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Capillary absorption of metal nanodroplets by carbon nanotubes
SHAUN HENDY, Industrial Research Ltd, DMITRI SCHEBACHOV, Victoria University of Wellington — We present a simple model that demonstrates the possibility of capillary absorption of non-wetting liquid nanoparticles by carbon nanotubes assisted by the action of the Laplace pressure due to the droplet surface tension. We test this model with molecular dynamics simulation and find excellent agreement with the theory, which shows that for a given nanotube radius, there is a critical size below which a metal droplet will be absorbed. We then consider the dynamics of capillary absorption using the steady-state flow model due to Marmur, which is based on the Lucas-Washburn model with the addition of a driving force due to the Laplace pressure of the droplet. We find an exact solution to Marmur's evolution equation for the height of the absorbed liquid column as a function of time, and show that this reproduces the dynamics observed in the simulations well. The simulations show that the flow of the metal exhibits a large degree of slippage at the tube walls, with slip lengths of up to 10nm. These findings suggest new methods for fabricating composite metal-CNT materials, and have implications for our understanding of the growth of CNTs from metal catalyst particles. The results also explain the recent observations of the absorption of Cu nanodroplets by carbon nanotubes.

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