**Development of Ultra-High Sensitivity Nano-Mechanical Resonators for RF Mechanical Filter Applications**

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Nanomechanical resonators can act as RF bandpass filters at specific center frequencies and bandwidths, and they promise several advantages in high-frequency RF communications. For many RF applications, the center frequency of the RF carrier wave is very high relative to the signal bandwidth. For this reason, RF filters require high Q (very accurate center frequency resolution) and high sensitivity (very low noise figure devices). One of the barriers for practical RF applications of mechanical resonators is the intrinsic energy loss, which lower the mechanical quality factor of the resonator and thus the sensitivity of the devices. To date, several factors have been shown to influence the loss factor or Q degradation in resonators including the character of the vibration (compressional, torsional, or flexural), the nature of the attachment to the substrate, the mode shape of the oscillation and hence the resonator geometry, and finally the material properties. Based on these findings, we are developing high Q nano-mechanical resonators by optimizing the design and materials of resonators via an iterative process of experimental verification followed by model refinement. We are focusing our efforts on torsional motion in order to take advantage of a novel transduction method that utilizes an electret located on the resonator. We fabricate resonators using Si, AlN, GaN and nanocrystalline diamond that promise high-Q performance through a combination of superior bulk and surface properties. Resonators are fabricated using optical and electron beam lithography and various Reactive Ion Etching (RIE) methods developed for each material. Evaluation of resonator designs is carried out using scanning Laser Doppler Vibrometry (LDV), which enables imaging of the dynamic behavior of the resonators by generating both "modal maps" as well as determining the energy flow into the attachments. Modeling of resonator performance is performed using the finite element-based structural dynamics numerical codes.