- Storm Greeter has excelled when immersed in seawater, blocking invasion by marine life and refusing to delaminate after being sectioned by a band saw

- Storm Greeter won't chip or crack
- Storm Greeter remains flexible for the lifetime of the substrate
- The Storm Greeter sheeting and MMA adhesive were used in wildlife shield testing at Florida Power & Light, where our products passed the 23Kv threshold.
- The Sheet-MMA combo allows repair and maintenance crews to apply a new coating to in-service structures quickly, whether they are tubular or lattice structures
- The sheet can be cured to fit complex shapes, such as those found on lattice towers and sub-stations, to provide a tight, custom fit
- In the factory, the Sheet-MMA combo requires less blasting of newly galvanized poles to achieve an anchor pattern (1 to 2 mil versus 4 to 5 mil profiles)
- The pre-cured sheet is manufactured with an anchor pattern on the inner surface to aid in adhesion to the substrate
- The pre-cured sheets are manufactured with uniform thickness and with a feathered edge to prevent water and particulate buildup at the top
- The pre-cured sheets are manufactured with thicker millage near the butt-end of the pole to stand up to the rigors of installation
- The pre-cured sheet reduces the need for a groundline sleeve
- The Sheet-MMA combo will stand up to the UV exposure and environment of pole storage yards

Given the information presented so far, it is clear that our MMA adhesive will perform well when used in conjunction with the Storm Greeter coating in applications for the electric utility industry, in situations where corrosion is a major concern.

The Storm Greeter liquid and pre-cured sheets are available in a wide range of colors. As long as the desired color exists in the Pantone Matching System, we can make it.

## References:

1. Nordin, Margareta (2001). *Basic Biomechanics of the Musculoskeletal System*. New York: Lippincott Williams & Wilkins. pp. 401–419
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3. "Chemically Curing Adhesives" Maxilam New Zealand, [www.maxilam.co.nz](http://www.maxilam.co.nz)
4. "Maybach: Adhesive Bonded Structural Composites", October 1, 2012, [www.maybach300c.blogspot.com/2011/11/aston-martin.html](http://www.maybach300c.blogspot.com/2011/11/aston-martin.html)
5. "Anchors Aweigh", Adhesives Magazine, March 1, 2011
6. "Tougher and Stronger Glue", Machine Design Magazine, Scott D. Anderson, Nov. 8, 2007