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Super-rolloff electron tunneling transduction of nanomechanical motion using frequency downmixing MENG KAN, MARK FREEMAN, WAYNE HIEBERT, National Institute for Nanotechnology, National Research Council of Canada and Department of Physics, University of Alberta, Edmontonton, Canada — Electron tunneling transduction has high sensitivity for detecting the motion of nanomechanical devices, but the relatively low detection bandwidth of a few 10's of kHz has limited its development. Here we demonstrate a novel downmixing transduction scheme which eliminates the detection bandwidth problem of electron tunneling transduction. With this technique, the high frequency vibration modes ($\sim$ 1 MHz) of a MEMS doubly clamped beam are measured. This measurement is 2 orders of magnitude above the electronic bandwidth of our readout circuitry with no fundamental limitation anticipated up to microwave frequencies. The displacement sensitivity is 40 fm/Hz$^{1/2}$ comparable to state-of-the-art low finesse free-space optical interferometry. The back-action force induced by the STM tip on the MEMS device is also explored and is shown to have a small effect on the measurement resonance frequency, causing slight resonance frequency shifts of order 1%.

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