Thermal Properties of Soft Nanomaterials: Thermal Measurement Design
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ABSTRACT

Soft materials like hydrogels have multiple tunable material properties because of their unique structures. Due to the ability to respond to stimuli like temperature or chemical environment, they have numerous applications in different fields like delivering drugs inside the human body and other medical uses. Details of the thermal transport mechanisms, as well as the overall thermal properties, are critical for a variety of applications. Multi-property measurements elucidate the underlying transport mechanisms in the soft materials. This research demonstrates a new methodology of measuring thermal properties of soft materials. This work uses the $3\omega$ method [1,2] for measuring the thermal conductivity of soft hydrogels. In the $3\omega$ method, heat is generated in thin heater line excited by a sinusoidal current at a frequency of $\omega$. We measure the voltage response at the third harmonic of the input frequency ($3\omega$). This response is related to the temperature rise and thus the thermal properties. Once the measurement technique is optimized, PVA-PVP hydrogels are tested. Using a 2D mathematical model of the heat transfer, the thermal conductivities of soft material are calculated from the experimental data. Based on the methodology built during this research, this technique is available now for other soft materials beyond hydrogels and the precision of this methodology can be improved by further studies.

KEYWORDS

REFERENCES


