Joule Effect in Electrically Aligned CNFs: Towards Ultrafast Heating of Liquids

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Heat, conceptualized as a byproduct or residue inherent in any energy transformation or consumption process, or even as a direct output in heating systems, requires special considerations. Currently, various types of composite materials with adjustable thermal transport properties have been developed. Specifically, those incorporating carbon nanostructures have shown promising results in terms of thermal efficiency and conductivity. We found that the electrical alignment of carbon nanofibers (CNFs) immersed in Ethylene Glycol (EG) results in ultrafast heating of this composite liquid. An external oscillating (AC) voltage is applied for a short duration across two copper electrodes, serving as the cell walls containing the liquid composite. System temperature evolution is monitored using an infrared camera. CNFs rapidly heat up via the Joule effect, consequently raising the surrounding liquid temperature concurrently. We provide experimental evidence demonstrating that CNFs act as an efficient and ultrafast internal heating source for the surrounding liquid during the application of an external AC voltage, while the remaining liquid functions as a dissipation medium during the cooling of CNFs.

Keywords: thermal transport properties, carbon nanofibers, Joule effect, ultrafast heating