HIGH THERMAL CONDUCTIVITY (HIK) AlSiC PLATES

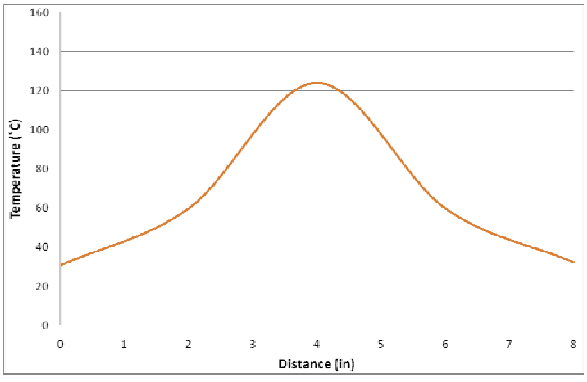
The HiK AlSiC plate is an advanced heat spreader that is made of CTE-tailorable aluminum silicon carbide (AlSiC) with embedded heat pipes. It is particularly suited for cooling of high power semiconductor devices where direct bonding between the devices (heat sources) and the heat spreader is required to minimize the interface thermal resistances.

By controlling the composition of the Al and SiC, the CTE (coefficient of thermal expansion) of the heat spreader can be matched to that of the electronic device. The CTE of the heat spreader can be specifically tailored with values ranging from 7 to 12 ppm/°C. This allows the electronic devices to be directly bonded to the heat spreader without incurring large thermally-induced stresses at the interface (a major reliability problem). The direct bond eliminates the need for stress compensating thermal interface materials, resulting in reduced interface thermal resistances.

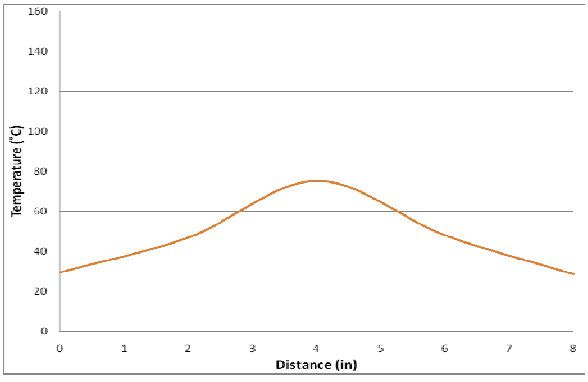
ACT's HiK AlSiC Plates

AlSiC plates have bulk thermal conductivities of approximately 200W/m-K. Heat pipes, because of their two phase heat transfer characteristics, have effective thermal conductivities between 50,000 and 200,000 W/m-K, depending on the heat pipe length. Embedding heat pipes into AlSiC plates improves the effective thermal conductivity to a range of 500 to 800 W/m-K.

The two figures below show measured temperature profiles on the surfaces of a pure AlSiC plate (left) and a HiK AlSiC plate (right). Both plates were subject to high heat flux inputs at the center. The hot spots of the AlSiC plate and the HiK AlSiC plate are 124°C and 75°C, respectively. The significant improvement is caused by the heat pipes embedded in the HiK AlSiC plate.



Temperature profile on an AlSiC plate



Temperature profile on a AlSiC Heat Spreader

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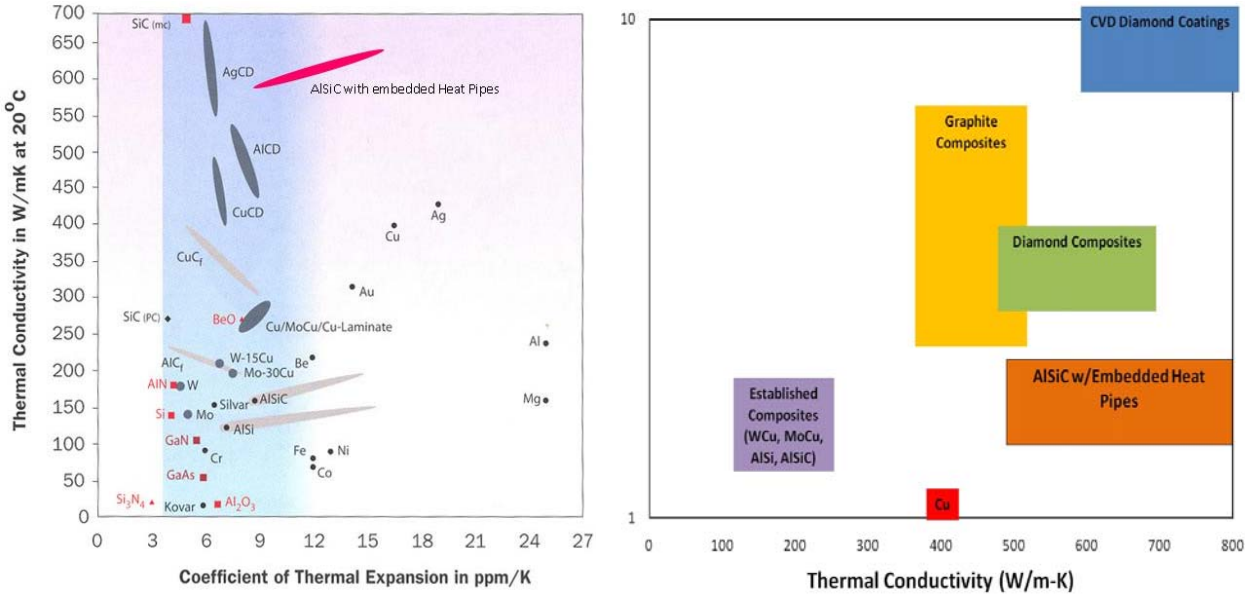
The increase in the effective thermal conductivity is achieved without negatively affecting the mass, strength or corrosion resistance of the heat spreader. The low density of AlSiC (3 grams/cm^3) makes it suitable for portable/hand-held electronic devices, avionics and spacecraft payloads. Coatings and finishes can be applied to the heat spreader for added corrosion resistance. The strength and stiffness of AlSiC are approximately three times greater than those of pure aluminum, making it ideal for structural thermal management solutions as well.

The figures below compare the thermal conductivity to the CTE (left figure) and cost (right figure) for several commercially available heat-spreading materials. In general, the HiK AlSiC plate has thermal conductivities comparable to high performance composite materials but can be manufactured at a reduced cost [1].



Multiple electronic devices can be mounted on a single HiK AlSiC Plate, making it ideally suited for applications where in addition to heat dissipation, device isothermality is also critical. Potential applications include: IGBT Arrays, Antenna Enclosures, Microprocessor Heat Spreaders/Sinks, High Power Lasers and LEDs.

Similar to ACT's HiK Aluminum Plate, the heat pipe embedment may be custom optimized based on the heat source profiles. A larger number of heat pipes may be embedded in areas on the plate where high power or high heat flux components are mounted.

References:

[1] S. Knippscheer, R. Bollina, "Advanced Metal Diamond Composites - Love and Heat Relationship", Electronics Cooling Magazine, November 2008, Volume 14, Number 4