

Pipetting Nanowires: In Situ Visualization of Solid-State Nanowire-to-Nanoparticle Transformation Driven by Surface Diffusion-Mediated Capillarity

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The most interesting applications of nanotubes include their use as storage media for atoms and small molecules, as nanoscale capsules for chemical reactions, and as nanopipettes for material delivery. The geometrical transformation of metallic copper nanowires, confined in graphitic coating, into crystalline nanoparticles of up to tenfold increased diameter is reported. In situ transmission electron microscopy images at 500 °C, recorded as movies, provide an exceptional real-time visualization of Cu draining out of the carbon coating. The solid content of the carbon tube is effectively evacuated over micrometer distances towards the open end, transforming each nanowire into a single monocrystalline, faceted Cu particle. Kinetic Monte Carlo simulations propose that this dramatic morphological transformation is driven by surface diffusion of Cu atoms along the wire/tube interface, thus minimizing the total free energy of the system.