Refractory Metal Based Schottky Diodes on β-Ga_2O_3 for Radiation Studies

Evan M. Cornuelle, Joe McGlone, Hemant Ghadi, Zixuan Feng, Hongping Zhao, and Steven A. Ringel
Department of Electrical and Computer Engineering
The Ohio State University
Columbus, OH 43210

Abstract:

β-Ga_2O_3 is an ultra-wide bandgap (UWBG) semiconductor that has received great interest in recent years. Device figures of merit for both RF and high voltage applications improve with bandgap, providing UWBG semiconductors significant advantages over conventional semiconductors. Additionally, radiation tolerance generally improves with bandgap as semiconducting materials with a larger bond strength tend to have a larger bandgap, thereby increasing the energy required to displace an atom from a lattice site. These factors make UWBG materials, and specifically β-Ga_2O_3, attractive for circuits and sensors to be used in harsh radiation environments. Critical to the success in real applications, it is important to understand the thermal stability of defects within irradiated devices. Here we explore the use of refractory metal Schottky contacts that can withstand post-irradiation high temperature annealing, using conventional electrical characterization and deep level optically and thermally based defect spectroscopies (DLOS, DLTS). Specifically, we have developed refractory Pt Schottky barriers on β-Ga_2O_3, for pre-, post-irradiation and post-annealing studies, and our aim is to demonstrate.

A 700nm epitaxial layer of β-Ga_2O_3 was grown by MOCVD on a Sn-doped (010) β-Ga_2O_3 substrate. Precursors for the epitaxial growth were triethylgallium and pure oxygen. The epitaxial layer was intentionally doped n-type with Si sourced by silane gas and a net ionized doping concentration of 1×10^{17} cm^{-3} was targeted. Pt and baseline Ni Schottky diodes were fabricated onto pieces diced from the substrate. Doping concentrations of 1.6×10^{17} cm^{-3} and 1.7×10^{17} cm^{-3}, for Ni and Pt, were extracted by capacitance-voltage measurements and are within statistical error. Schottky barrier heights of 1.3V and 1.9V were measured by internal photoemission for Ni and Pt, respectively, tracking different work functions. The deep level defect spectra from both DLTS and DLOS were identical between the two samples measured by deep level transient spectroscopy and deep level optical spectroscopy, indicating the suitability of the Pt contacts. Proton irradiation and subsequent annealing studies are ongoing, and updates will be provided at the workshop. to not alter the results from defect spectroscopy, which is promising for radiation studies.