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Realising damage-tolerant nacre-inspired CFRP

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Abstract

In this work, a nacre-inspired Carbon Fibre Reinforced Polymer (CFRP) composite is designed, synthesised and tested. Analytical and numerical models are used to design a tiled micro-structure, mimicking the staggered arrangement of ceramic platelets in nacre and exploiting geometrical interlocks for crack deflection and damage diffusion. The designed pattern of tiles is then laser-engraved in the laminate plies. In order to increase the damage-spreading capability of the material, a thin layer of poly(lactic acid) (PLA) is film-cast on the interlaminar region, both as a continuous film and as a pattern of fractal-shaped patches. Three-point bending tests show how the nacre-like micro-structure succeeds in deflecting cracks, with damage diffusion being significantly improved by the addition of PLA at the interface between tiles. It is observed that a texture of discontinuous fractal-shaped PLA patches can increase damage diffusion, by promoting the unlocking of tiles whilst preserving the interface strength.

Keywords: Microstructures (A), Biological material (B), Fibre-reinforced composite material (B), Fractography (C), Biomimetics

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