GeSnSi CVD epitaxy using Silane, Germane, Digermane, and Tin tetrachloride

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Abstract:

In this study, strain relaxed and compressive strained $Ge_{1-x}Sn_x$ ($0.015 \le x \le 0.15$) layers were epitaxially grown on Si substrate in a chemical vapor deposition reactor at atmospheric pressure. Digermane (Ge_2H_6) and germane (GeH_4) were used as Ge precursors and tin tetrachloride ($SnCl_4$) was used as Sn precursor. The growth temperature was kept below 350°C to suppress Sn out diffusion. The layers crystal quality and strain were characterized using XRD, high resolution reciprocal lattice mapping and transmission electron microscopy and the surface morphology was investigated by atomic force microscopy (AFM). Furthermore, the low temperature epitaxial growth up to 15% Si atoms incorporation in $Ge_{0.94}Sn_{0.06}$ was demonstrated by adding silane (SiH_4) as Si precursor. Sn contents calculated from high resolution XRD patterns were confirmed by Rutherford backscattering spectroscopy which shows that Sn atoms are mostly positioned in substitutional sites. AFM analysis showed below 1nm surface roughness for both strained and strain relaxed GeSn layers which make the promising materials for photonics and electronics applications.