Paper ID: 59932
student

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Advancements in Materials Applications and Rapid Prototyping (5)

Author: Ms. Federica Zaccardi
Sapienza University of Rome, Italy

Dr. Susanna Laurenzi
Sapienza University of Rome, Italy
Mr. ALESSANDRO SANTILLI
University of Rome "La Sapienza", Italy
Ms. Elisa Toto
Sapienza University of Rome, Italy
Dr. M. Gabriella Santonicola
Sapienza University of Rome, Italy

# 3D PRINTED POLYETHYLENE-BASED COMPOSITES FILLED WITH MARTIAN REGOLITH SIMULANT USING FUSED FILAMENT FABRICATION

**Abstract**

Interplanetary manned missions, for which cargo resupply is not possible, require development of radiation protection materials that can be fabricated in situ to ensure crew safety. The 3D printing process via fused filament fabrication (FFF) enables repair of spacecraft components and fabrication of tools by recycling available materials. In addition, FFF 3D printing is increasingly viewed as an interesting approach for the in situ manufacturing of buildings using regolith as a feedstock material. In this work, we investigate the FFF 3D printing process to fabricate polyethylene-based composites filled with Martian regolith simulant, using a basalt powder with chemical composition similar to that of Mars soil. The basalt powder was integrated in medium density polyethylene (MDPE) at different loadings (up to 60% by weight with respect to the polymer), and customized filaments were produced by extrusion. The thermal properties of MDPE and MDPE/basalt composite powders were investigated by differential scanning calorimetry (DSC), in order to analyze the effect of basalt on the process parameters of filament extrusion and 3D printing. Low-impact Izod tests were performed on molded MDPE and MDPE/basalt specimens. An increase of the absorbed impact energy with respect to the neat MDPE was observed at all investigated basalt concentrations, with the highest values of impact strength achieved at 5% and 10%. The filament extrusion and the FFF 3D printing processes of MDPE and MDPE/basalt composites at filler loadings of 5% and 10% were optimized to produce samples with high surface quality. Morphological investigations of the customized extruded filaments were performed using scanning electron microscopy (SEM). Tensile specimens of MDPE and of MDPE/basalt composites at 5% and 10% basalt loading were 3D-printed, and their tensile strength was comparable to those of traditionally molded samples.