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Comparison of PEALD-AlN films prepared with different plasma sources

Małgorzata Kot¹, Emilia Pożarowska¹, Franziska Naumann², Samiran Garain¹, Hassan Gargouri²,
Karsten Henke¹ and Dieter Schmeißer¹

¹*Brandenburg University of Technology Cottbus-Senftenberg, Applied Physics and Sensor Technology,
K.-Wachsmann-Allee 17, 03046 Cottbus, Germany*

²*SENTECH Instruments GmbH, Schwarzschildstraße 2, 12489 Berlin, Germany*

AlN has remarkable properties making it attractive for a wide range of applications in the field of (opto)electronics, acoustics and sensors.

We present a comparative study of thin AlN films deposited by PEALD in the SENTECH SI ALD LL system applying either a direct inductively coupled (ICP) or an indirect capacitively coupled (CCP) plasma source. All films were prepared at 350°C on 8" Si wafers using TMA and NH₃ and varying the power and duration of the plasma pulse. The films were characterized by ellipsometry, XPS, GIXRD, FESEM, AFM and electrical measurements.

In general, smooth (RMS roughness < 1nm) and homogeneous (thickness inhomogeneity < 4%) films with a certain content of the wurtzite hexagonal phase having a predominant (002) orientation and round grain morphology are achieved. The dielectric constant is in the range of 8.0±0.5 and the breakdown voltage above 2.2 MV/cm.

The films prepared with the ICP source exhibit improved properties concerning the GPC, total cycle duration, homogeneity, refractive index, fixed and mobile electrical charges and residual oxygen content compared to the CCP process. The increase of the plasma power to 600 W in the ICP process significantly reduces the residual oxygen content and enhances the electrical breakdown field. The AlN layers grown under these conditions, with a GPC of 1.54 Å/cycle, contain residual oxygen and carbon concentrations of about 10 and 4 %, respectively and possess a refractive index of 2.07 (at 632.8 nm).