NOVEL POROUS WALL VASCULAR NETWORKS FOR REPEATED SELF-HEALING

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ABSTRACT

A key limitation in the vascular self-healing systems to date has been the inability to achieve repeated healing for an infinite number of cycles due to fracture of the fluid-carrying vessel, which ultimately restricts and then terminates the transportation of the healing agent throughout the structure.
In order to overcome this limitation, a novel concept employing a porous thermoplastic network integrated within a fibre-reinforced composite laminate has been utilised. This approach does not require the fracture of the healing network architecture, but rather promotes the adhesive failure between the network and the surrounding host matrix material; thus exposing a series of radial pores and permitting the secretion of the liquid healing agent into the damage crack plane.
In this study holes of varying diameter have been introduced into PTFE tubes to create a porous vascular network (for the release of a healing potential), which in turn are embedded within a carbon fibre reinforced epoxy composite laminate. A microfluidics investigation into the effect of the shape and size of the pores on volume flow rate of a designated healing system has been undertaken. Mechanical characterisation of the crack-vascule interaction through a fracture mechanics (Mode I, Mode II and Mixed-Mode) assessment has indicated that moderate crack arrest occurs at the location of each vascule resulting in a controlled fracture process; a desirable attribute for self-healing composites. On arrival of a propagating crack to the external wall of the network, adhesive failure between the epoxy matrix and circumference of the network occurs which exposes the radial pores and allows the healing agent to permeate out into the damage area without fracture of the network.
The experimental characterisation of this system is on-going with self-healing trials imminent. These studies will investigate the integration of a low viscosity healing system into the network and the secretion of the healing agent through the pores into the crack plane. Mode I, Mode II and Mixed-Mode fracture toughness tests will be undertaken to determine the full potential of this approach to accomplish repeated self-healing in fibre reinforced composite laminates.