TECHNISCHE UNIVERSITÄT DRESDEN

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Heat Sink for the Cooling of Power Electronics

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Motivation

IGBT-modules are widely used in switching power supplies. During their operation a certain amount of heat is generated and must be removed appropriately to assure a reliable operation. With the trend of downsizing and high power density in the development of new IGBT-modules, there has been a need for efficient heat sinks for different applications.

Fig. 1: IGBT-module tested in experiment

Requirements on heat sink:

dimensions:	190 mm x 140 mm
heat dissipation:	max. 3 kW
chip temperature:	max. 125 °C
cooling water:	40 °C, 30 l/min
clearance:	40 mm
electrical conductivity:	10^{-8} S/cm

Concept of the heat sink

The heat sink combines a vapor chamber with liquid cooling. The vapor chamber (see Fig. 2, transparent component) provides the functions of heat transfer and electrical insulation. The fluorocetone Novec-649 is filled in the chamber and transports heat from the base plate to the condenser (see Fig. 2). The heat is finally removed by the condenser at the top side of the vapor chamber. With the electrical insulation regular water with high fouling tendency can be used as coolant, instead of deionized water.

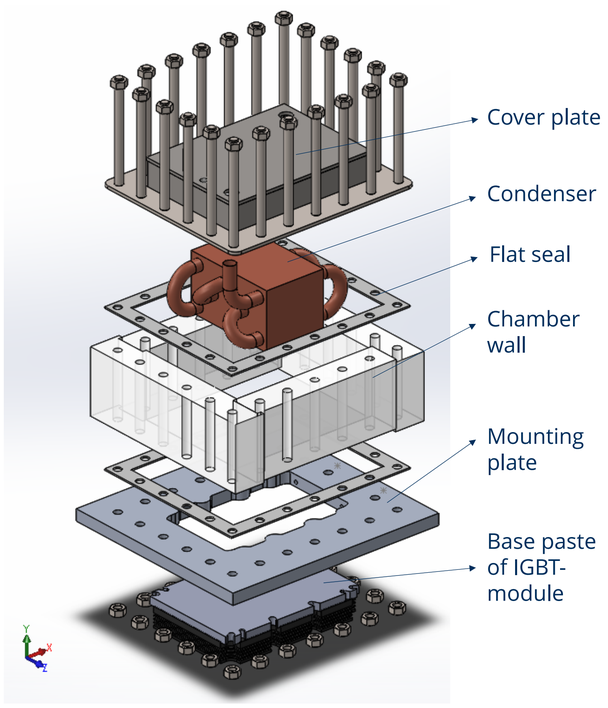

Fig. 2: Components of the cooling module

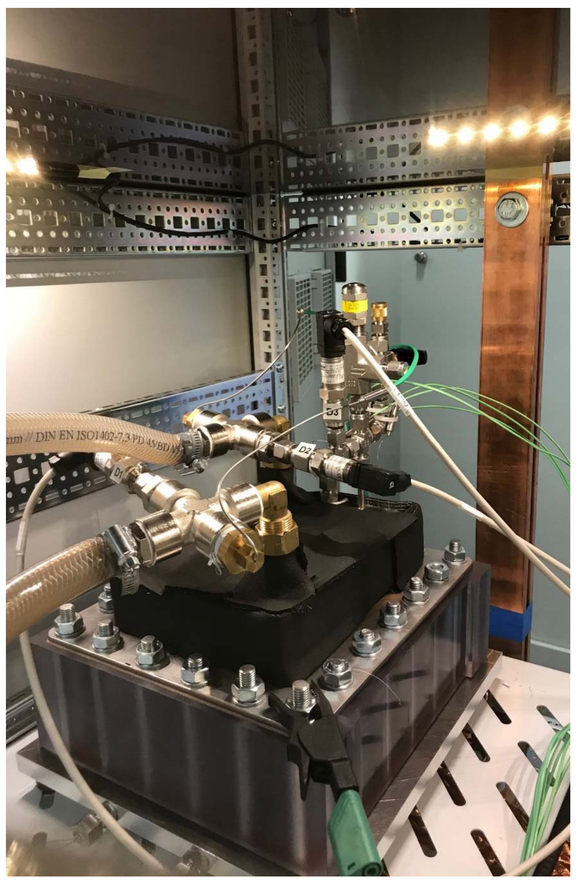

Fig. 4: Experimental set up

Results and future works

The heat sink with a original plain surface is able to dissipate heat flux of 1.9 kW. The junction temperature is calculated to be max. 93 °C, lower than the limit for the chips of 125 °C. With the combination of Novec 649 and a typical IGBT base plate a CHF of 98 kW/m² was reached at a saturation temperature of 63.2 °C (see Fig. 3). The future work focus is on the enhancement of the CHF.

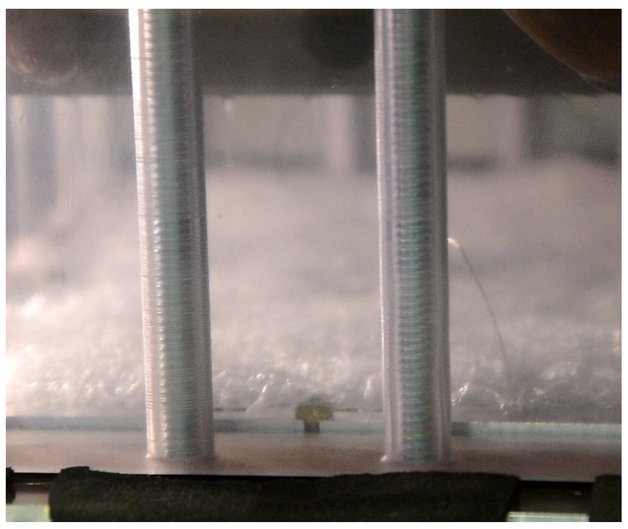

Fig. 3: Boiling coolant at surface of IGBT module

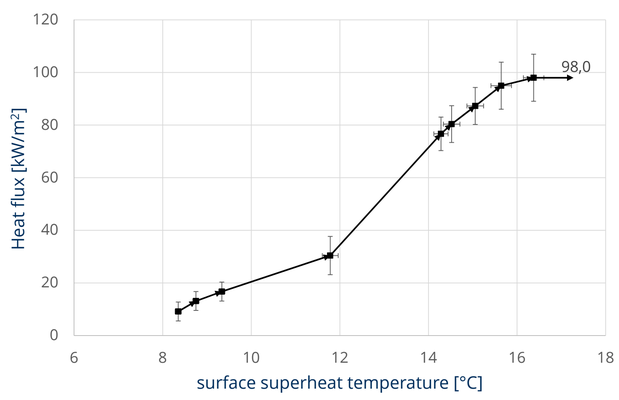

Fig. 5: Boiling curve at v = 0,006 m³/kg

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