Proceedings of the 12th World Congress on Mechanical, Chemical, and Material Engineering (MCM 2026)
August 18 – 20, 2026 – London, United Kingdom
DOI: 10.11159/htff26.002

Energy Transport in sub-10 nm SWCNT Bundle: From Measurements to Physics Exploration

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Extended Abstract

The interfacial energy transport between single-walled carbon nanotubes (SWCNTs) and the surrounding is of great science and engineering importance, but is rarely experimentally investigated. Even the few reported experimental work suffers very large uncertainties, which hinders in-depth physics understanding of the SWCNT interface energy transport. This is attributed to the very large difficulty faced in characterizing the thermal transport across a nm-wide 1D interface. This talk will cover our latest work on new technique development and characterization of the energy transport between an SWCNT bundle (<10 nm thickness) and silica substrate. Our ET-Raman technique makes it possible to simultaneously measure the thermal conductivity and interfacial thermal resistance (ITR) of the bundle with high confidence. Our study of the ITR dependence on temperature uncovers very strong phonon diffuse mismatch at the interface, which is further interpreted by our equivalent interfacial medium (EIM) theory. By studying the thermal response of the SWCNT under different modulated laser heating up to 25 MHz, we are able to distinguish the optical and acoustic phonon temperatures of SWCNTs, which is the first time to date. It uncovers very strong phonon mode-wide thermal nonequilibrium, and cryogenic temperature-suppressed energy coupling factor between optical and acoustic phonons.