New Designs For Spectral Control In Nanowire Lasers

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The miniaturization of optoelectronic devices is essential for the continued success of photonic technologies. Nanowires have been identified as potential building blocks that mimic conventional photonic components such as interconnects, waveguides, and optical cavities at the nanoscale[1-3]. Semiconductor nanowires with high optical gain offer promising solutions for lasers with small footprints and low power consumption[4-5]. Although much effort has been directed toward controlling their size[6], shape[7], and composition[8-9], most nanowire lasers currently suffer from being low-quality cavities, a problem that is universal in nanocavities because miniature features induce significant optical loss. Because of this difficulty, it remains an outstanding challenge to rationally control the spectra of room-temperature nano-lasers. This talk will focus on the development of experimental and theoretical strategies to manipulate the lasing modes of a semiconductor nanowire while also improving the performance of the laser. Lasing operation at a controlled single UV wavelength at room temperature was achieved using a simple coupling scheme[10]. The measured lasing spectra and laser threshold are in good agreement with the calculated spectral modes and threshold gain. This agreement between theory and experiment provides design principles for next-generation nanowire lasers.

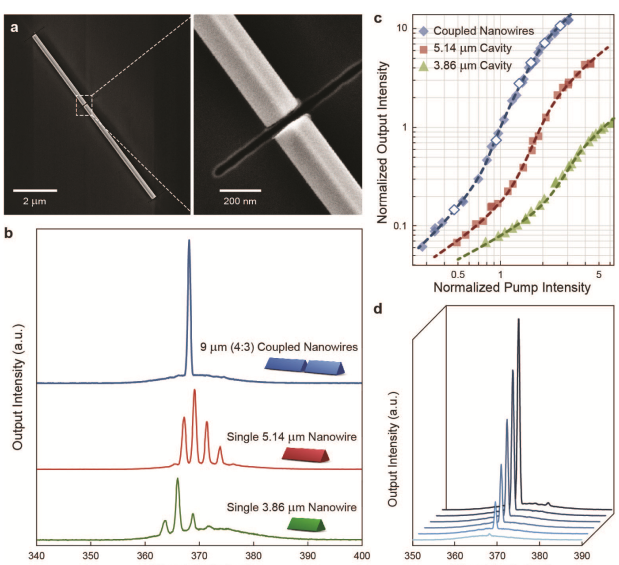

Figure 1. Single-frequency lasing in coupled nanowires[10]. (*a*) SEM images showing the axially coupled GaN nanowires on a Si substrate with 250–nm–thick thermal oxide. The two-component nanowires are coupled via an intercavity gap. (*b*) Single-wavelength lasing is observed from the coupled cavity (blue line), and each component nanowire lases at multiple wavelengths when they are separated. (*c*) Clear lasing transitions can be seen from the power-dependent measurements. The pump intensity and the output intensity are both normalized to the values at the threshold of the coupled nanowires. The dashed lines were fitted using a rate equation analysis. (*d*) Output spectra of the cleaved-coupled nanowires show clean single-wavelength lasing at different excitation intensities corresponding to the open diamonds in *c*.

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