Band gap engineering of pseudomorphic Ge$_{1-x-y}$Si$_x$Sn$_y$ alloys on Ge for photonic applications

N FERNANDO, S ZOLLNER, New Mexico State University, R HICKEY, J HART, R HAZBUN, D ZHANG, J KOLODZEY, University of Delaware — Band gap engineering of Ge by controlling strain and alloying with Si and Sn has attracted great interest since a Ge$_{1-x-y}$Si$_x$Sn$_y$ ternary alloy with two compositional degrees of freedom allows decoupling of the lattice constant and electronic structures. We report the effects of alloying and the strain of the direct and indirect band gaps of pseudomorphic Ge$_{1-x-y}$Si$_x$Sn$_y$ alloys on Ge using deformation potential theory. The predictions for the compositional dependence of the $E_0$, $E_1$ and $E_1 + \Delta_1$ band gaps were validated for pseudomorphic Ge$_{1-y}$Sn$_y$ alloys on Ge using spectroscopic ellipsometry. The complex pseudodielectric functions of pseudomorphic Ge$_{1-y}$Sn$_y$ alloys grown on Ge by MBE were measured using ellipsometry from 0.1-6.6 eV for Sn contents up to 11%. Critical point energies were obtained by analyzing the second derivative spectra of the dielectric function of the GeSn epilayers. The band gaps of pseudomorphic Ge$_{1-y}$Sn$_y$ alloys obtained from ellipsometry are in good agreement with the theoretical predictions.