On-Chip Ultra-High-Q Microtoroidal Resonator
with Applications Towards Sensing

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Abstract: Whispering-gallery-mode (WGM) optical microresonators with ultra-high quality factor (Q) and microscale mode volume are of interest for a variety of scientific disciplines ranging from fundamental science to engineering physics. Significantly enhanced light-matter interactions make WGM resonators remarkably sensitive transducers for detecting perturbations in and around the resonator, e.g., nanoparticle/virus detection at single particle resolution and ultrasensitive detection of nano-mechanical displacement. One interesting phenomenon associated with enhanced light-matter interactions is the splitting of the initially degenerate cavity modes in the strong coupling regime. We present a nanoparticle spectrometry scheme for label-free, real-time and continuous detection, counting and sizing of nanoparticles using split WGMs in an ultra-high-Q microtoroidal resonator. The polarizability of each binding particles can be derived from relative changes in the spectral properties of split resonances which allows us to measure the each particle as they continuously bind to the resonator. Moreover, with Erbium lasers and Raman lasers in microtoroid, we detect single gold particles of radii 10 nm, which is the smallest size ever detected with an optical resonator.