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Enhancing fire and mechanical strengths of epoxy nanocomposites for metal/metal bonding of aircraft aluminum alloys
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Abstract
Epoxy adhesives have a wide range of applications in aerospace, automotive, marine, and construction industries. Epoxies reduce the weight of a structure by minimizing the use of fasteners. With the application of epoxy adhesive, a structure can achieve uniform stress distribution, structural integrity, durability, and cost-effectiveness. A mechanical weakness of epoxy adhesives is their lack of thermal stability and failure at post-curing-cycle temperatures. Fire retardancy can be improved by incorporating graphene nanomaterials as reinforcements in epoxy resins. These graphene additions have the potential to improve the epoxy's thermal, mechanical and electrical properties. The thermal characterization of the epoxy nanocomposites was carried out using thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). Surface morphology analysis was carried out for epoxy nanocomposites by using scanning electron microscopy. The test results showed that fire retardancy was significantly improved with the additions of 3 wt% and 5 wt% graphene nanomaterial inclusions when compared with pristine epoxy. The DSC results, when compared to 0.5 wt% and 5 wt% graphene inclusions showed the glass transition temperatures were increased by about 6.2%. The TGA results showed a decrease in the mass reduction by 6.2%, due to the inclusion of graphene nanomaterials. The lap shear strength when tested under tensile tests were enhanced about 27%, compared to pristine epoxy. Overall, graphene nanomaterial inclusions improved both mechanical and thermal properties while increasing the thermal stability of the epoxy when compared to pristine epoxy and other polymeric adhesives. POLYM. COMPOS., 40:3691–3702, 2019. © 2019 Society of Plastics Engineers. © 2019 Society of Plastics Engineers

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