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INORGANIC FILLERS INFLUENCE ON THE RADIATION-INDUCED AGEING OF A SPACE-USED SILICONE ELASTOMER

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ABSTRACT

A space-used filled silicone rubber (silica and iron oxide fillers) and its polysiloxane isolated matrix were exposed to high energy electrons in order to determine their ageing mechanisms from a structural point of view. Physicochemical analysis evidenced that both filled and unfilled materials predominantly crosslink under such irradiation. Solid-state ^{29}Si NMR spectroscopy allowed the identification of T-type SiO_3 units as the main new crosslinks formed in the polymer network. It also revealed an increase in Q-type SiO_4 units in the irradiated filled sample. Thanks to the combination of NMR spectroscopy and ammonia-modified swelling tests, these Q-type units were associated with new crosslinks formed at the silica fillers-matrix interface. While the main interaction between the polysiloxane network and the fillers was shown to proceed mainly through hydrogen bonding in the pristine filled samples, it was suggested that the hydrogen bonds were progressively replaced with SiO_4 chemical bonds. These additional chemical crosslinks induced evolutions of the shear modulus on the rubber plateau and crosslink density that were significantly more pronounced in the filled material than in the neat one.

1. Introduction

In space applications, the ageing of surface dielectric materials is a main concern as it may lead to spacecraft failures and mission degradation. In 2009, a study carried on a panel of 129 spacecrafts showed that 45% of total on-orbit spacecraft failures were due to electrical malfunction [1]. Solar

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