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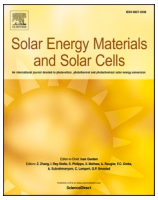

Quantifying thermophysical properties, characterization, and thermal cycle testing of nano-enhanced organic eutectic phase change materials for thermal energy storage applications

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ABSTRACT

Dispersion of highly conductive nanoparticles in Phase Change Materials (PCMs) tends to improve the thermophysical properties of nanocomposites. The current research condenses the synthesis, chemical, physical, and thermal characterization of novel nano-enhanced eutectic phase change materials (NeUPCMs) dispersed with TiO_2 nanofillers for thermal management applications. The base matrix primarily comprises of a eutectic of paraffin wax and palmitic acid. Detailed analysis of the uncertainty of each thermophysical property measured was performed. The synthesized nanocomposite logged a maximal thermal conductivity of 0.59 W/mK (2.3-fold as compared with the base-0.25 W/mK) with 0.5% nanofillers. The composites displayed excellent solar transmissivity (82%) as they were doped with nanofillers having a high refractive index. The latent heat of the NeUPCMs got enhanced by 17% whereas the melting point showed a slight decrement in nanocomposites. Further, zero phase segregation, no subcooling, stable phase transition temperature, and good chemical, and thermal stability were noted from digital scanning calorimetry results with NeUPCMs. The composites exhibited good thermal reliability beyond 500 thermal cycles. It could be potentially deployed in the thermal management of medium-temperature systems like PVT and LCPVT systems.

1. Introduction

Energy got elevated to a topic of concern in science prominently owing to sustainability and green concerns. An efficient energy storage technology is needed to combat the intermittencies and instabilities existing in present sustainable and renewable energy sources. Thermal energy storage(TES) is attaining relevance although heat is the most common form of energy loss [1]. The projected energy demand of the world for the next 20 years is around 27 TW, whereas the earth absorbs 122,000 TW of solar irradiation [2]. The seventh sustainable development goal (one among the seventeen laid by the Paris agreement in 2015) stresses the need to provide cost-effective and green energy for all which is mainly possible by embracing energy-efficient and clean energy sources. Furthermore, as per the energy road map for 2050, the EU proposes renewable energy sources must deliver two-thirds of energy [3]. TES remains a sustainable resolution for solving the issue of energy space-time mismatch. Medium and high-temperature TES system has been extensively deployed in numerical applications like industrial waste heat recovery and solar thermal power plants for thermal

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