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EPOXY BASED SHAPE MEMORY POLYMERS FOR SPACE APPLICATIONS

Abstract

Shape memory polymers (SMPs) are smart materials with a wide range of properties and diverse applications, such as temperature sensors, actuators, and medical devices. SMPs are characterized by an ability to recover mechanically-induced strains (temporary shape) upon application of external stimuli, such as heating or electrical field, returning into their original, permanent shape. The mechanism of a shape memory effect is based on the property of SMPs to retain a permanent strain below the glass transition temperature (Tg), where the material is glassy and rigid, and to release that strain above Tg, where the material is rubbery and flexible. Potential space applications of these materials include deployable space systems, solar panel arrays, antennas and radiators. However, creating an SMP which is durable to the harsh conditions of the low Earth orbit (LEO) space environment forms a great challenge. In the present work, flexible amine-cured aromatic epoxy system was used as a basic structure possessing a shape memory effect under thermal stimuli. The primary components of the produced SMP are Epon 826 and Jeffamin D230. This material system was modified by addition of resistive heaters such as graphite fibers and polyhedral oligomeric silsesquioxane (POSS) nano-fillers. The graphite fibers allow resistive heating of the SMP by creating an electrical resistance in the range of 15-100 enabling a controlled heating of the SMP to a temperature of about 90C, above its Tg. The addition of POSS at various loadings enhanced the SMP durability to atomic oxygen, the most hazardous component of the LEO space environment. This unique materials system demonstrates promising characteristics for potential use in the LEO environment.