

## Thermal Management and High-temp Packages

Aegis Materials has developed advanced, high-efficiency heat exchangers, such as heat sinks, and radiators, and condensers, designed for thermal management of high-power-density electronics. These components use a range of innovative technologies, including composite heat spreader, micro-jet arrays, network microchannels/foam materials, phase change materials, nanocoolants, and nanomaterials based thermal interface materials. These technologies/systems were developed, partially through the research projects funded through the U.S. Army, U.S. Department of Energy, and NASA. Benefits using these technologies include: a 100% improvement over conventional heatsinks and allow for more uniform temperature distribution.

We have designed both Al-based and Cu-based MMCs, Metalized Substrates ceramic substrates ( $\text{Si}_3\text{N}_4$ ,  $\text{Al}_2\text{O}_3$ , AlN, BeO) used in applications such as power electronics, RF/microwave devices, amplifiers, laser diode arrays, and photodetectors. Such metal insulated substrates can be scaled to large dimensions and can be used as part of a printed circuit board. In addition, such substrates have high thermal conductivity and low CTE (coefficient of thermal expansion). These substrates are compatible with Si, GaAs, SiC, and GaN devices. for high heat flux.

We have also developed high-performance Thermoelectric Coolers & Generators. designed with high-“ZT” thermoelectric nanocomposite materials. Such coolers are lightweight and high in efficiency. Such thermoelectric coolers can be used for IR sensors, laser diodes, and other electronics. In addition, we adapted high thermal conductivity and low thermal expansion metal insulated substrates for use in thermoelectric cooling. Alongside these goals was the development of lightweight, efficient thermoelectric generators.

Aegis Materials employs a range of advanced process techniques to support high-temperature packages primarily for SiC power electronics, including ceramic-to-metal, carbon-to-ceramic, and carbon-to-metal brazing, as well as high-temperature interconnections and soldering. The company also performs metallization on AlN and  $\text{Si}_3\text{N}_4$  substrates.

Aegis specializes in advanced thermal management systems for SiC power electronics, combining innovatively engineered designs to enable high power density and high-temperature operation. Its solutions include high efficiency heatsinks utilizing microchannels/microjet heatsink, phase change materials, thermal interphase materials, and nanocoolants. The company also develops high-temperature AlN packaging capable of operating up to 500-600°C, along with high thermal conductivity ceramic substrates such as metallized AlN and  $\text{Si}_3\text{N}_4$ . These thermal management technologies support a wide range of applications, including vehicle propulsion systems, high-power laser systems, microwave amplifiers and radar systems.