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Thermal energy harvesting of highly conductive graphene-enhanced paraffin phase change material

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Abstract

Solar energy is the most plentiful renewable energy source that has the capability to keep up with the growing demand. When the sun's energy is not available, thermal energy storage (TES) using phase change material (PCM) is a promising technique for storage and utilization. However, PCM's low thermal conductivity may limit its use. The use of nanomaterials to enhance the thermal conductivity is one of the prominent solutions to overcome this issue. This research work reports that graphene nanoparticles (0.1%, 0.3%, 0.5%, 0.7% and 1% mass) enhanced paraffin wax (PW) to improve the thermophysical properties and transmittance capability. Thermogravimetric analyzer (TGA), differential scanning calorimeter (DSC), Fourier transform infrared spectroscopy (FTIR) and ultra-violet visible spectroscope (UV–VIS) were used for the characterization of the base PCM and nano-enhanced phase change materials (NePCM) composites. A significant improvement of 110% in thermal conductivity was obtained at 0.7% mass ratio compared to base PW without compromising the prepared composites' latent heat storage (LHS) capacity. TGA and FTIR outcomes demonstrated excellent thermal and chemical stability, respectively. To check the thermal reliability of composite, the PW and nanocomposite were subjected to repeated thermal cycling. The outcome evidence that the NePCM composite had consistent thermal energy storage properties even after repeated thermal cycles. The composite's light transmission was drastically lowered by 56.34% (PW/Gr-0.5) compared to base PW, resulting in PW/Gr composite has better thermal reliability in relation to thermal conductivity and LHS than base PCM, which can be used specifically in photovoltaic thermal systems and TES.

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