Spatial distribution of strain and Mg composition in $Mg_xZn_{1-x}O$ layers on *a*-plane sapphire examined by high-resolution x-ray diffraction

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We have studied the influence of the magnesium doping on strain distribution in the $Mg_xZn_{1-x}O$ layers on *a*-plane sapphire substrate grown by molecular beam epitaxy. The main technique to examine this effect was high-resolution x-ray diffraction (HR-XRD). The estimation of Mg concentration in $Mg_xZn_{1-x}O$ layers on *a*-plane sapphire substrate is not obvious. We assume the linear dependence of Mg level for lattice parameters. The calculation of Mg concentration is difficult because of no existence of wurzite-MgO. To accurate determination of relaxed lattice parameters of $Mg_xZn_{1-x}O$ layers we need to know the lattice parameters and Poisson ratio of wurzite-MgO. Therefore we use the results of Mg composition from energy dispersive X-ray spectroscopy and Rutherford backscattering spectrometry. For the small amount of Mg content ($0 < x \leq 0.1$) the results obtained from these three techniques are in agreement. The optimization of wurzite-MgO lattice parameters is crucial for determination of $Mg_xZn_{1-x}O$ structural behavior. Taking into account the information obtained for the above considerations, we can investigate the strain distribution in $Mg_xZn_{1-x}O$ layers on *a*-plane sapphire substrate. We observe the gradual gain of strain with the increase of Mg content in $Mg_xZn_{1-x}O$ layer. The examination of lattice parameters shows that the $Mg_xZn_{1-x}O$ layers are biaxially strained on a-plane sapphire. The values of lateral coherence length obtain from HR-XRD is the smallest for sample with the highest content.

Acknowledgements: The project was supported by the Polish National Science Centre (NCN) based on the decision No: DEC-2013/09/D/ST5/03881.