



Department of
Mechanical Engineering
The University of Hong Kong

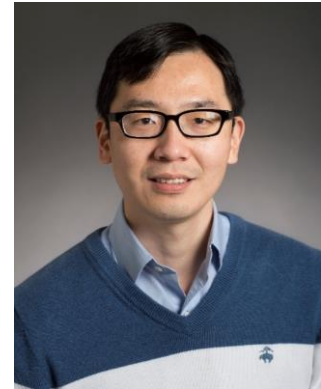


SEMINAR

Engineered Nanostructured Materials for Advanced Thermal Management, Rectification, and Encryption

Date: 24 July, 2024 (Wednesday)
Time: 2:00 p.m.
Venue: Room 7-34 & 7-35, Haking Wong Building
HKU

Speaker: Professor Sheng Shen
Department of Mechanical Engineering
Department of Electrical and Computer Engineering (Courtesy)
Department of Materials Science and Engineering (Courtesy)
Carnegie Mellon University



Abstract:

In this talk, I will give three examples about utilizing specially engineered nanostructured materials to develop advanced thermal components. First, I will introduce new types of nanostructured thermal interface materials that can thermally bridge the interfaces with ultra-low thermal resistance and mechanical compliance. Compared with the state-of-the-art thermal interface materials, the nanostructured thermal interface materials exhibit a thermal resistance as small as about $0.5 \text{ mm}^2\text{K/W}$, polymer-like compliance, and exceptional long-term reliability with $>1,000$ thermal cycles over a wide temperature range. With the significantly enhanced heat transfer and reliability, these nanostructured thermal interface materials hold great promise for enhancing the thermal management of energy-dense devices and systems, contributing to future energy efficiency and sustainability. Second, I will report an ultra-high-contrast and reversible nanoscale thermal switch based on the structural phase transition in crystalline polyethylene nanofibers, which enables a $\sim 10\text{X}$ thermal switching ratio between the on-state (high) and the off-state (low) thermal conductance values. The observed high switching ratio exceeds by far any reported experimental values for solid-solid phase transition, solid-liquid phase transition and desiccation-hydration of materials. By fabricating a heterogeneous “irradiated-crystalline nanofiber junction” using an electron beam, we also demonstrate a high-performance solid-state nanoscale thermal diode with a rectification factor as high as $\sim 54\%$. Finally, I will present the design and fabrication of bio-inspired brochosome structures with and without through-holes, which appear visually similar under visible light but have their thermal emission profiles significantly distinct from each other. Such a property allows us to encode physical information with brochosome arrays that can only be decoded under infrared signals, which is potentially useful in the areas of thermal encryption, infrared holograph, and data storage.

Biography:

Sheng Shen is a Professor at the Mechanical Engineering Department of Carnegie Mellon University (CMU). He also holds courtesy appointments in both the Electrical and Computer Engineering and the Materials Science and Engineering Departments at CMU. He received his PhD degree from the Mechanical Engineering Department, MIT, in 2010. Prior to joining CMU in 2011, he conducted his postdoctoral research at UC-Berkeley. His research interests include nanoscale heat transfer and energy conversion, nanophotonics, and their applications in energy conversion, thermal management, sensing, and multifunctional materials. Professor Shen is a recipient of NSF CAREER Award, DARPA Director's Fellowship, DARPA Young Faculty Award, and Elsevier/JQSRT Raymond Viskanta Award for Spectroscopy and Radiative Transfer. He also received the CMU Dean's Early Career Fellowship, the Philomathia Foundation Research Fellowship in Alternative Energy Research from UC-Berkeley, a Hewlett-Packard Best Paper Award from ASME Heat Transfer Division, and a Best Paper Award in Julius Springer Forum on Applied Physics.

ALL INTERESTED ARE WELCOME

For further information, please contact Prof. X.B. Yin at 3910 2659.