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Mechanical and fracture properties of epoxy adhesives modified with graphene nanoplatelets and rubber particles

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Abstract

Graphene nanoplatelets (GNP) were introduced into a rubber-modified epoxy adhesive in order to simultaneously improve the bulk mechanical properties, fracture toughness and single joint lap shear strength of the adhesive. The Young's modulus was observed to increase marginally from 2.46 GPa to 2.56 GPa due to the addition of 0.1 wt.% GNPs. No further increase in modulus was observed for GNP loading above 0.1 wt.%. A negligible effect on the measured tensile strength was observed. The fracture energy of the bulk adhesive increased by 21 % due to the addition of 0.1 wt.% GNPs. No further increase in measured fracture energy was observed as the GNP content was further increased to 0.5 wt.%. A systematic decrease in the lap shear strength was observed due to the addition of GNPs, i.e. the lap shear strength decreased from 21.7 MPa of the control adhesive gradually to 17.2 MPa of the adhesive modified by 0.5 wt.% GNPs. Imaging analysis of the failed adhesive joints reveal that the reduction in lap shear strength was attributed to the preferential alignment of the GNPs in the direction parallel to the adhesive bonding surface. This was further confirmed by comparing the electrical behaviour of the lap shear joints with that of the bulk adhesive samples.