Advances in fabrication and electrical transduction of silicon nanowire mechanical resonators

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Resonating nanomechanical structures[1] are attractive building blocks for the realization of high performance sensors and integrated oscillators. For example, a double clamped nanometric beam (DCB) (a silicon nanowire or a carbon nanotube) presents very large resonance frequency and extremely low mass, which are both highly convenient to detect minuscule quantities of mass.[2] Also, DCBs or more complex structures can be integrated within CMOS circuits to build high frequency oscillators that eventually may substitute present hybrid approaches.[3]

However, their small dimensions pose a challenge for their fabrication and measurement of these devices. In this presentation, we will present recent developments in fabrication, including novel approaches based on top-down and bottom-up methods. We will focus specially in a novel, fast, simple, and flexible fabrication method based in focused ion beam exposure, silicon etching and annealing.[4]

Piezoresistive electrical transduction is one of the most effective methods to transform the minuscule motion of the nanomechanical resonator into detectable electric signals. While the so called giant piezoresistance effect has enabled piezoresistive read-out in DCB silicon nanowires fabricated by bottom-up methods, it has not been observed in top-down fabricated DCBs. Recently, it has been shown that asymmetries present on DCBs are responsible of enhancing the transduced piezoresistive signals, allowing to obtain large electrical signals from silicon devices obtained by top-down fabrication methods.[5] We show that piezo-resistive read-out signal in DCBs nanomechanical resonators can be tuned by engineering the geometry of the device, and in particular, by inducing on-purpose asymmetries that enhance the transduction of specific resonant modes.

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