Thermal Characterization of Carbon Nanotube-based Organic Composites for Thermoelectric Applications using the 3-Omega Method

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Abstract

Thermoelectric devices have emerged as effective solid-state energy harvesting solutions. Thermal conductivity plays a crucial role in the performance of thermoelectric materials and maximizing the thermoelectric figure of merit. Among them, polymer-based thermoelectric materials offer an attractive alternative, particularly for flexible device applications and are being extensively investigated. However, thermal characterization of these materials has been challenging due to their porous and relatively rough surfaces and elastic nature. In this study, we focused on characterizing the thermal conductivity of carbon nanotube-polymer composites for potential thermoelectric applications. The objective is to employ the frequency-dependent 3-Omega method to understand the thermal transport behavior and figure of merit of these materials at room temperature as a means to optimizing their performance for device applications. To overcome the challenges in characterizing the porous films, we attach a flat Teflon tape on the film to properly fabricate micro-heaters on the tape, and then perform the 3-Omega technique with varying film thicknesses to eliminate the parasitic interface resistances. We present the experimental methodology employed for the thermal conductivity measurements using the 3-Omega method, and its advantages and limitations are discussed.

Biography of Presenter

Nilesh Raut is a graduate student currently pursuing dual Master and Ph.D. degrees in Mechanical Engineering at the University of Cincinnati, working in the field of Thermal and Fluid Sciences, and a member of the Thermoelectric Energy Conversion group at UC. Current research efforts are focused on Material Characterization for Thermal Conductivity using 3-Omega method and solid-state energy conversion technologies.