Backscattering analysis of ZnO/MgO superlattices grown by PA-MBE

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Interesting physical properties of zinc oxide, like transparency throughout the entire visible range of wavelengths and in UV have attracted interest toward application of ZnO to light emitters, ultraviolet UV sensors, and transparent thin-film transistors. Solid solution of ZnO with MgO, random $Mg_xZn_{1-x}O$ alloys, having larger band gap with the possibility of tuning is expected to improve the efficiency of UV or blue light emitting devices. Unfortunately, $Mg_xZn_{1-x}O$ alloys for Mg content beyond 45% have a tendency to form a metastable material and $Mg_xZn_{1-x}O$ films segregate to hexagonal and cubic phases. This is due to the different crystallographic structures of ZnO and MgO. Wurtzite MgO does not exist in nature despite the small difference (0.1%) in the bond length of Zn-O and Mg-O. Because of the higher ionicity of the Mg-O bond the octahedral co-ordination of Mg is more favorable than the tetrahedral one. Segregation of different phases reduces the conductivity and mobility of charge carriers and also luminescence efficiency. Therefore, the steps towards preserving the wurtzite structure of high-Mg ZnMgO alloys are necessary. As manipulating with growth parameters during deposition of ZnMgO alloy can be not enough some other approach is desired.

Another way to make MgZnO alloys with high Mg content is to grow structures in which ZnO and MgO layers are deposited sequentially creating a superlattice (SL), or another words – to create artificial ordered alloys instead of random ones.

In this work we present Rutherford backscattering and channeling studies of ZnO/MgO short period superlattices grown on crystalline ZnO substrates. All structures were growth with Molecular Beam Epitaxy. ZnO and MgO layers were deposited sequentially and their thickness was controlled by the growth time. The structures were composed of 30 - 80 pairs of ZnO/MgO thin layers. Channeling measurement revealed that in the case of the thinnest MgO layers the growth of superlattices was coherent, as χ_{min} of the backscattering yield for the superlattice is the same as for ZnO substrate. Angular scans across off-normal axis were measured to determine strain in the structures. Transmission Electron Microscope imaging was performed to confirm which structure – superlattice or alloy was obtained during the growth.

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