Spectroscopic and electrical investigations on gallium oxide PEALD-films

Ali Mahmoodinezhad[1], Christoph Janowitz[1], Franziska Naumann[2], Hassan Gargouri[2], Karsten Henkel[#1,3], Dieter Schmeißer[3], and Jan Ingo Flege[1]

[1]Applied Physics and Semiconductor Spectroscopy, Brandenburg University of Technology Cottbus-Senftenberg, Konrad-Zuse-Str. 1, 03046 Cottbus, Germany

[2]SENTECH Instruments GmbH, Schwarzschildstraße 2, 12489 Berlin, Germany

[3]Applied Physics and Sensor Technology, Brandenburg University of Technology Cottbus-Senftenberg, Konrad-Wachsmann-Allee 17, 03046 Cottbus, Germany

[#]henkel@b-tu.de

Gallium oxide, a transparent semiconducting oxide, is promising for a wide range of applications in the fields of electronics, optoelectronics, and sensors [1].

In this work thin gallium oxide layers were prepared by plasma-enhanced atomic layer deposition (PEALD) on silicon four inch wafers in the SENTECH SI PEALD system [2] at substrate temperatures ranging from 80 °C to 200 °C. The films were characterized by ellipsometry, X-ray photoelectron spectroscopy (XPS), and electrical measurements.

The growth rate per cycle was almost constant in the investigated substrate temperature range and reached values of about 0.67 Å/cycle. The thickness distribution of the layers across the four inch wafers was very uniform, with low inhomogeneity values of 2.0% and below. The refractive index and the permittivity were determined to 1.86±0.01 (at 632.8 nm) and 9.9±0.4 (at 10 kHz), respectively. Fixed and mobile oxide charges in the order of 10^{12} cm^{-2} were observed in the capacitance-voltage characteristics. For the gallium oxide films, the gallium to oxygen ratio is very close to the ideal stoichiometric ratio (2:3) in the full investigated substrate temperature range as evaluated by XPS analysis of the Ga3d and O1s core levels. Results from depth profiling analysis of the layer composition based on cyclic Ar^+ ion sputtering combined with XPS will also be reported.

[1] Z. Galazka, Semicond. Sci. Technol. **33**, 113001 (2018).
[2] K. Henkel et al., J. Vac. Sci. Technol. A **32**, 01A107 (2014).