Nanostructured Thermal Interface for Advanced Thermal Management

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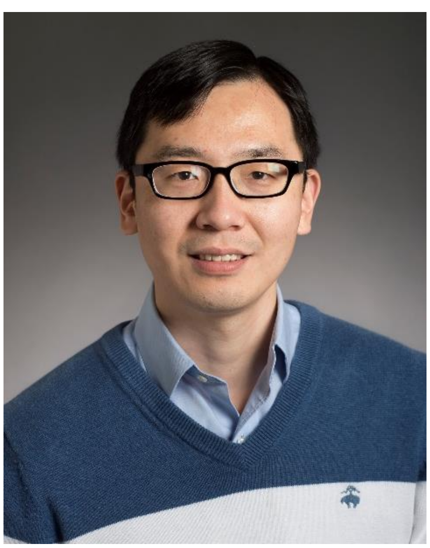
Thermal resistance of interfaces has been widely identified as the critical technical bottleneck in cooling electronic devices and systems. The “ideal” thermal interface materials must simultaneously possess high thermal conductivity for minimizing thermal resistance, and high flexibility and compliance for adapting to soft and curved surfaces and accommodating the thermal stress derived from the mismatch of thermal expansion between two jointed materials. However, conventional thermal interface materials, such as solders, greases, gels and epoxies, cannot satisfy the demanding technical criteria, making the development of high-performance thermal interfaces extremely imperative. Solders display high thermal conductivity but feature poor mechanical compliance. Thermal greases, epoxies and other polymer-based composites have high compliance but struggle with low thermal conductivity. Here we demonstrate new types of nanostructured thermal interface materials that can thermally bridges 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 demonstrate a thermal resistance as small as about 0.5 mm^2K/W and polymer-like compliance. They exhibit exceptional long-term reliability with >1,000 thermal cycles over a wide temperature range. With the significantly enhanced heat transfer and compliance, these nanostructured thermal interface materials can greatly benefit flexible electronics and microelectronics by allowing the systems to reliably operate at lower temperatures or at the same temperature but with higher performance and higher power.

BIOGRAPHY



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