Smart self-healing material systems using inductive and resistive heating

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This paper describes self-healing smart coatings that recover their strength after crack damage and subsequent healing has occurred. Compliant (modulus = 200 MPa) and structural (modulus > 2 GPa) polymers have been synthesized and combined with a small amount of heating material (<10% volume fraction) to facilitate the healing process. These materials and associated heating mechanisms include nanoscale and microscale magnetic particles for inductive heating and carbon fibers for resistive heating. Due to their Curie temperatures, magnetic materials possess an inherent shut-off mechanism which prevents overheating during material repair. Carbon fibers are interesting as they can be used for damage detection as well as heating. Current approaches describe both in-situ healing where external power must be delivered to generate heating as well as active self-healing where work towards coupling a damage response with the healing mechanism has recently begun. Self-healing polymers are composited with other conventional materials to provide an overall multifunctional solution. One application funded by NASA KSC includes the combination of ionomeric and ionene self-healing material systems layered with Kapton and PTFE to form self-healing wire insulation multilayer composites. The US Army's AMRDEC funds another application which uses a highly cross-linked remendable polymer material system as the matrix for conventional carbon-fiber composite fabrication to mitigate damage caused by both matrix cracking and delamination. These multifunctional materials systems serve both their conventional role as well possess self-healing properties.

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