Magnetically Assembling Nanoscale Metal Network into Phase Change Material — Percolation Threshold Reduction in Paraffin Using Magnetically Assembly of Nanowires

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Abstract

A high throughput manufacturing process to magnetically assembling nanowire (NW) network into paraffin was developed for enhancing conductivity in phase change materials (PCMs) used in energy storage applications. The prefabricated nickel NWs were dispersed in melted paraffin followed by magnetic alignment under a strong magnetic field. Measuring electrical and thermal conductivity of the nanocomposite, as well as observing cross section of the sample slice under an optical microscope characterized the alignment of NWs. As a comparison, nickel particles (NPs) based paraffin nanocomposites were also fabricated, and its electrical and thermal conductivity with and without applied magnetic field were measured. The effects of aspect ratio of fillers (particles and NWs) and volume concentration on percolation threshold were studied both experimentally and theoretically. It was found that the NW based paraffin nanocomposite has much lower percolation threshold compared to that of particle based paraffin composite. Furthermore, the alignment of particles and NWs under magnetic field significantly reduces the threshold of percolation. This work provides solid foundation for the development of a manufacturing technology for high thermal conductivity PCMs for thermal energy storage applications.