

### Transport of ions along the exterior of single-walled carbon nanotubes

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Single walled carbon nanotube (SWNT) is an excellent material for studying the transport phenomenon at nanoscale due to their atomically smooth surface, small diameter (1-2 nm), and extremely high aspect ratio. The tubular nature of the material allows efficient molecular transport both externally and internally. Due to challenges in setting up a reliable experimental platform experimental studies on the transport has started only recently. Here we show experimentally the evidence of the ionic transport along the exterior of SWNTs. When an electrical bias is applied to droplets of salty water placed on each side of carbon nanotubes, nanocrystals are formed along the nanotubes. This result is a direct evidence of the exterior transport of ions and helps one visualize individual nanotubes under an optical microscope. Surface analyses show the distribution of cations and anions during the transport. We also investigate using Raman spectroscopy how the transport of ions depends on the diameter and metallicity of nanotubes. Recent studies in this area have largely focused on the interior of nanotubes, but our study suggests there still remain many questions to answer and opportunities to explore in the exterior of nanotubes.