A diamond made microchannel heat sink for high-density heat flux dissipation

Flow boiling in microchannels is a promising technique for cooling high power-density electronic devices. In this study, a microchannel heat sink using ammonia as working fluid is developed, and its cooling efficiency is experimentally investigated under nonuniform high-density heat flux, which well simulates a practical heat dissipation scenario for microthermal systems. Diamond with high thermal conductivity of 1500 W/m·K is selected as the microchannel heat sink material. A total of 37 parallel triangular microchannels with aspect ratio of 5, channel length of 45 mm and hydraulic diameter of 280 μm are uniformly engineered on the diamond film by laser ablation processing. The significance of diamond substrate as a heat spreader to minimize the nonuniformity of heat flux imposed by a central hotspot is verified. The influences of heat flux and mass flux on the cooling efficiency are experimentally investigated. An optimal range of outlet vapor quality from 0.10 to 0.13 is found, within which the minimum heat source temperature can be achieved. Notably, the microchannel heat sink is capable of managing a central hotspot with heat flux of 267 W/cm² while maintaining the heat source temperature at 53.3 °C for a mass flux of 320 kg/m²s.

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