Paper ID: 82815
student

22nd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Technologies (2B)

Author: Ms. Federica De Rosa
Sapienza University of Rome, Italy

Mr. Alessandro Minnella
Sapienza University of Rome, Italy
Prof. Susanna Laurenzi
Sapienza University of Rome, Italy

RECYCLING OF SPACE FOOD PACKAGING FOR PRODUCTION OF POLYETHYLENE TOOLS BY ADDITIVE MANUFACTURING

Abstract

Long-duration interplanetary human missions require careful planning and management of resources such as fuel, water, food and spare parts. Resupply missions may not be feasible, necessitating efficient resources utilization and recycling. Additive manufacturing technologies play a significant role not only in the field of extra-terrestrial infrastructures construction, but also in small components or spare parts production. In this work, we investigated the possibility of recycling space food packaging into a new composite material based on low density polyethylene (LDPE) filled with PET-aluminum-LDPE (PAL) trilaminate. LDPE was recovered from septum adapter and straw, while PAL trilaminate was obtained with the entire beverage packaging. Due to the limited availability of space beverage packaging, septum adapter and straw material were simulated by LDPE powder with a particle size of 500 μm, while commercial coffee package was used as surrogate of the entire trilaminate wrapping. At first, as proof of the similarity between the thermoplastic layers which characterize the coffee packaging composition and those of the space beverages, a chemical behavior investigation was performed by Fourier-transform infrared spectrometer (FTIR). Furthermore, raw PAL trilaminate was milled and sieved to be mixed with LDPE. The thermal properties of this new filler were investigated by differential scanning calorimetry (DSC), while the average grain size was preliminarily carried out via scanning electron microscope (SEM) and more thoroughly by Bootstrap resampling technique. Then, specimens were produced via casting process by melting the composite powders in oven while degassing. Different weight percent (wt%) of PAL trilaminate filler (5, 10 and 20 wt%) were incorporated to LDPE matrix. Two different groups of specimens were produced, according to DIN EN ISO 527-2 and the technical specifications for single cantilever mode, respectively, for performing tensile tests and dynamic mechanical analysis (DMA). Tensile tests showed constant tensile strength behavior for the LDPE-PAL composite up to 10 wt% filler, a consistent reduction was recorded by introducing 20 wt% PAL trilaminate. During dynamic mechanical analysis (DMA) of composite specimens, it was observed that the storage modulus remained constant with the filler weight fraction until reaching a loading of 20 wt%. At this point, a significant decrease in the modulus was recognized. Due to its higher tensile modulus while maintaining the same tensile strength, LDPE-PAL with 10 wt% filler loading was selected for an extrusion process to obtain a filament with a suitable shape and size for additive manufacturing process.