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Kinetic Limited Water Evaporation in Hydrophilic Nanofluidic Channels[1] YINXIAO LI, MOHAMMAD AMIN ALIBAKHSHI, QUAN XIE, CHUANHUA DUAN, Department of Mechanical Engineering, Boston University — Capillary evaporation is one of the most efficient approaches for heat and mass transfer, but the interfacial resistance in capillary evaporation governed by the kinetic theory has remained poorly understood. Here we report experimental studies of the kinetic-limited water capillary evaporation in 2-D hydrophilic nanochannels. A novel hybrid nanochannel design is employed to guarantee sufficient water supply to the liquid/vapor evaporation interface and to enable precise evaporation rate measurements. We study the effects of confinement (16 $\sim$ 105nm), temperature (20 $\sim$ 40 °C), and relative humidity (0% $\sim$ 60%) on the evaporation rate and the evaporation coefficient. A maximum evaporation flux of 21287 micron/s is obtained in 16-nm nanochannels at 40°C and RH=0%, which corresponds to a heat flux of 4804 W/cm°. The evaporation coefficient is found to be independent on geometrical confinement, but shows a clear dependence on temperature, decreasing from 0.55 at 20°C to 0.5 at 40 °C. These findings have implications for understanding heat and mass transport in nanofluidic devices and porous media, and shed light on further development of evaporation-based technologies for thermal management, membrane purification and lab-on-a-chip devices.

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