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Design and fabrication of optically-tunable nanostructured particles for thermal applications

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Optically-tunable nanostructured particles (e.g. nanoshells) have potential for applications in thermal systems including property-specific nanofluids and nano light-heat convertors. This talk will discuss the model-aided design and controllable fabrication of these types of structured nanoparticles specifically tailored towards thermal applications. A comprehensive computational model for multi-scattering of electromagnetic waves by individual and aggregate of single- and multi-layer-structured nanoparticles will be presented. The model is based on the Mie solution, coupled with the spherical translation addition and Wigner-Eckert theorems and implemented with a recursive algorithm, with full account for nonlocal and nanosize effects. Model results are validated with available optical measurements. Numerical simulations for light-heat conversion and novel nanoscaled phenomena associated with the localized surface plasma resonance–enhanced heat generation in the nanostructured particle systems are discussed. Along with the model, we present an optimally-tuned "seed and growth" synthesis procedure by which structured nanoparticles with predictable properties are fabricated in a controllable fashion and with good repeatability. The optimality is a result of extensive experimental trials, combined with the understanding of chemistry and physics local to the interface of the particle template. Structured nanoparticles of both over- and sub-100nm size are synthesized and characterized. Experimental measurements are compared with model predictions. Finally, work will be presented of embedding these optically-tunable nanostructures in thin film media as a heat absorber from the excitation of an NIR laser. The optical and thermal characteristics of these nanostructure-embedded thin films are determined using a spectrophotometer with an integrated sphere and localized thermal sensors.

Biography

Ben Q. Li has completed his Ph.D. from University of California at Berkeley and subsequently worked as a research associate at Massachusetts Institute of Technology. He is Professor and Chair, Department of Mechanical Engineering, University of Michigan, Dearborn. His expertise area includes the theoretical and experimental study of nanoscale light-thermal interaction in energy and biomedical systems. He has authored/co-authored 4 monographs and over 200 technical papers and served as associate editor for the ASME journal of heat transfer. He is an ASME fellow.

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