Preparation of InSb Surfaces for Molecular Beam Epitaxy Growth and Re-growth

Mihir Pendharkar [a], Joon Sue Lee [b], Prasad P. Iyer [a], Borzoyeh Shojaei [c], Anthony P. McFadden [a], Jon A. Schuller [a], Chris J. Palmstrøm [a,b,c,+]

[a] *Electrical and Computer Engineering, UC Santa Barbara, Santa Barbara, CA, 93106*
[b] *California NanoSystems Institute, UC Santa Barbara, Santa Barbara, CA, 93106*
[c] *Materials Engineering, UC Santa Barbara, Santa Barbara, CA, 93106*

Molecular Beam Epitaxy of III-V semiconductors has allowed for a continued improvement in the understanding of materials and the discovery of novel physical phenomenon. The narrow band gap of InSb coupled with its low electron effective mass have generated significant interest for its applications in high electron mobility transistors and infrared detectors and metasurfaces. Lack of lattice matched wide band gap III-V substrates and the challenging thermal desorption of the InSb surface oxide, has led to the growth of InSb on highly lattice mismatched materials. Performance of functional InSb devices based on mismatched substrates has been limited due to very high defect and dislocation densities.

In this work, preparation of InSb (001) substrates by atomic Hydrogen cleaning, in Ultra High Vacuum, and subsequent growth of InSb epi-layers by Molecular Beam Epitaxy, has been demonstrated. The efficiency of Hydrogen cleaning on the surface of InSb, for removal of the surface oxide, was studied by X-Ray Photo-Electron Spectroscopy (XPS), Reflection High Energy Electron Diffraction (RHEED) and Scanning Tunneling Microscopy (STM). The developed surface preparation technique has allowed for the first demonstration of an InSb quantum well on an InSb substrate, with record electron mobility.

Re-growth of III-V epi-layers of InSb, after *ex-situ* device fabrication, has also been demonstrated. A combination of wet chemical etching and *in-situ* atomic Hydrogen cleaning has been used to achieve an epi-ready surface. The demonstrated ability of growth and re-growth on InSb (001) surfaces is expected to be a paradigm shift in the discovery and development of new electronic and photonic devices using $(Al,Ga)_xIn_{1-x}Sb$ material system as a template.

This is a student paper.

[+] Corresponding author: cpalmstrom@ece.ucsb.edu

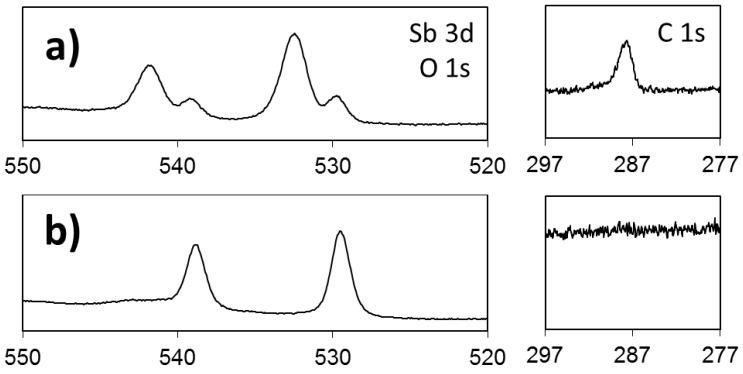

Fig. 1. X-Ray Photo-Electron Spectroscopy (XPS) of InSb (001) substrate before (a) and after (b) atomic Hydrogen cleaning, indicates a removal of Carbon and desorption of the surface oxide.