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ENHANCED CAPILLARY PERFORMANCE OF HIERARCHICAL MICRO/NANO-SCALE WICK STRUCTURES IN FLAT HEAT PIPE

Abstract

This study investigates the design and fabrication of a super-hydrophilic surface made of hierarchical micro/nano-scale wick structures for a silicon-based flat heat pipe. A two-step etching process, including the deep reaction ion etching (DIRE) and the photo-electrochemical (PEC) etching, was used to fabricate the proposed wick structure. The wettability and capillary performance of the fabricated wick structure were characterized by the contact angle measurement and liquid droplets spreading characters (i.e. spreading velocity and distance) testing. Compared with a surface made of micro-scale structure only, the wettability and capillary performance of hierarchical micro/nano-scale structures show dramatic enhancement. Preliminary in-vivo testing results indicate that utilizing the hierarchical micro/nano wick structure for heat pipe is a promising technique to improve the limited capillary performance, as a result, the heat transfer capability and lower the heat pipe application environment limitations such as complex loading conditions.

For the fabrication of the proposed wick structure, a two-step etching process is used. A fairly-doped (1-10-cm)P-type (100)-oriented Si wafer was used as the substrate. First, the primary micro-scale structure was formed by DIRE. Second, on the surface of the DRIE-etched primary structure, a uniform layer of nano-scale structure (nano pores) was formed by PEC etching. In this step, we have improved the etching apparatus and etching reaction conditions for mass production with high efficiency.

In order to characterize the wettability and capillary performance, the contact angle of water droplets on the proposed wick was measured. According to the preliminary results, the contact angle of water droplets on the proposed wick is nearly zero, and the droplets spread instantly, indicating a high spreading velocity.