GaN interlayer Effects on structural properties of ZnO nanorods fabricated by MOCVD

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Well-aligned ZnO nanorods were fabricated epitaxially on n- and p-GaN/Al_2O_3 [0001] substrates with a catalyst-free metal-organic chemical vapor deposition (MOCVD) method. We studied the structural strain due to a lattice mismatch between the sapphire substrates and ZnO nanorods. There is a large lattice mismatch between ZnO and Al_2O_3 while ZnO and GaN have similar lattice constants. The structural properties of the ZnO nanorods with and without a GaN interlayer were studied with various structural analysis techniques. From the ZnO nanorods grown on Al_2O_3 substrates directly, we observed that the ZnO nanorods were oriented randomly in ab-plane, although they were well-aligned along c-axis. Field emission scanning electron microscope showed that the ZnO nanorods had a different shape and density, depending on the doping conditions of the GaN interlayer. A best crystalline quality of the ZnO nanorods was obtained as grown on the n-GaN interlayer. X-ray diffraction (XRD) and x-ray absorption fine structure measurements showed that the residual structural strain in the ZnO nanorods grown with the n-GaN interlayer was at least three times smaller than that in the nanorods grown directly on Al_2O_3 substrates. From XRD ϕ-scans on the (101) Bragg peak of ZnO, we found that the ZnO nanorods grown on the n-GaN interlayer were well-aligned in ab-plane. We also found that the ZnO nanorod growth was affected by the surface conditions of the interlayer. The measurements of the structural properties of ZnO nanorods suggested that the structural strain due to the lattice mismatch and the surface conditions of the interlayer effectively affected the crystalline quality and orientations of ZnO nanorods