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A Field Emission Based Electromechanical System for Tunable, High-Resolution Position Sensing RUDOLPH RESCH, BENJAMIN ALEMAN, University of Oregon — Scanning Probe Microscopy (SPM) techniques like Atomic Force Microscopy and Scanning Tunneling Microscopy opened the doors to direct investigations of the nanoscale world. Pre-dating these technologies, however, was an instrument known as the topografiner, capable of imaging surface topography with nanometer scale vertical resolution. The topografiner utilized a field emission current originating from a sharp metal tip, and so possessed a distinct advantage over conventional SPM by not requiring contact with the sample (operating ~ 20 nm from the surface). In the end, the DC field emission techniques used in operation and the tip-geometry hindered the potential of the technique to reach atomic-scale resolution. By using a high-aspect-ratio multi-walled carbon nanotube as a field emitter, we achieve vertical displacement sensing with sub-atomic resolution. In our approach, we employ an AC electromechanical coupling technique and demonstrate a position sensitivity of $\eta = 5$ pm/$\sqrt{Hz}$ while the emitter is located ~ 500 nm from the surface. The sensitivity of our system has a strong dependence on both the vertical position and the oscillation amplitude of the mechanical resonator, and we discuss how our sensitivity may approach the femtometer regime.

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