Structural and Optical Properties of Sn$_x$Ge$_{1-x}$ thin films and Quantum Dots JORDANA BLACKSBERG, L. DOUGLAS BELL, SHOULEH NIKZAD, Jet Propulsion Labs — Sn$_x$Ge$_{1-x}$ layers and quantum dots (QDs) are of great interest as materials that could provide tunable direct band gaps, allowing completely group IV-based optoelectronic devices. These materials could be used in a wide range of applications such as emitters, infrared detectors, and thermophotovoltaics. However, substantial challenges remain in the growth and processing of these materials. We have grown Sn$_x$Ge$_{1-x}$ films by Molecular Beam Epitaxy (MBE), using low growth temperatures (<200°C) in order to grow fully strained layers. X-ray diffraction, transmission electron microscopy, and Rutherford backscattering spectroscopy data indicate high-quality epitaxial films. Post-growth annealing was used to form QDs. Either QDs or quantum wires may be formed depending on annealing parameters. The effects of varying substrate temperature between 400°C (wires) and 750°C (QDs) on size and distribution of quantum structures were explored and will be discussed. Sn concentration (0-10%) and film thickness (40nm - 200nm) were also varied. Optical properties probed by Fourier transform infrared spectroscopy (FTIR) will be presented. FTIR spectra clearly show the decrease in band gap of Sn$_x$Ge$_{1-x}$ layers with increasing Sn fraction up to 10%. Photomodulated reflectance (PR) is another sensitive method for probing critical points in Sn$_x$Ge$_{1-x}$ band structure, and can detect both direct and indirect transitions. PR results for Sn$_x$Ge$_{1-x}$ layers will also be discussed.

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