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IMPACT PROPERTIES OF MICRO-CHANNELED EPOXY FOAMS AND FIBER REINFORCED MICRO-CHANNELED COMPOSITES

Abstract

Lightweight polymer composite designs are in continuous development for applications in space environments. The fabrication of anisotropic hollow micro-channel shaped voids has recently been demonstrated as an effective technique to tailor the bulk densities, mechanical properties, and thermal insulation performance of polymer foam structures, as well as impart vascular multi-functionalities such as active fluid cooling or delivery of unreacted polymer resin for self-healing applications. However, the mechanical properties of any foam material are significantly reduced from those of the non-porous polymer, especially at increasingly high void volume fractions. The impact strength has also been observed to decline with increasingly high fractions of micro-channel voids, with greater than 90% reduction observed at void fractions of 0.7, relative to the neat polymer matrix. Since protection from impact events is critical to the success of space missions, improvement of the micro-channel foam impact properties are of paramount importance. To offset the loss in impact strength due to the presence of the micro-channels, a number of lightweight carbon, aramid, and poly(phenylene sulfide) fiber veils have been utilized as fiber reinforcements embedded in the micro-channel foam matrix structure. A variety of fiber weight fractions and layup designs have been explored, including both sandwich-style composites and, more interestingly, multi-layered structure configurations. Low areal density aramid fiber veils proved capable of improving impact performance by more than 450% with negligible increases in composite density. Results of this work reveal the effects of the micro-channel fraction and orientation on foam impact performance, as well as demonstrate the practicality of using the lightweight fiber veil as a standalone reinforcement strategy in composite designs, which is undoubtedly useful for a variety of composite applications in the aerospace industry.