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ADDITIVE MANUFACTURING OF SPATIALLY EFFICIENT, ARCHITECTURED MMOD SHIELDING

Abstract

Shielding elements used to protect against micrometeoroids and orbital debris (MMOD) typically incorporate thin bumper sheets that intercept and vaporize incident MMOD traveling at speeds in excess of several km/s. In some applications, however, space limitations prevent the use of large stand-offs, and components must instead be protected by a single monolithic shielding element. Electronics, for example, are often only protected by their housing. With such applications in mind, we describe a class of spatially efficient composite shielding elements fabricated using a hybrid additive manufacturing approach termed PrintCasting. The PrintCast process consists of two steps: First selective laser melting is used to fabricate a lattice preform in the shape of the final component. Next this preform is infiltrated with a liquid metal that has a melting point lower than that of the lattice. The resulting solidified part is a periodic interpenetrating composite in which each constituent forms a continuous network. Using a combination of hypervelocity impact experiments and shock transmission calculations, we demonstrate that these interpenetrating composite shielding elements mitigate spallation and other failure modes through multiple internal shock reflections at the buried heterophase interfaces.