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"Thresholdless nanoscale lasers and the promises of metallic nano-cavities"

By

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Date: April 24, 2014

Time: 4:00 pm

Location: 160 Willard Bldg.

Abstract

The applications of nano-lasers range from on-chip optical communication to high-resolution and high-throughput imaging, sensing and spectroscopy. This has fueled interest in developing the ‘ultimate’ nano-laser: a scalable, low-threshold source of radiation that operates at room temperature and occupies a small volume on a chip. However, progress towards realizing this ultimate nano-laser has been hindered by the lack of a systematic approach to scaling down the sizeof the laser cavity without significantly increasing the threshold power required for lasing. In other words, the miniaturization of laser resonators using dielectric or metallic structures, across all previously proposed solutions, faces twochallenges; First, the (eigen) mode scalability, implying the existence of a self-sustained electromagnetic field regardless of the cavity size. Second, the disproportionate reduction of optical gain and cavity losses, which results in a largeand/or unattainable lasing threshold as the volume of the resonator is reduced.

In this talk, I present our experimental findings about lasing in the newly introduced nanoscale, sub-wavelength in all three dimensions, coaxial cavities that potentially solve the resonator scalability challenge by the choice of geometry and metal composition. In particular, I discuss the design, fabrication, characterization, and analysis that resulted in the smallest, room-temperature, continuous wave, telecommunication wavelength laser to date. Furthermore, by utilizing the unique properties of the coaxial cavities, which may have a single non-degenerate mode, I demonstrate thresholdless lasing at cryogenic temperatures, thus providing a scalable solution to overcoming the metal losses.

At the end, I will discuss important directions toward other applications of metallic nano-cavities in engineering absorption, and tailoring emission spectra of upconversion materials, as well as their potential use for quantum cavity electrodynamics.

Biography

Mercedeh Khajavikhan received B.S. and M.S. in Electronics from Amirkabir University of Technology, Tehran, Iran, in 2000 and 2003, respectively, and Ph.D. in Electrical Engineering from University of Minnesota in 2009. Her Ph.D. dissertation was on coherent beam combining for high power laser applications. In 2009, she joined University of California in San Diego as a postdoctoral researcher where she worked on the design and development of nanolasers, plasmonic devices, and silicon photonics components. In August 2012, she joined the College of Optics and Photonics (CREOL) at University of Central Florida as an assistant professor.