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“Taming the Monster: Manipulating the Cs concentration in SIMS”

Abstract

SIMS is routinely used for depth profiling of semiconductors, due to its excellent chemical sensitivity and nm scale depth resolution. Quantitative SIMS has long been hampered by the matrix effect, which can lead to improper quantification of impurities outside the dilute limit (<1% atomic). The MCs⁺ method has been applied in the past to minimize SIMS matrix effects. While this method has been shown effective at reducing matrix effects in some materials, it has been less effective in others. Critical to understanding this material dependence is knowledge of the concentration of retained Cs in the sample, i.e. the instantaneous surface Cs concentration.

The ability to control the in-situ cesium concentration, [Cs], and accurately measure the [Cs] are the first steps towards understanding the effectiveness of the MCs⁺ technique in SIMS. We have developed a method to control the instantaneous [Cs] by using in-situ NEG heating and improved the measurement of [Cs] by ex-situ heating with the hot stage on the X-ray photoelectron spectrometer (XPS). The samples of interest for this study are (100) silicon and (100) indium arsenide. By simultaneous heating with the Normal Incidence Electron Gun (NEG) and sputtering with a Cs⁺ ion beam, we have demonstrated the ability to lower the instantaneous [Cs] during the SIMS analysis. Ex-situ heating enhances the mobility of Cs causing the implanted Cs to migrate towards the surface, providing a more accurate measurement of the retained Cs. Several characterization techniques are utilized to measure [Cs] including scanning electron microscopy/energy dispersive spectroscopy (SEM/EDS), transmission electron microscopy/energy dispersive spectroscopy (TEM/EDS), and x-ray photoelectron spectroscopy (XPS). The goal of this work is to improve the quantification of the MCs⁺ technique used in SIMS by understanding how Cs is incorporated and retained in different materials.

Biosketch

Mr. Andrew Giordani is a Ph.D. candidate in the Department of Materials Science and Engineering at Virginia Tech and received his B.S. degree in Mathematics and Physics in 2010 from Emory and Henry College in Emory, Virginia. He is currently advised by Dr. Jerry Hunter and Dr. Louis Guido with research interests in SIMS technique development.