Mechanical Engineering Master's Defense

Quantifying the Properties of Elastic, Liquid Metal Based Thermal Interface Materials

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abstract

Advancements in thermal interface materials (TIMs) allows for the creation of new and more powerful electronics as they increase the heat transfer from the component to the heat sink. Current industrial options provide decent heat transfer, but the creation of TIMs with higher thermal conductivities is needed. In addition, if these TIMs are elastic in nature, their effectiveness can greatly increase as they can deal with changing interfaces without degradation of their properties. The research performed delves into this idea, creating elastic TIMs using liquid metal (LM), in this case galinstan, along with other matrix particles embedded in Polydimethylsiloxane (PDMS) to create an easy to use, relatively inexpensive, thermally conductive, but electrically insulative, pad with increased thermal conductivity from industrial solutions.

The pads were created using varying amounts of LM and matrix materials ranging from copper microspheres to diamond powder mixed into PDMS using a high-speed mixer. The material was then cast into molds and cured to create the pads. Once the pads were created, the difficulty came in quantifying their thermal properties. A stepped bar apparatus (SBA) following ASTM D5470 was created to measure the thermal resistance of the pads but it was determined that thermal conductivity was a more usable metric of the pads' performance. This meant that the pad's in-situ thickness was needed during testing, prompting the installation of a linear encoder to measure the thickness. These iterative changes to the system now allow for accurate thickness and pressure readings, allowing for proper thermal conductivity measurements.

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