All data in the Excel file refer to the paper published in Microelectronics Engineering having DOI:10.1016/j.mee.2017.04.010.

Two main characterization methods are used in this paper, namely XPS and VASE. The XPS was performed in a standard ultra-high vacuum (UHV) system consisting of a PSP Vacuum Technology dual anode (Mg/Al) X-ray source and a hemispherical electron energy analyser equipped with five channeltrons. The spectrometer was calibrated so that the Ag 3d5/2 photoelectron line had a binding energy (BE) of 368.35 eV with a full width at half maximum (FWHM) of 0.8 eV. Room temperature VASE measurements were performed using a J.A. Woollam M2000 ellipsometer in the energy range 0.7 – 5.1 eV at three incident angles 65°, 70° and 75° to maximize the accuracy in extracting thickness, optical properties and band gap of the GaN and Ta2O5 layers.

Figure 1(a) shows XPS background subtracted O 1s CL for GaN surface treated using the three different etchants: NH4OH, (NH4)2S and HCl. The HCl treatment shows the lowest oxygen contamination.

Figure 1(b) shows de-convoluted Cl 2p spectra. From the spectra it is clear that Cl present in the sample is in the form of Ga-Cl due to Ga rich surface of GaN.

Figure 2 shows VASE data for the GaN sample (circle) and the best multiple-layer model fit (full line) in the wavelength range of 240–1700 nm: Δ for incident angles (a) 60˚, (b) 65˚, (c) 70˚, and (d) Ψ for three incident angles (60-75˚).

Figure 3 shows VASE data for the bulk Ta2O5/GaN sample (circle) and the best model fit (full line) in the transparent wavelength region (240-340 nm): (a) Δ and (b) Ψ for three incident angles (60-75˚). The thickness of Ta2O5 is estimated to be 10.6 ± 0.2 eV.

Figure 4 shows photon energy dependence of parametric dielectric function, ε1 and ε2, for: (a) as received GaN substrate, and (b) 10 nm (nominal) Ta2O5/GaN. The band gap obtained from ε2 spectra using linear extrapolation of the leading edge to the baseline is 3.34 ± 0.15 eV for GaN and 4.40 ± 0.15 eV for Ta2O5**.**

Figure 5 shows the XPS spectra of: (a) Ga 3d core level (CL) for GaN substrate; (b) Ta 4f CL for bulk Ta2O5/GaN sample; (c) Ga 3d and Ta 4f CLs for interfacial Ta2O5/GaN sample showing the difference between the CLs. The insets in (a)-(b) show the valence band maximum (VBM) estimation from valence band leading edge linear fitting. The envelope refers to the fitted curve to experimental data.