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Effects of initial blister radius and shaft diameter on energy release rate of metal-polymer composite coating

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Abstract

Shaft loaded blister tests were performed to study the interfacial fracture behaviour of a polymer composite coating material adhesively bonded to a metal substrate. For this purpose, the energy release rate required to propagate the crack along the polymer composite coating-metal interface was measured. To do this, six different initial blister radii (a), three different loading rates and two different spherical ended shaft sizes were employed. Fresh water conditioning at 55^{o}C for 1000 hours was also carried out on the blister specimens to study the environmental effect on the total energy release rate (G_T) of initial blister debonding. For a 5 mm diameter shaft, with the increase of loading rate, the G_T values were found to increase for the controlled samples while the loading rate followed the similar trend with a lower G_T values for the conditioned samples. The G_T values obtained using two different shaft sizes showed that the larger shaft diameter had higher G_T values than the smaller shaft diameter. Conditioned specimens tested using both of the loading shafts were generally found to have lower G_T values than the controlled specimens. A comparison with the linear and nonlinear finite element analyses reveals the application ranges of the solutions for determining the energy release rate based on the plate bending model or the nonlinear membrane model. It is shown that the plate based energy release rate solutions should be used for a small blister and the membrane based solution should be adopted for a large blister.

Keywords Blister test, Energy release rate, Mode mixity, Loading shaft, Polymer coating

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