Thermal interface materials (TIMs) are extensively used in thermal management applications especially in the microelectronics industry. With the advancement in microprocessors design and speed, the thermal management is becoming more complex. As length scales shrink, power density and heat dissipation have increased.

With these advancements in microelectronics, there have been parallel advancements in TIMs. Novel materials were introduced, from liquid and paste based materials, to more advanced materials such as carbon nanotubes. The primary goal of all these materials is to reduce the thermal resistance between the microprocessor and its cooling solution and hence increase the overall heat transfer capability.

Given the vast number of available TIM types, selection of the material for each specific application is crucial. Robust metrologies for TIM characterization are essential to enable this selection. Most of the metrologies currently available on the market are designed to measure the thermal resistance and thermal conductivity of the TIMs between two perfectly flat surfaces, mimicking an ideal scenario. However, in realistic applications parallel surfaces may not be the case. In this study, a unique characterization method is proposed to address the need for TIM characterization between non-parallel surfaces.

Two different metrologies are custom-designed and built to measure the impact of tilt angle on the performance of TIMs. The first metrology, Angular TIM Tester, is based on the ASTM D5470 standard but allows the flexibility to perform characterization of the sample under specified and induced tilt angle. The second metrology, Bare Die Tilting Metrology, is designed to validate the performance of TIM materials under induced tilt angle between the bare die and the cooling solution in an “in-situ” package testing format.

Several types of off-the-shelf TIMs were tested. Data was collected using both metrologies for all selected materials. It was found that small tilt angles, up to 0.6°, have an impact on thermal resistance of all materials especially for in-situ testing. In addition, resistance change between 0° and selected tilt angle was found to be in close agreement between two metrologies for paste based materials and phase change material. Clear difference in thermal performance of the tested materials was observed between the two metrologies for the gap filler materials. Detailed results for all tested materials are outlined in the study.