Semiconductor Nanowire and Plasmonic Nanolasers

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One of very active areas of nanophotonics research is to investigate the possibility of making ever smaller lasers, eventually measured at sub-wavelength scales or nanoscales. According to basic principles of laser operation, one can easily conclude that the size of a laser is limited by two length scales: one half of the effective wavelength and the gain length. For all types of lasers, the latter length scale is much larger than the former. Therefore the focus of the present research on nanolasers should be on reducing the required gain length or on increasing optical modal gain[1]. Two options are available in achieving a larger modal confinement or increasing modal gain: semiconductor nanowires and semiconductor-metal integrated plasmonic laser structures. In our talk, we will demonstrate many unique features[2-5] of nanowires that make them unique candidate as nanolasers including smallest size, strong waveguiding, large confinement factor, and world-record wavelength tunability of ~200 nm[6]. To reduce the size of nanowire lasers further, we show a semiconductor-metal core-shell structure can improve mode confinement and achieve positive modal gain at the same time[7-9], producing smallest lasers under electrical injection[9,10]. Results of our most recent theoretical and experimental investigations[8,10] will be presented.

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