Application of Local Regolith in Sealing Materials Designed for Lunar Equipment and Infrastructure

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Introduction

Elastomers are irreplaceable materials for producing high-performance seal systems because of their ability to recover to the original shape after elastic deformation. Ethylene-Propylene-Diene rubber (EPDM) is a promising elastomer for aerospace applications due to its good aging resistance. The fully saturated polymer chain of EPDM provides high resistance to oxidative aging that can be triggered by atomic oxygen in the upper part of the atmosphere or by plasma present on the surface of the Moon. EPDM-based compounds contain in most applications a significant amount of reinforcing filler improving their performance and lowering the costs of the final product. In order to meet the In-Situ Resource Utilization (ISRU) expectations this study aims to investigate the reinforcing potential of Lunar regolith used as filler for EPDM.

In this study EPDM rubber was filled with small-size-fraction (below 103 μm) of Lunar regolith simulants (TUBS-M and TUBS-T [1]) and fibers made of home-made Lunar regolith simulant [2] to evaluate their reinforcing potential. Additionally, the bis[3-(triethoxysilyl)propyl] tetrasulfide coupling agent was applied to improve the filler-rubber interfacial adhesion. The processing, the morphology and the wear of the composites were investigated before the accelerated aging, while their mechanical and thermal properties were tested before and after the aging treatment simulating radiation present on the Moon surface, performed by electron-beam irradiation of 20, 50 or 100 kGy.

The addition of all fillers improves the in-rubber properties compared to the unfilled EPDM compound especially in terms of thermal resistance. The application of the coupling agent resulted in a noticeable further increase in mechanical properties of the EPDM compounds. The accelerated radiation aging caused additional cross-linking of EPDM macromolecules resulting in an improvement of the thermal resistance of the samples but also slightly deteriorating their mechanical properties. The study shows that Lunar regolith has a potential to become a filler for elastic materials produced on Moon and thus meet the ISRU expectations by partial replacement of the common rubber reinforcing fillers.

References

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[2] MoonFibre aims to produce fibres from the Moon's soil, https://moonfibre.de/, (access on 2nd March 2021)

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