REGENERATIVE POLYMERIC COATINGS

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ABSTRACT

Autonomic healing of coatings has been previously demonstrated using both capsule-based and vascular network approaches. However, healing in both systems has been limited to small damage volumes resulting from scratches or cracks. In this work, we demonstrate a system capable of regenerating a protective coating after large scale damage, for multiple cycles. Our bio-mimetic design incorporates pressure sensitive valves which open upon coating removal to release liquid (uncured) monomer onto the vascularized substrate whereby exposure to UV light polymerizes the monomer to form a protective barrier (coating).

Results are presented summarizing coating regeneration performance as characterized by hardness recovery and resistance to abrasion. The evolution of coating formation is captured through optical microscopy. Multiple damage and regeneration cycles are demonstrated through repeated delivery of coating materials through the vascular substrate. Results from both ex-situ and in-situ regeneration tests are discussed. Specimens incorporating arrays of pressure valves for regeneration of larger scale damage are also presented.

The autonomic flow valves are characterized by flow rate measurements as well as optical inspection. The influence of coating formulation, vascular pressurization, and environmental temperature are presented. The feasibility of using the sun as a source of UV light for curing the regenerated coating as well as the importance of valves as a mechanism for preventing backflow and channel blockage is discussed.

By restoring their protective function autonomously, regenerative coatings could significantly increase the service life of coated substrates. Future design challenges such as the reduction of valve footprint, improved adhesion between the substrate and coating, and manufacturing scalability will be discussed.