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# PASSIVE SELF-HEALING DIELECTRIC ELASTOMER SENSORS FOR STRUCTURAL HEALTH MONITORING OF INFLATABLE SPACE STRUCTURES

**Abstract**

Habitable space structures encounter environmental hazards consisting of extreme temperatures, radiation, and micrometeoroid and orbital debris (MMOD) exposure. Current state of the art integrated vehicle health monitoring for detecting the MMOD impact damage of space structures utilize piezoelectric accelerometers, piezoelectric panel sheets, elongation foil strain gages, and fiber optic sensors. Such sensors may not be ideal for future structural health monitoring (SHM) applications as they are active, requiring the implementation of batteries, and are difficult to maintain when installed in tough to reach locations. As such, the National Aeronautics and Space Administration (NASA) is seeking to improve innovative passive SHM methods for inflatable space structures. Among other emerging intelligent technologies, dielectric elastomer (DE) sensors demonstrate great promise due to their high stretchability, high accuracy, and stability over a wide range of temperatures. Moreover, current DE technology can exhibit self-healing capabilities required for the long-term SHM of space structures.

This paper will present the novel development and adaptation of stretchable passive self-healing DE strain sensors to detect MMOD impact location and depth for inflatable space structures. The autonomous self-healing elastomer utilized in the presented experimentation is synthesized by incorporating multi-strength H-bonds and disulfide metathesis in polydimethylsiloxane (PDMS) polymers. The DE strain sensors arrays utilized are developed using the synthesized PDMS with poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) electrodes using additive manufacturing techniques. A test article is constructed using the typical MMOD protection for inflatable space structures consisting of three layers of woven ceramic fiber separated by open-cell foam with a Kevlar restraint layer. Integrating the manufactured sensor arrays behind each layer of woven ceramic fiber, low velocity impact testing is performed to characterize the sensor's capabilities. The performed tests can demonstrate a measurable change in capacitance associated with impact damage, location, and penetration depth. Furthermore, passive operation can be achieved and the penetrated sensors can exhibit self-healing recoverability without compromising the sensor's impact detection capabilities.