Proposing a repair and structural health monitoring method of adhesively bonded joints based on eco-adhesives from tannic acid

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Objectives / Description / Main outcomes

This research aimed to study the self-healing capability of fractured aluminium joints bonded with novel eco-epoxide adhesives synthesized from a bio-renewable raw material (tannic acid – TA). Two synthesized eco-epoxy components based on TA, (A) glycidyl ether and (B) glycidyl phosphate ester of TA, were used as a replacement for the toxic epoxy component based on Bisphenol A, found in reference epoxy (R) [1]. The effect of the eco-epoxy components on the self-healing capability was measured as a recovery of maximal loads in the Double Cantilever Beam (DCB) test. A combination of three monitoring techniques, Acoustic Emission (AE), Fibre Optical Sensors (FOS) and Digital Image Correlation (DIC), were used to monitor the strain distribution and damage propagation in the DCB joints. Figure 1 shows the DCB set-up in a combination of mentioned monitoring techniques. This combination of techniques was used to propose a comprehensive guidelines protocol for accurate and robust crack-tip monitoring in adhesively bonded joints. Out of all adhesives, only the A adhesive demonstrated the capability to heal. Figure 2 shows a comparison of load-displacement curves of self-healed and virgin A specimens. Healing efficiency (HE), calculated as a ratio of maximal DCB loads of virgin and self-healed specimens, was ~65% for adhesive A. Besides, the AE analysis managed to capture a clear distinction between the signals for the virgin and the self-healed tests for adhesive A. Results obtained in this study highlighted the promising potential of using bio-based epoxy adhesives in structural adhesive bonding with the possibility of using self-healing in the recovery of the strength of such bonded joints.

References

[1] N. Z. Tomić, M. N. Saleh, S. Teixeira de Freitas, A. Živković, M. Vuksanović, J. A. Poulis, A. Marinković, Polymers 12(7), 1541 (2020) 1541

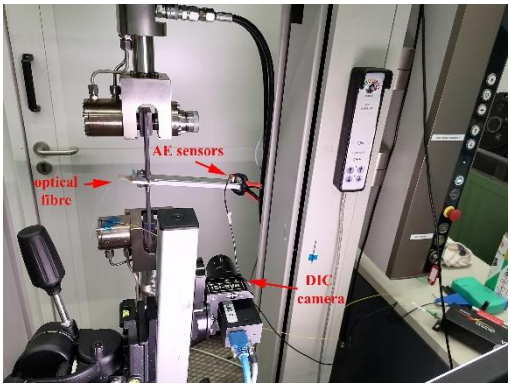

Figure 1: *DCB test set-up in combination with monitoring techniques*

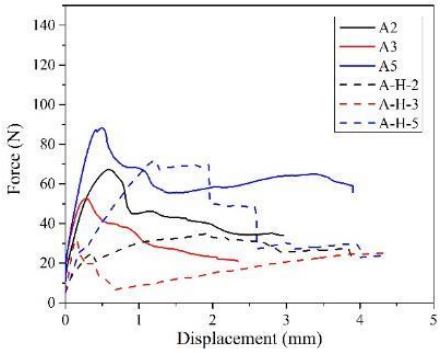

Figure 2: *Comparison of load-displacement curves of self-healed A-H and virgin A specimens*