Optical Characterization of GeSn Thin Films

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Background/Relevance

- Group III-V Semiconductors are currently used for Si Photonics but aren't suitable for industry due to their high cost, and incompatibility with CMOS processes.
- Group IV Semiconductor Ge is considered as a pseudo-direct bandgap material, because the difference between the direct and indirect bandgap of Ge is only 0.140 meV.
- Since the difference between the direct and indirect bandgap is small, the bandgap can be modified to eventually achieve a direct bandgap Ge.

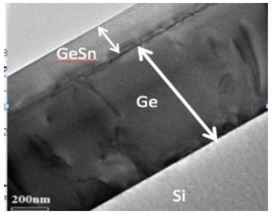
Innovation

- Fabrication of cost effective and high-efficient Si-based emitters that can cover the short-wave and mid-infrared range of spectrum for Si photonics and optoelectronic industry.

Approach

- Alloying GeSn as opposed to strain or heavily n-doping deals with wavelength limitations.
- Testing GeSn alloy for temperature and excitation power using temperature dependent photoluminescence.
- Increasing Sn composition x> 9%, results in decreased bandgap material to GeSn alloy providing a direct bandgap GeSn material through temperature testing ranging from 10-300K.

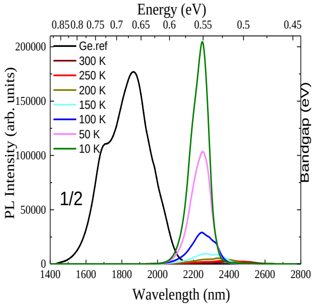
ASM Epsilon CVD Reactor



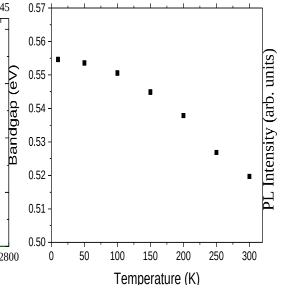
SiGeSn Structural Layer

Key Results

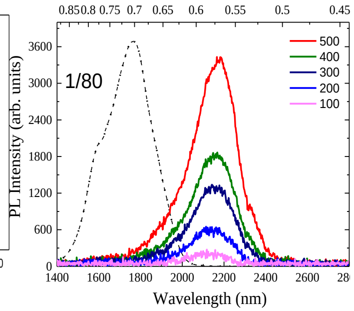
- High quality GeSn thin films were grown using commercial CVD machine
- Temperature dependent and power dependent PL was performed on 9% GeSn sample
- PL intensity in low temperature was significantly higher than the room temperature intensity



Temp. dependent PL GeSn



Bandgap of temp dep. PL



Power Intensity PL 9% GeSn

Conclusions

- GeSn thin films can be grown monolithically on Si or Ge buffer in an inexpensive way compared to group III-V semiconductors
- GeSn grown on Si has a capability to be applied in the future of Si Photonics technology
- High Sn composition GeSn samples with higher thickness presents a direct bandgap material for the future of infrared light emitting devices and lasers

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