Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Electric Charging Effects on Condensed Droplet Jumping NENAD MILJKOVIC, DANIEL J. PRESTON, MIT, RYAN ENRIGHT, Bell Labs Ireland, RONG YANG, KAREN K. GLEASON, EVELYN N. WANG, MIT — 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 transfer. Furthermore, for more than a century, researchers have shown that droplet-surface interactions can be dominated by electrostatic charge buildup. In this work, we studied droplet jumping dynamics on nanostructured copper oxide and carbon nanotube surfaces coated with tri-chloro silane and PFDA hydrophobic coatings, respectively. Through analysis of droplet trajectories and terminal velocities under various electric fields (0 – 50 V/cm), we show that condensation on these surfaces having both conducting and insulating substrates results in a buildup of positive surface charge (H^+) due to dissociated water ion adsorption on the superhydrophobic coating. Consequently, an accumulation of the opposite charge (OH^-) occurs on the condensing droplet interface, which creates an attractive force between the jumping droplet and the condensing surface. Using this knowledge, we demonstrate a novel condensation mechanism whereby an external electric field is used to oppose the droplet-surface attraction, further enhancing the coalescing droplet jumping frequency and overall surface heat transfer.

Nenad Miljkovic
MIT

Date submitted: 09 Nov 2012 Electronic form version 1.4