A Nanowire-Based Very-High-Frequency Electromechanical Resonator

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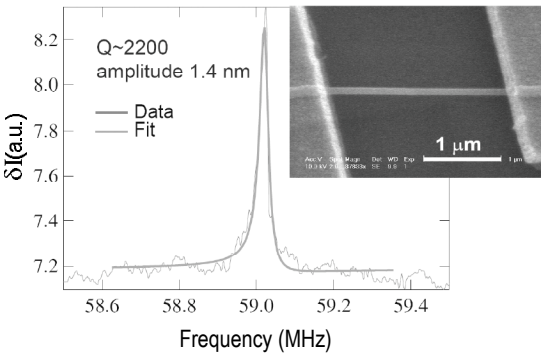
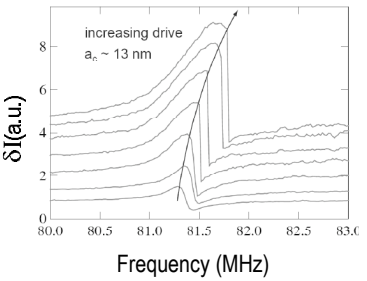
Nano-electromechanical resonators may lead to on-chip RF filters and ultra-sensitive mass, position, and force sensors. This project seeks to develop flexural mode electromechanical resonators using suspended semiconductor nanowires. Compared to resonators formed by nanofabricated structures, energy dissipation in resonators formed by chemically synthesized nanowires is reduced due to the near-perfect crystal structure (reduction of surface loss) and the large-aspect-ratio (reduction of clamping loss). Flexural mode very-high-frequency (VHF) electromechanical resonators with $Q > 2000$ were demonstrated. A frequency down-mixing circuit was used to actuate and detect the motion of the resonators. Due to the minuscule mass of the nanowire, excellent force (1×10^{-13} $N/\sqrt{Hz}$) and mass sensitivity (80 attogram) were obtained. The resonant frequency can be tuned *in-situ* through a gate voltage which adjusts the effective spring constant of the resonator. Due to the large-aspect-ratio, the nanowire resonator can be readily driven into the non-linear regime that offers possibilities for parametric amplification and sensing. The demonstration of high-frequency, high-Q nanowire electromechanical resonators moves us significantly closer to the realization of ultra-sensitive mass and force sensing, and quantum-limited position measurements. Currently, efforts are being made to further improve the resonator's Q and resonant frequency, and to integrate the nanowires with MEMS structures through controlled direct growth. This project is supported by the National Science Foundation under award number ECS-0601478.



A VHF nanowire electromechanical resonator.



A nanowire resonator driven into non-linear regime.