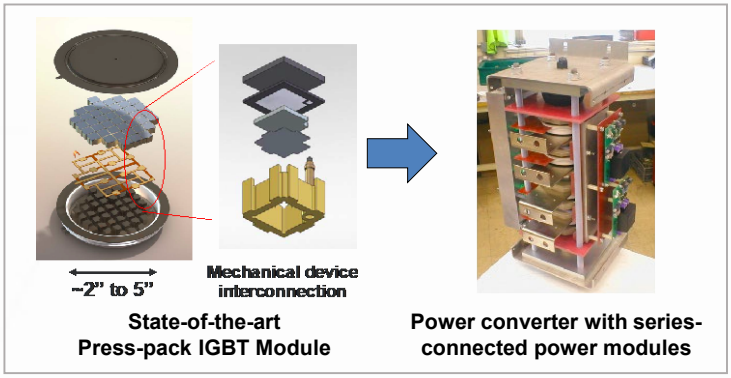
Double-side Cooled Medium-voltage Power Modules

VTIP 20-111 “Double-side Cooled Medium-Voltage Power Modules for Electric Grid Applications”

THE CHALLENGE

Packaging innovations are needed for medium-voltage semiconductor devices to enable their integration into electric grid applications due to a unique trade-off between the insulation requirement and thermal management of the medium-voltage power modules. The conventional packaging technology utilizes a wire-bonded or press-pack module in which power chips are soldered on an insulated-metal substrate and then interconnected with aluminum wires or metal-to-metal mechanical contact after which the devices are then encapsulated inside a silicone gel. Modules made using these techniques have low power density limited by a maximum heat dissipation. They also generally have higher parasitic inductances and poor reliability due to wire-bond lift-off and die-attach cracking.



Example of a state-of-the-art packaging of a medium-voltage power module of silicon-based device where the interconnection to the device chips is achieved by mechanical press-contact resulting in high electrical and thermal resistance.

OUR SOLUTION

Guo-Quan Lu his team at Virginia Tech have developed a novel double-side cooled power module intended for medium-voltage power devices used in the electric grid. The two key elements to this new design are a multi-chip power module design with sintered-silver device interconnection and double-sided cooling for the module. Although double-sided cooling has been used for lower voltage power modules before, this design brings the advantages of double-sided cooling to higher voltage modules intended for electric grid applications. The sintered-silver interconnection has the benefit of allowing the devices to work reliably at over 700 °C and at least five times better thermal and electrical conductivities than the solder joints used in current modules. The double-side cooling provides over 50% more effective heat extraction capability and additional layout flexibility.

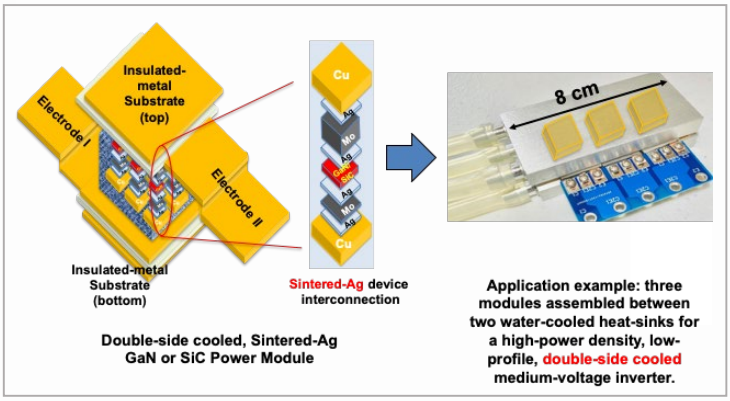


Illustration of the new, innovative packaging concept involving interconnection on both sides of the device achieved by our patented silver-sintering material for double-sided cooling which enables more than 50% more effective heat extraction and significantly lower electrical parasitics.

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