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Wettability Patterning for Enhanced Dropwise Condensation[1]
ARITRA GHOSH, RANJAN GANGULY[2], CONSTANTINE MEGARIDIS, University of Illinois at Chicago — Dropwise condensation (DwC), in order to be sustainable, requires removal of the condensate droplets. This removal is frequently facilitated by gravity. The rate of DwC heat transfer depends strongly on the maximum departing droplet diameter. Based on wettability patterning, we present a facile technique designed to control the maximum droplet size in DwC within vapor/air atmospheres, and demonstrate how this approach can be used to enhance the corresponding heat transfer rate. We examine various hydrophilic-superhydrophilic patterns, which, respectively sustain DwC and filmwise (FwC) condensation on the substrate. The fabrication method does *not* employ any hydrophobizing agent. By juxtaposing parallel lines of hydrophilic (CA $\sim 78^\circ$) and superhydrophilic (CA $\sim 0^\circ$) regions on the condensing surface, we create alternating domains of DwC and FwC. The average droplet size on the DwC domain is reduced by $\sim 60\%$ compared to the theoretical maximum, which corresponds to the line width. We compare heat transfer rate between unpatternend DwC surfaces and patterned DwC surfaces. Even after sacrificing 40% of condensing area, we achieve up to 20% improvement in condensate collection rate using an interdigitated superhydrophilic pattern, inspired by the vein network of plant leaves. The bioinspired interdigitated pattern is found to outperform the straight hydrophilic-superhydrophilic pattern, particularly under higher vapor loadings in an air/vapor ambient atmosphere.

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