Analytical Seminar

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"Whispering-Gallery Microresonators & Microlasers for Nanoscale Sensing & Beyond"

Thursday

March 5

12:15 p.m.

1315 Chem

Optical sensors based on Whispering-Gallery-Mode (WGM) resonators have emerged as front-runners for label-free, ultra-sensitive detection of nanoscale materials and structures due to their superior capability to significantly enhance the interactions of light with the sensing targets. A WGM resonator traps light in circular orbits in a way similar to a whisper, i.e., a sound wave, traveling along a circular wall, an effect found in the whispering gallery of St. Paul's Cathedral in London. The basis for resonator sensors is that the physical associations and interactions of nanomaterials on the surface of a high-Q optical WGM resonator alter the trajectory and lifetime of photons in a way that can be measured and quantified. I will first present a laser-assisted processing method to create Si-chip based optical microresonators with Q-factors in excess of 100 million.

Sol-gel process will be introduced as a convenient and efficient method to incorporate optical gain dopants into the oxide layer deposited on a silicon wafer, providing a route to achieve arrays of microlasers on silicon wafer with emission spectral windows from visible to infrared. I will then present a recent discovery of using ultra-high-Q microresonators and microlasers for ultra-sensitive self-referencing detection and sizing of single virion, dielectric and metallic nanoparticles. I will also discuss using optical gains in a microlaser to improve the detection limit beyond the reach of a passive microresonator. These recent advancements in WGM microresonators will enable a new class of ultra-sensitive and low-power sensors for investigating the properties and kinetic behaviors of nanomaterials, nanostructures, and nanoscale phenomena.

In the end, I will discuss exploration of fundamental physics, such as parity-time symmetry and light-matter interactions around exceptional point in high-quality WGM resonators, which can be used to achieve a new generation of optical systems enabling unconventional control of light flow.