"Ultra-thin vapor chambers incorporating superhydrophilic and superhydrophobic surfaces"

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ABSTRACT

The rapid development of a variety of portable and slim electronic devices has increased the requirements for heat flux management beyond the limits of traditional air convection cooling. To this direction, several miniaturized thermal management devices to cool high-power, compact electronic devices have been presented.[1] Herein, we present the fabrication and the evaluation of an ultra-thin (< 1 mm) vapor chamber acting as thermal diode utilizing phase-change heat transfer and self-propelled jumping droplet for heat regulation.

To create the vapor chambers, we use copper-clad polyimide surfaces (12.5 μm polyimide layer and 12 μm copper layer) and plasma micro-nanotexturing to transform them to superhydrophilic and to superhydrophobic.[2] Depending on the bonding method we can create devices with thickness down to 110 μm, which is one of the lowest values reported in the literature. [1]The thermal diode function is enabled due to the predesigned wetting properties of each plate of the device. In particularly, the superhydrophilic plate is acting as the evaporator improving the cooling liquid (water) dispersion on the plate, whereas the superhydrophobic plate acts as the condenser enabling dropwise instead of flimwise condensation and also self-propelled jumping droplets.[3], [4] Different water filling ratios ranging from 30% to 100% and operation temperatures ranging from 30-75 ^{o}C are tested, whereas an untreated device is used as reference. Our results demonstrate that the device incorporating superhydrophilic and superhydrophobic surfaces exhibits 2.5 times higher heat transfer coefficient compared to the untreated device.

KEYWORDS: ultra-thin flexible vapor chambers, superhydrophilicity, superhydrophobicity.

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