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NOVEL PHASE CHANGE MATERIAL COMPOSITE FOR SUSTAINABLE SMALLSAT THERMAL MANAGEMENT

Abstract

In this paper, improvements in thermal conductivity and form-stability during the phase change of paraffin phase change material (PCM) were benchmarked between PCM infused with an interconnected graphene scaffold and a discrete graphene of the same filler loading. Paraffin PCM has been considered as a passive thermal management system (TMS) on board satellites, especially Smallsats, owing to its high energy storage density, low weight, and requiring zero additional power consumption. However, paraffin is limited by its low thermal conductivity, poor shape stability and large density change of more than 10Paraffin/3DC was fabricated by immersion in liquid paraffin for 3DC, and paraffin/GP was fabricated by mixing liquid paraffin with grounded 3DC in acetone solvent, followed by solvent evaporation. Thermal conductivity of the PCM composite was measured using the hot-disk method and form-stabilization was compared through thermal cycling of the PCM composites in an environment chamber. We measured a larger increase in thermal conductivity for paraffin/3DC, which is 5 times that of neat paraffin, and only a 1.3 times improvement for paraffin/GP. We also found that 3DC optimizes the solidification process with heterogeneous nucleation, helps to retain the shape of the composite over multiple phase changes and reduces void formation in the sample. In summary, 3DC provides a significant stable thermal conductivity improvement at a lower filler loading as compared GP for paraffin composites. 3DC also effectively retains the shape of the composite, therefore improving the effective contact with a paraffin container.