Characterizing and Engineering Nanoscale Thermal Interfaces for Advanced Thermal Insulation and Lithium-Ion Batteries

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As device feature sizes and structured material characteristic lengths shrink to the nanoscale, heat transfer across interfaces begins to dominate the overall heat transfer capabilities of a system. We are applying theoretical and experimental techniques to study and leverage this effect at both ends of the spectrum: to suppress and to enhance thermal transport. We are engineering thermal interfaces for a new nanoparticle-based thermal insulation material that has a theoretical thermal conductivity less than air, while still being over an order of magnitude more mechanically robust than aerogel and comparable in price to contemporary fiberglass insulation. We are also utilizing sensors to characterize the thermal conductivity and thermal interface resistances of Li-ion battery materials, to pinpoint which interfaces are limiting the heat transfer inside the battery. The results of this work could lead to thinner and more transportable robust thermal insulation for buildings and aerospace, and batteries that are smaller, safer, longer lasting, and which can be recharged faster.