THE INTERACTION OF MOBILE LIQUID FRONTS WITH NANOPARTICLES: PURIFICATION OF CARBON NANOTUBE DEPOSITIONS

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Capillary effects related to wetting of liquids can become dominant in nanoscale systems. In particular, surface tension force of water is sufficient to detach colloidal particles from smooths substrates, and mobile liquid interfaces can thus be utilized for cleaning of irregular particulate surfaces. We outline the central results of our studies on arc-discharge carbon nanotubes (CNTs) [1, 2, 3], where selective detachment of the intrinsic carbonaceous debris has been demonstrated from spin-coated depositions.

Practical experiments show that efficient removal of irregular debris can be routinely achieved in a simple experiment where CNT samples prepared on silica surfaces are vertically immersed into water at gradual pace. The extent of particle detachment has been evaluated by comparative atomic force microscopy measurements, which verify that up to $90\,\%$ of the debris can vacated from the surface while CNTs are detached to lesser extent.

Our results show that hydrophilic treatment of the underlying silicon substrate is a prerequisite for systematic particle detachment. This suggests that the effect is brought about by the surface tension force whose magnitude depends on the surface-liquid contact angle, and can be qualitatively understood with help of a model original conceived for spherical microcolloids. However, other interactions may also play a role in explaining the lack of effect on hydrophobic substrates, i.e. changes in intrinsic particle adhesion, or hydrophobic interactions.

Intriguingly, modifying the chemistry of the immersion liquid only appears to weakly affect the extent of particle detachment, while reducing the velocity of the liquid interface improves the detachment. All these observations suggest that the retention and detachment of particles is primarily dictated by physical interactions at the advancing contact line. The technique can be utilized to prepare pure CNT depositions for research applications, i.e. microraman spectroscopy of individual CNTs

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