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Electronic Structure of $Ge_{1-y}Sn_y$ and $Ge_{1-x-y}Si_xSn_y$ Alloys from Optical and Electro-Optical Measurements JAMES GALLAGHER, Department of Physics, Arizona State Univ, CHARUTHA SENARATNE, Department of Chemistry and Biochemistry, Arizona State Univ, CHI XU, LIYING JIANG, DOUG BOPP, Department of Physics, Arizona State Univ, JOHN KOUVETAKIS, Department of Chemistry and Biochemistry, Arizona State Univ, JOSE MENENDEZ, Department of Physics, Arizona State Univ — Optical transitions in $Ge_{1-y}Sn_y$ and $Ge_{1-x-y}Si_xSn_y$ alloys have been studied in detail using spectroscopic ellipsometry, photocurrent, and photoluminescence experiments on films grown on Si, Ge, and Ge-buffered Si platforms using CVD and gas-source MBE reactions of germanes, silanes, and deuterated stannane. The compositional, x and y, dependence of the lowest direct and indirect band gaps, as well as other transitions, are determined through these techniques. This has enabled mapping the direct-indirect gap crossover in composition space to reveal the potential of these alloys for optoelectronic applications via band gap engineering. All the measured transition energies can be described by second-order polynomials as functions of composition whose quadratic coefficients (bowing parameters) show systematic chemical trends. The transferability of these parameters between binary and ternary alloys is studied in detail. Due to a larger negative bowing for the direct than for the indirect gap, the crossover to direct gap behavior occurs for Sn concentrations much lower than predicted from a simple linear interpolation between the corresponding elemental semiconductors.

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