

Sapphire Nitridation for Highly Crystalline (0002) AlN Heteroepitaxy

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Direct nitridation of sapphire and aluminum oxide substrates via nitrogen plasma treatments is well reported for improving heteroepitaxy of AlN. In this work, plasma treatments of c-plane sapphire were conducted in-situ in a sputtering chamber directly preceding AlN deposition. Plasma treatment parameters were varied to investigate variations in resulting aluminum oxynitride formation via x-ray reflection, where x-ray diffraction was used to determine AlN crystalline texture and mosaicity. AlN (0002) rocking curve full-width-half max of $\sim 0.1^\circ$ was measured for optimal sapphire plasma treatments. A narrow processing window is reported to maintain crystalline registry with the sapphire substrate, without growing too thick and rough leading to disordered AlN films. Transmission electron microscopy interrogated the thickness, crystallinity, and stoichiometry via electron energy loss spectroscopy (EELS) of the aluminum oxynitride buffer layer. Improving AlN quality through the use of nitriding sapphire with CMOS compatible fabrication will enhance device performance and templating with other materials.