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Comprehensive study of thin film evaporation from nanoporous membranes for enhanced thermal management KYLE WILKE, BANAFSHEH BARABADI, ZHENGMAO LU, Massachusetts Inst of Tech-MIT, TIEJUN ZHANG, Masdar Institute of Science and Technology, EVELYN WANG, Massachusetts Inst of Tech-MIT — Performance of emerging electronics is often dictated by the ability to dissipate heat generated in the device. Thin film evaporation from nanopores promises enhanced thermal management by reducing the thermal transport resistance across the liquid film while providing capillary pumping. We present a study of the dependence of evaporation from nanopores on a variety of geometric parameters. Anodic aluminum oxide membranes were used as an experimental template. A biphilic treatment was also used to create a hydrophobic section of the pore to control meniscus location. We demonstrated different heat transfer regimes and observed more than an order of magnitude increase in dissipated heat flux by confining fluid within the nanopore. Pore diameter had little effect on evaporation performance at pore radii of this length scale due to the negligible conduction resistance from the pore wall to the evaporating interface. The dissipated heat flux scaled linearly with porosity as the evaporative area increased. Furthermore, it was demonstrated that moving the meniscus as little as 1 μm into the pore could decrease performance significantly. The results provide a better understanding of evaporation from nanopores and provide guidance in future device design.

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