Thermal stability and Sn segregation in GeSn structures

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Group IV GeSn alloys are extensively studied for efficient Si-based photonics. The interest is elevated recently due to the demonstration of direct bandgap emission in Ge [1]. Specifically, a combination of strain and *n*-type doping reduces the small separation (~140 meV) between the indirect (L) and direct (Γ) valleys in Ge [2] and raises the Fermi level for sufficient electron population in the Γ valley. Nonetheless, the high level of strain (2%) and doping (10^{19} cm^{-3}) only allows a tunable Ge bandgap between 1.3 and 1.6 μm. Alternatively, alloying Ge with the negative bandgap α-Sn results in a fundamental direct bandgap GeSn material with better tunability. The theoretical and experimental estimations indicate an indirect to direct bandgap transition for Sn compositions above 6%.

Achieving Sn-rich GeSn alloys is difficult. This relates to (i) the low equilibrium solid solubility of Sn in Ge (<1%) and (ii) the large lattice mismatch between Ge and α-Sn (15%). However, Sn-rich GeSn alloys have been demonstrated by non-equilibrium growth techniques. The thermal stability of such structures is an issue. We study the structural and optical properties of CVD grown GeSn films in detail. The strain relaxation and Sn segregation is reported for thermal treatment at 300 °C. We discuss on the mechanism of Sn segregation trough the interaction with dislocation.

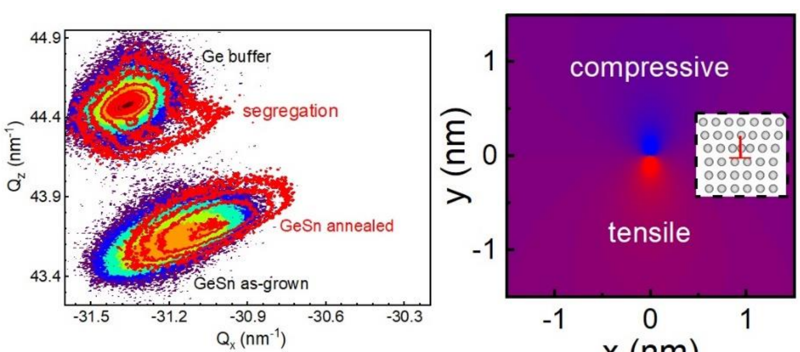

Figure 1 XRD RSMs of the as-grown and annealed samples (left) and the strain filed around a dislocation line (right)

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[2] K.P. Homewood, M.A. Lourenço, Nat. Photonics. **9**, 78-79(2015)

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