X-ray photoemission spectroscopy has been used as a tool to study the surface band bending of a semiconductor sample with a metal film. Due to the importance of GaN as a material for shorter wavelength LEDs and laser diodes, it is important to monitor the surface barrier height on GaN samples during the formation of a Au-contact to the surface. Although it is common practice to use the shifts of core levels to monitor the position of the Fermi level within the band gap of a semiconductor during formation of a metal overlayer, great care must be taken to ensure that the system is under electronic equilibrium.[1] The non-equilibrium phenomenon of surface photovoltage (SPV), which occurs when the sample is illuminated for spectroscopy has been observed during metal deposition on other semiconductor systems previously, such as GaP.[2-4]

n-GaN samples were prepared with annealed Ti ohmic contact patches, to ensure the samples were properly grounded and that the observed shifts were not due to a resistive voltage drop. The Ga 3d and valence band spectra for the sample and the Fermi edge spectrum of a thermally cleaned Ta foil were collected. Au was then deposited at sub-nm coverages on the GaN samples and Ga 3d and Fermi edge spectra were re-collected at each step of the Au coverage. The shift of the Au Fermi level to lower kinetic energy indicates that a surface photovoltage (SPV) is present during these measurements. The SPV causes a band flattening and, if unaccounted for, such SPV-induced shifts will lead to misinterpretation of the surface barrier height data. The SPV effects can be accounted for and a more accurate determination of the surface Fermi level motion can be ascertained.

References


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