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Length, Radius, and Tilt Angle Control of Carbon Nanotube Probes for High Resolution Atomic Force Microscopy BENJAMIN ALEMAN, BIBIANA ONOA, University of California, Berkeley, CLAUDIO RIVETTI, Università degli Studi di Parma, MARTA KOPACZYNSKA, CARLOS BUSTAMANTE, ALEX ZETTL, University of California, Berkeley — The lateral spatial resolution of modern atomic force microscopy (AFM) is largely limited by the radius of curvature of the probe. Owing to their extraordinary mechanical strength, large aspect-ratio, and sub-nanometer radius, carbon nanotubes (CNTs) have emerged as the ideal AFM probe tip material, yet existing methods for CNT-AFM probe fabrication have not been optimized. In this work, we present a fabrication method that yields direct control over the CNT's length, radius, and tilt angle by using a positioning stage operated in a transmission electron microscope (TEM) to directly attach a single-walled CNT to the apex of an AFM probe tip. The CNT probes are then utilized to image gold nanoparticles and DNA with tapping-mode AFM in ambient conditions. While imaging gold nanoparticles, we report a full-width radius dilation of 5.5 Å and nearly 8 nm resolution enhancement compared to commercially available super sharp Si AFM probes. We also measure a DNA fullwidth of less than 5.0 nm and observe, in some cases, the fine structure associated with the DNA double-helix with a pitch of 3.32 nm, which agrees well with the theoretical value of 3.4 nm.

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