Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Electric-Field-Enhanced Jumping-Droplet Condensation NENAD MILJKOVIC, DANIEL PRESTON, Massachusetts Institute of Technology, RYAN ENRIGHT, Bell Labs Ireland, ALEXANDER LIMIA, EVELYN WANG, Massachusetts Institute of Technology — When condensed droplets coalesce on a superhydrophobic surface, the resulting droplet can jump due to the conversion of surface energy into kinetic energy. This frequent out-of-plane droplet jumping has the potential to enhance condensation heat and mass transfer. In this work, we demonstrated that these jumping droplets accumulate positive charge that can be used to further increase condensation heat transfer via electric fields. We studied droplet jumping dynamics on silanized nanostructured copper oxide surfaces. By characterizing the droplet trajectories under various applied external electric fields (0 – 50 V/cm), we show that condensation on superhydrophobic surfaces results in a buildup of negative surface charge (OH-) due to dissociated water ion adsorption on the superhydrophobic coating. Consequently, the opposite charge (H3O+) accumulates on the coalesced jumping droplet. Using this knowledge, we demonstrate electric-field-enhanced jumping droplet condensation whereby an external electric field opposes the droplet vapor flow entrainment towards the condensing surface to increase the droplet removal rate and overall surface heat transfer by 100% when compared to state-of-the-art dropwise condensing surfaces. This work not only shows significant condensation heat transfer enhancement through the passive charging of condensed droplets, but promises a low cost approach to increase efficiency for applications such as atmospheric water harvesting and dehumidification.

Nenad Miljkovic
Massachusetts Institute of Technology

Date submitted: 02 Aug 2013 Electronic form version 1.4