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Controlling Atomic Movement on the Nanoscale[1]

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Some of the grand challenges in nanoscience are the ability to control movement of atoms either to propel nanometer-sized machines, or to synthesize novel electronic devices and materials. To that end, electrical current can be used to move a wide range of metals (Fe, Cu, W, In, Ga) along the outside and inside of a carbon nanotube. In this talk I will present our finding of a peculiar way in which these metals move. For example, we find that an iron nanocrystal is able to pass through a constriction in the carbon nanotube with a smaller cross-sectional area than the nanocrystal itself. Remarkably, through in situ transmission electron imaging and diffraction, we find that, while passing through a constriction, the nanocrystal remains largely solid and crystalline and the carbon nanotube is unaffected. We account for this behavior by a pattern of iron atom motion and rearrangement on the surface of the nanocrystal. The nanocrystal motion can be described with a model whose parameters are nearly independent of the nanocrystal length, area, temperature, and electromigration force magnitude. I will also discuss implications of this work on synthesis of nanocomposite materials, and on the stability of carbon-based electronic devices.

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