Carbon Nanocone Probes for Atomic Force Microscopy Imaging

I-Chen Chen, Li-Han Chen and Sungho Jin
Materials Science and Engineering, University of California, San Diego, CA 92093-0411

A simple catalyst patterning technique combined with electric-field-guided growth is utilized to synthesize a sharp and high-aspect-ratio carbon nanocone (CNC) probe on a tipless cantilever for atomic force microscopy. A single or an array of carbon nano-dot(s) produced by electron-beam-induced deposition serves as a convenient chemical etch mask for catalyst patterning, thus eliminating the need for complicated, resist-based e-beam lithography for nanoprobe fabrication. A gradual, sputtering-induced size reduction and eventual removal of the catalyst particle at the probe tip during electric-field-guided growth creates a sharp probe. These fabrication processes are amenable for wafer-scale synthesis of multiple probes. The CNC probe demonstrates high-resolution imaging of three-dimensional features and deep trenches in tapping-mode as well as in contact-mode, and exhibits strong adhesion and mechanical durability as confirmed by continuous operation for many hours without noticeable deterioration of image quality.