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Growth and characterization of periodically polarity-inverted ZnO structures grown on Cr-compound buffer layers

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Periodically polarity inverted (PPI) ZnO structures on (0001) Al2O3 substrates are demonstrated by plasmas assisted molecular beam epitaxy. The patterning and re-growth methods are used to realize the PPI ZnO by employing the polarity controlling method. For the in-situ polarity controlling of ZnO films, Cr-compound buffer layers are used.[1, 2] The region with the CrN intermediate layer and the region with the Cr2O3 and Al2O3 substrate were used to grow the Zn- and O-polar ZnO films, respectively. The growth behaviors with anisotropic properties of PPI ZnO heterostructures are investigated. The periodical polarity inversion is evaluated by contrast images of piezo-response microscopy. Structural and optical interface properties of PPI ZnO are investigated by the transmission electron microcopy (TEM) and micro photoluminescence (μ-PL). The inversion domain boundaries (IDBs) between the Zn and the O-polar ZnO regions were clearly observed by TEM. Moreover, the investigation of spatially resolved local photoluminescence characteristics of PPI ZnO revealed stronger excitonic emission at the interfacial region with the IDBs compared to the Zn-polar or the O-polar ZnO region. The possible mechanisms will be discussed with the consideration of the atomic configuration, carrier life time, and geometrical effects. The successful realization of PPI structures with nanometer scale period indicates the possibility for the application to the photonic band-gap structures or waveguide fabrication. The details of application and results will be discussed.

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