MASTERBOND®
CASE STUDY

EP33CLV: Utilized to prevent galvanic corrosion

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Overview of EP33CLV

Master Bond EP33CLV is a two-part, room-temperature curing epoxy system suitable for a variety of bonding, sealing, coating, and encapsulation applications. It shows excellent high-temperature resistance and bonds well to a variety of substrates. EP33CLV is also electrically-insulating, making it suitable for encapsulating materials such as Mg alloys to inhibit galvanic corrosion in composites.

Application

Both carbon fiber-reinforced composites (CFRCs) and Mg alloys are promising lightweight materials that can be used to form composites to replace steel parts in automobiles. However, it is difficult to find a machining technique suitable for processing both simultaneously, so their composites are often fabricated by bolting these individual components together. Bolting is performed using steel bolts and washers, but Mg readily forms galvanic couples when it contacts such metallic components. To mitigate galvanic corrosion, an electrically insulating material (such as a polymer resin or polymer tape) can be placed at the interface between Mg and other composite components.

Researchers at Oak Ridge National Laboratory investigated a method to inhibit galvanic corrosion between AZ31B Mg alloy and other components of lightweight composites. As part of the experiments, a layer of Master Bond EP33CLV was used to prevent AZ31B Mg alloy from contacting other composite components, including an SS316 washer and CFRC.

Key Parameters and Requirements

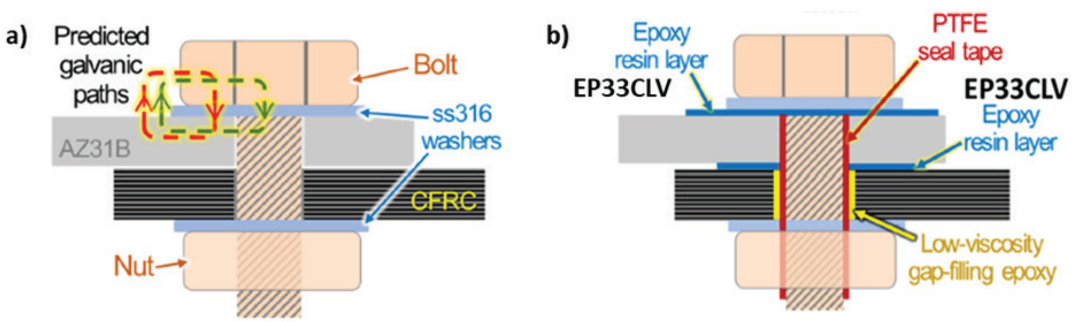

Figure 1. a) Schematic diagram showing the location of the predicted galvanic paths in the unprotected bolted composite. b) Schematic diagram of the polymer-insulated joints where EP33CLV was used to prevent galvanic corrosion between AZ31B Mg alloy and an SS316 washer, and between AZ31B Mg alloy and the CFRC. (Figure modified from ref. 1)

As shown in ***Figure 1a***, the authors prepared bolted joints of AZ31B Mg alloy and a CFRC, in which AZ31B directly contacted the CFRC and SS316 washer. To inhibit the galvanic paths in ***Figure 1a***, the authors placed a 200 µm thick layer of EP33CLV onto the top (contact with SS316 washer) and bottom (contact with CFRC) surfaces of the AZ31B surfaces around the pilot hole. This was followed by the application of a low-viscosity epoxy-acrylate resin to heal any microcracks that might develop due to pre-drilling. Finally, PTFE tape was used to wrap the threaded sections of the steel bolts to prevent contact between AZ31B and the Zn-coated steel bolt.

EP33CLV can be cured readily at room temperature in 2–3 days, or at 150–200°F in 2–3 hours.

Results

After bolting the composite joints, the authors subjected the unencapsulated and polymer-insulated joints to NaCl immersion and salt spray corrosion resistance tests. As shown in ***Figure 2a*** and ***Figure 2b***, encapsulation with EP33CLV and PTFE sealing tape helped mitigate the corrosion of AZ13B and the steel bolt in the inner area of the joint. Although some local galvanic corrosion was observed, this occurred only under extreme conditions (i.e., a salt-spray exposure time of 1264 h).

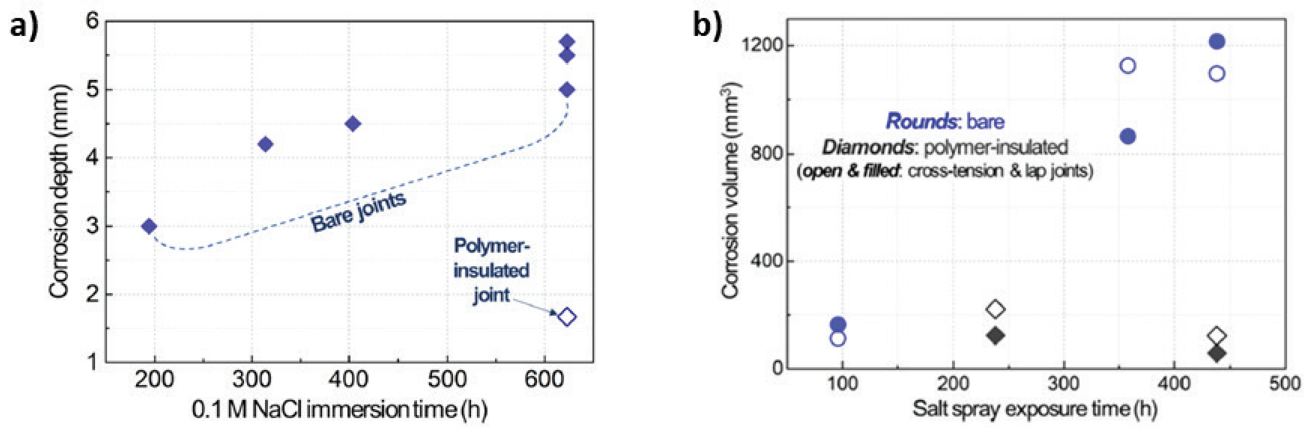

Figure 2. Results of a) NaCl immersion corrosion tests and b) salt spray exposure tests showing that the joints insulated with EP33CLV showed less corrosion.

In the EP33CLV-encapsulated joints, the number of corrosion-induced cracks was reduced, which helped preserve the joint integrity by preventing crack propagation during tensile loading. The EP33CLV-coated specimens retained 80–90% of their joint strength after corrosion tests, in stark contrast to the mere 10% strength retention of the uncoated joints.

Overall, this study highlights that EP33CLV protects against galvanic corrosion in composites containing Mg-steel galvanic couples, ultimately helping mitigate the formation of corrosion-induced microcracks and preserving the strength of composite joints.

References

Jun, J.; Lim, Y. C.; Li, Y.; Warren, C. D.; Feng, Z. Mitigation of Galvanic Corrosion in Bolted Joint of AZ31B and Carbon Fiber-Reinforced Composite Using Polymer Insulation. Materials (Basel) 2021, 14 (7), 1670. https://doi.org/10.3390/ma14071670.