Epitaxial Growth of GeSn/(Si)Ge(Sn) heterostructures for optoelectronic applications

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The observation of lasing action in GeSn opens a new path for monolithic integration of electronics and photonics based on Si. In this context, the incorporation of Si into GeSn and epitaxial growth of GeSn/(Si)Ge(Sn) heterostructures are essential for electrically pumped optoelectronic devices.

We will discuss the electronic band structure calculations for a variety of Group IV heterostructures, including e.g. SiGeSn claddings and GeSn active layers with type I band alignment suitable for light emitting diodes and electrically pumped laser diodes. Here, Si and Sn concentrations up to 14 at.% in the cladding layer offer an effective carrier confinement with band offsets of a few hundred meV with respect to the active layer.

Epitaxial growth of direct GeSn and indirect SiGeSn layers using an industry compatible AIXTRON reduced pressure CVD reactor with showerhead technology will be presented. Si_2H_6, Ge_2H_6 and $SnCl_4$ were employed as precursors, while B_2H_6 and PH_3 allow in-situ doping of the grown layers. Single epilayers and multi quantum well structures have been analyzed using RBS, TEM and X-Ray diffraction showing excellent layer morphology and high Sn substitutionality. Optical characterization was performed via photoluminescence and electroluminescence on both layers and pin diodes. Room temperature electroluminescence is observed for small current densities of about 50 Acm^{-2}. This demonstrates the potential of Group IV heterostructure for optoelectronics.