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Multi-wall carbon nanotubes tailored eutectic composites for solar energy harvesting

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ABSTRACT

Carbonaceous thermal energy storage involving PCMs has gained an increasing research interest owing to their higher thermal conductivity and energy storage density. The current work analyses the thermophysical properties of a nano-enhanced eutectic phase change material (NeUPCM) laden with different concentrations (ranges from 0 wt% - 0.7 wt%) of multi-wall carbon nanotube (MWCNT). Paraffin wax-palmitic acid (PW-PA) binary eutectic was produced initially by facile melt blending, and then MWCNTs were doped via standard two-step nanocomposite synthesis protocol. Nanocomposites showed a slower decomposition rate, and the thermal resistance index improved. MWCNT enhance the thermal conductivity of the eutectic base (140 %), which reaches a maximum value of 0.619 W/(m·K) for 0.5 wt% loadings, and the maximum increment of 13.2 % of latent heat was noted for 0.7 wt% loading of MWCNT (which is having a melting temperature of 53 °C). The sample doped with 0.5 wt% MWCNT(C3) showed the highest thermal effusivity. The NeUPCMs also displayed improved photothermal performance and solar absorptivity. Corrosion analysis against copper revealed that the composite is suitable for long-term usage. The NeUPCMs maintained good reliability even after 500 melt-freeze cycles. In short, the proposed NeUPCMs hold significant potential to be employed for thermal energy storage purposes.

Author statement

Jeeja Jacob: Methodology, Formal analysis, Investigation, Data curation, Writing–original draft; **A. K. Pandey:** Conceptualization, Methodology, Funding acquisition, Investigation, Writing–review & editing, Resources, Supervision; **Nasrudin Abd Rahim:** Writing–review & editing, Supervision; **Jeyraj Selvaraj:** Investigation, Writing–review & editing, Supervision; **John Paul:** Investigation, Writing–review & editing.

1. Introduction

Thermal energy is one among the most prevalent global power sources, even though it is interpreted to be a substandard energy source [1]. Being the by-product of numerous energy conversion process makes thermal energy abundant in nature [2]. Moreover, it contributes a staggering 70% to the world's current energy consumption comprising domestic and industrial applications [1]. An intermittent supply of thermal energy coupled with a terrible wastage typically results in a supply-demand mismatch. This eventually leads to degraded energy utilization efficiency. Researchers have made continuous efforts (since the latter part of the 20th century) to attain the desired thermal energy regulation and improve energy utilization efficiency in thermal energy storage (TES) technology [3]. Being an economical and highly efficient storage method to balance out non-dispatchable sustainable energy production and utilization, researchers are currently concentrating on TES utilizing latent heat energy storage (LHES) [4]. The current emphasis has indeed been narrowed down to phase change material

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