SELF-HEALING COATINGS UTILIZING A SHAPE MEMORY EFFECT

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ABSTRACT

Self-healing (SH) coatings are desired for the reduction or repair of corrosion cause by mechanical damage. SH coatings, particularly clear coatings, are also sought for the facile or autonomous repair of mechanical damage to optical lenses. In this report we will present and compare two distinct approaches to self-healing coatings that share in common the use of a shape memory effect but differ dramatically in process and microstructure.

Our first approach is that of an immiscible blend prepared by a combination of electrospinning and spin-coating. The coatings feature a phase-separated morphology with electrospun thermoplastic poly(ε-caprolactone) (PCL) fibers randomly distributed in a shape memory epoxy matrix. Mechanical damage to the coating can be self-healed via heating, which simultaneously triggers two events: (1) the shape recovery of the matrix to bring the crack surfaces in spatial proximity, and (2) the melting and flow of the PCL fibers to rebond the crack. In controlled healing experiments, damaged coatings not only heal structurally, but also functionally by almost completely restoring the corrosion resistance.

Comparison will be made to our second approach involving a transparent blend of linear acrylate copolymer with a crosslinked acrylate copolymer network. Shape memory assisted self-healing enabled crack closure and linear polymer chain diffusion to rebond damaged surfaces. Coatings on glass were prepared by mold-filling and UV-cure, followed by asymmetric demolding that yielded a coating on one glass surface. Coating with a range of composition were prepared in this manner and subjected to scratch damage and subsequent heat-induced recovery. We found that an optimum glass transition temperature exists for maximum healing efficiency.