GeSn Light-Emitting Diodes for Si Optoelectronic Integration

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Background/Relevance
- Si photonics integrates optoelectronic devices to traditional CMOS based integrated circuits.
- Efficient light-emitting source monolithically on Si is missing.
- Hybrid III-V lasers result in high cost and is incompatible with CMOS process.

Innovation
- Using light-emitting diodes enables cost effective and high density integration of Si photonic devices and CMOS on Si.
- Light emission wavelength from near- to mid-infrared enables a wide range of applications.

Key Results
- Material characterization was performed by using Raman spectroscopy, X-ray diffraction, transmission electron microscopy, and photoluminescence to confirm the quality.
- Fabricated GeSn based LEDs with various Sn composition of 6%, 8%, 9%, and 10%.
- Temperature dependent electroluminescence was characterized.
- Optical power was measured with ~ 50 µW power output at room temperature.

Approach
- Material growth for p-i-n double heterostructure.
- Material characterization using techniques such as X-ray diffraction, Raman spectroscopy, transmission electron microscopy, and photoluminescence spectroscopy.
- Device fabrication including photolithography, mesa etching, passivation, and metal deposition.
- Device characterization at room and cryogenic temperature, including current-voltage measurement, electroluminescence, and optical power.

Conclusions
- Increasing Sn composition results in bandgap narrowing as well as band structure transition from indirect to direct.
- Decreasing the temperature results in dropping the intensity from 300 K to 100 K.
- Direct transition emission was observed from photoluminescence under 100 K.

Future Work
- Calculate recombination rate for GeSn based LED device
- Optimize the device performance, achieve higher efficiency.