Effects of γ-Al_2O_3 nanoparticles on the adhesive strength of composite epoxy/sol-gel materials

M. May, H. M. Wang, R. Akid

1. Material Engineering Department, Faculty of Engineering, Sebha University, Sabha - Libya
2. Materials and Engineering Research Institute, Sheffield Hallam University, Howard Street, Sheffield S1 1WB, UK.
3. School of Materials, the University of Manchester. Oxford Road, Manchester M13 9PL, U.K

Abstract

The use of composite sol-gel/epoxy adhesive based on the combination of organic and inorganic components within the adhesive matrix have been studied. The incorporation of different amounts of γ -Al_2O_3 nano-particles into the adhesive matrix was evaluated. Mild steel specimens were prepared for lap joints, which were cured in an oven at 200°C for 16 hours. The bond strength of the sol-gel/epoxy matrix was investigated using a universal tensile test machine. Initially there was an increase in shear strength of sol-gel/epoxy adhesive with increase in γ-Al_2O_3 up to 4.0 wt%. This may be because the nano γ-Al_2O_3 increased the crosslinkage where many surface hydroxyl group on γ-Al_2O_3 materials and in silica sol-gel may react during the polymerisation stage as Al-O-Si bond and enhanced the adhesion strength per interaction area within the adhesive matrix. The maximum adhesive strength of composite sol-gel/epoxy adhesive recorded was 23±0.4MPa. However, as the level of these inorganic materials in adhesive matrix increased further, the adhesive shear strength gradually decreased. The reduction in the strength can be attributed to the increase in adhesive viscosity. The behaviour of the adhesive formulation changes from a liquid-like to a more solid-like state, reducing its wetting ability on the substrate surface, and thus decreasing shear strength.