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DEVELOPMENT OF A DEGRADATION MODEL OF EPOXY ADHESIVE DUE TO RADIATION IN SPACE ENVIRONMENT

Abstract

The present work develops a model for the mechanical degradation of structural adhesive due to radiation. Bulk specimen of epoxy adhesive are eposed to γ-radiation and tested under tensile laoding. The degradeted mechanical properties of the adhesive are implemented into a single lap joint (SLJ) model to enhance the design process of structural adhesive in space.

The project iBOSS (intelligent Building Blocks for On-Orbit Satellite Servicing) develops a full modular satellite architecture where building blocks called iBLOCKs are combined to build up the satellite bus. Adhesive bonding is the only bonding technique which is used in the primary structure of the iBLOCK. Therefore the effect of space environment e.g. radiation, thermal cycling, atomic oxygen and vacuum on the mechanical properties of the adhesive are of highest interest. The present paper focuses on the effect of radiation and its mechanism of interacting with the adhesive joints. Analysis considering different orbit with respectively radiation doses are executed. These doses are added up to a total ionizing dose (TID). Bulk specimen of the examined adhesive are then exposed to the worst case orbits TID using a γ-radiation source. Furthermore the specimen are loaded in tensile direction with a unique designed fixture to investigate the effect of creep in combination with radiation, a scenario which can be found on moon/mars base. After irradiation the specimen are tested under tensile loading. Mechanical properties like Young modulus, shear modulus and tensile strength are determined and compared to unirradiated specimen. Using these results a degradation model for the adhesive is developed and applied to a SLJ model. With this, the stress distribution for a degradated SLJ under tensile loading in space environment can be derived. This model will enhance the design process of adhesive joints in the iBLOCK and in space structures in general.