GeSn Light-Emitter for Si Integrated Photonic Circuits

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Background/Relevance
- Si photonics plays great role in applications such as data communication and chemical sensing.
- Efficient light-emitting source monolithically on Si is missing. Monolithic integration of light source on Si would make the Si photonics more cost-effective, compact, and reliable.

Innovation
- Low-cost light source on Si meet the need of light source integration for Si photonics.
- Tunable light emission wavelength from near- to mid-infrared enables a wide range of applications.

Key Results
- On Si direct band gap GeSn LEDs were achieved with peak power of ~ 50 µW.
- Optical pumped GeSn bulk Laser was achieved towards room temperature operation.
- Multiple quantum well GeSn/SiGeSn laser was studied for higher emission efficiency.

Approach
- Device simulation was performed by using MATLAB, TCAD, FDTD simulation software.
- Epitaxial growth using commercial available UHV-CVD under CMOS compatible temperatures.
- Material characterization using techniques such as XRD, SIMS, TEM, and etc.
- LED and laser devices fabrication using standard IC process.
- Device characterization at cryogenic temperatures.

Conclusions
- Increasing Sn composition results a bandgap narrowing and band structure transition from indirect to direct.
- Direct-band GeSn LED was achieved with the 9% Sn composition.
- Increase of Sn composition also resulted in enhancement of material gain. 20% Sn bulk laser was achieved up to 280 K.
- MQW laser was achieved up to 90 K with reduced threshold and increased emission efficiency comparing to bulk laser.

Future Work
- Optimize the device performance, achieve higher efficiency.
- Design the waveguide for light transmission in the photonics circuits.
- Develop GeSn based emitter for electrically pumped laser.

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