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Multi-Layer Thin Film Composite Thermal Interface Materials with In Situ Alloying of Liquid and Solid Metal Inner Components

Advancements in technology have allowed modern machines to have powerful computing in small integrated circuits. As the size of these integrated circuits decrease, thermal loads increase due to densely packed features contained within these integrated circuits. Air gaps in the integrated circuit between components, such as processors and heat sinks increase the thermal contact resistance resulting in lower computing efficiency. As a solution, manufacturers and consumers use thermal interface materials (TIMs) to eliminate air gaps by filling them with materials that have high thermal conductivity. However, conventional TIMs have large mismatches of thermal expansion between components and pose many risks, making integrated circuit assembly more complex and costly. Manufacturers and consumers alike are in increasing need of better thermal management for integrated circuits.

Researchers at Arizona State University have developed a novel multi-layer thin film thermal interface material (TIM) architecture with improved thermal management. This "sandwich" TIM consists of soft exterior polymers composites encapsulating thin-films of liquid metal and solid metal additives separated by a thin barrier. Prior to application, the layers are separated by a native oxide barrier layer on the liquid metal or by an additional thin barrier. When the TIM is placed between a heat exchanger and a substrate, the liquid metal and solid metal additives are compressed into each other, thereby breaking the barrier and molds to the surfaces. Additionally, the layers are composed in such a manner to avoid pump-out and corrosion.

Potential Applications

- Thermal Interface Materials
- Integrated Circuit Architecture
- High Performance Computing

Benefits and Advantages

- Innovative – This "sandwich" style TIMs provides excellent heat management and simple application even by non-expert users
- Powerful – Allows for improved thermal conductivity, conformability to surface roughness, and capable of handling warpage without leaking of liquid

components

- Novel – Manufacturers can now produce a convenient, easy to manufacture, and easy to distribute high performance TIM
- Versatile – The TIM thin layer films can be produced from a variety of different metals and alloys

For more information about the inventor(s) and their research, please see

Konrad Rykaczewski's Research Page

Robert Wang's Directory Page