AUTONOMIC REGENERATION OF LARGE DAMAGE VOLUMES

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ABSTRACT

Bioinspired microvascular networks possess the ability to deliver a renewable supply of healing agents to damaged materials. Damage recovery has been successful primarily in high surface area to volume ratio configurations such as delaminations or thin surface coatings. Self-healing of large, open damage volumes presents a significant challenge.

Here we implement vascular delivery of a new bi-phase healing chemistry to regenerate large damage volumes in 3mm thick epoxy sheets with embedded microvascular channels. Damage is introduced through the thickness of the sample by excising a cylindrical volume of material of varying size. Similar to many two-part commercial resins, the bi-phase resin system consists of two separate fluid components. As a damage event occurs, the bi-phase resin components enter the injury region via the vascular networks. The viscosity of the combined resin system rapidly increases and a cross-linked polymer gel forms. Additional bi-phase resin continues to deposit and gel in the damage area until the injury is filled with a soft gel. After the entire damage volume has been recovered, the gel undergoes a second polymerization reaction to form a structural solid.

The bi-phase resin system can be formulated to possess independent control of gelation and polymerization kinetics, a 1:1 stoichiometric mixing ratio, and a viscosity below 100 cps. These desirable design parameters assist in microvascular delivery of the system, making it possible to recover damage diameters in excess of 6mm.