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Effects of Nitrogen Passivation layers on Structural and Optical Properties of ZnO Epitaxial Layers Grown by Plasma-Assisted Molecular Beam Epitaxy

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ZnO epilayers on Si (100) substrates with nitrogen passivation layers were grown by plasma-assisted molecular beam epitaxy (PA-MBE). The nitrogen passivation layers on surface of the Si substrates were grown at different temperature in the range from 100 to 700 ^{o}C. High resolution X-ray diffraction (HR-XRD), scanning electron microscope (SEM), atomic force microscope (AFM), and photoluminescence (PL) were carried out to investigate the effects of the pretreatment on the ZnO epilayers. All samples show the typical XRD patterns, AFM images, and PL emission peaks of ZnO. The higher intensity and the narrower full width at half maximum (FWHM) of the XRD (002) diffraction peak are observed from the ZnO epilayers grown on the pretreated substrates. The residual stress of the ZnO epilayers is relaxed and the average grain size is gradually increased as the temperature is increased to 300 ^{o}C. The luminescent properties of the ZnO epilayers grown on the pretreated Si at the temperature of 100 ^{o}C are enhanced. However, the ZnO epilayers grown on the pretreated Si at the temperature of 300 ^{o}C show the anomalous PL behaviors. By further increase in the temperature up to 700 ^{o}C, the nitrogen-passivation efficiency of the substrate surface is degraded. Therefore, the temperature below 300 ^{o}C during the pretreatment process is the most suitable to obtain the high-quality ZnO epilayers with good luminescence performance.