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Structured Polydimethylsiloxane (PDMS) Composite with Enhanced Thermal and Radiative Properties for Heat Dissipation

Background Heat sink operation relies on two major processes: conducting heat out of the device and dissipating the heat to a medium. Because the conduction process requires materials to have high thermal conductivity, metals like aluminum and copper are commonly used. However, the thermal emittance of metals is usually very low, resulting in suppressed thermal radiation. Considering that thermal radiation contributes 25–40% of the total heat transfer in natural-convention heat sinks, a significant opportunity for improvement exists.

Polymer materials, unlike metals, possess high thermal emittance. Polymers are usually lightweight, more readily manufactured, and able to be formed with complex topologies. Despite these features, polymers are rarely used for heat sinks due to their low thermal conductivity. Therefore, a composite material with both polymer and metal components may be the key to optimizing overall heat dissipation performance. Invention Description Researchers at Arizona State University have developed a polymer-based heat sink composite with enhanced thermal conductivity and high thermal emittance. The material is a moldable composite of polydimethylsiloxane (PDMS) and copper that can readily be molded or 3D printed into various shapes and sizes, such as high-surface-area fins. Incorporating PDMS improves thermal emissivity over conventional metals, while the copper improves thermal conductivity over conventional polymers. Experiments show that the thermal conductivity of the PDMS/Cu composite was enhanced by 500%, from 0.18 W/mK of pure PDMS to 1.1 W/mK. The thermal emissivity of the composite, 0.8, was ten times that of aluminum, 0.07. Potential Applications • Air-cooled, moderate-load heat sinks • Electronic heat dissipation • On-chip cooling fins Related Publication: Structured polydimethylsiloxane (PDMS) composite with enhanced thermal and radiative properties for heat dissipationResearch Homepage of Professor Liping Wang