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Effects of In-Situ Annealed Buffer Layers in Oxygen Plasma on Properties of ZnO Epitaxial Layers Grown by Plasma-Assisted Molecular Beam Epitaxy

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ZnO epitaxial layers were grown on a Si (100) substrate by a two-step growth process using annealed ZnO buffer layers by plasma-assisted molecular beam epitaxy (PA-MBE). The effects of the O_2 plasma during the in-situ annealing process on the properties of the ZnO epilayers were investigated by atomic force microscopy (AFM), high-resolution X-ray diffraction (HR-XRD), scanning electron microscopy (SEM), and room-temperature (RT) photoluminescence (PL). The surface roughness measured by AFM was improved from 2.71 to 0.59 nm. The full width at half maximum (FWHM) of the rocking curve observed for ZnO (002) XRD and PL for the ZnO epilayers was decreased from 0.24 to 0.18° and from 232 to 133 meV, respectively. The intensity of the XRD rocking curve and the PL emission peak were increased. The XRD intensity ratio of the ZnO (002) to Si substrates and PL intensity ratio of the near-band edge emissions (NBEE) to the deep-level emissions (DLE) as a function of the RF power was increased from 0.166 to 0.467 and from 2.54 to 4.01, respectively. The structural and optical properties of ZnO epilayers were improved by the annealing process.