

Eco-friendly bio-based epoxy coatings for corrosion-resistant and self-cleaning applications

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Abstract Corrosion and contamination of engineering metals and alloys can cause serious problems to the functionality and aesthetic appearance of pipelines, bridges, highways, vehicles, and even home appliances, leading to public safety hazards and economic loss. Epoxy resin has been widely applied as a protective coating due to its excellent properties. However, the raw material for industrially available epoxy, bisphenol A (BPA), is derived from fossil resources. BPA is proven to be harmful to the human endocrine system. Therefore, a sustainable and bio-based green epoxy resin would be ideal to replace the fossil-derived epoxy. In this work, an eco-friendly bio-epoxy coating without volatile organic solvents was fabricated by introducing nanoparticles, (3-glycidyloxypropyl) trimethoxysilane (GLYMO) into the isosorbide-based epoxy resin and hydroxyl-terminated polydimethylsiloxane (PDMS). A superhydrophobic bio-epoxy coating was achieved with a contact angle of around 153° by optimizing the coating formulation. Meanwhile, a slippery liquid-infused porous surface (SLIP) coating was obtained by infusing silicone fluid to the optimal superhydrophobic bio-epoxy coating, exhibiting an extremely low sliding angle below 1°. Both the superhydrophobic and SLIP coatings exhibited good water repellency and corrosion resistance. Electrochemical measurement results showed that the two produced coatings have a decrease of 1-2 orders of magnitude in the corrosion current density and a positive shift from -0.306 V to -0.265 V and -0.282 V in the corrosion potential as compared to the bare substrate. Furthermore, the SLIP coating was enhanced to display better self-cleaning performance and proven to function well after the weathering resistance test.

Keywords eco-friendly; bio-based epoxy coating; corrosion-resistant; self-cleaning