Investigations of ZnO/$Mg_xZn_{1-x}O$ double quantum wells grown on m- plane ZnO substrates

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ZnO-based heterostructures are promising candidates for application in blue and UV light-emitting devices. A large exciton binding energy of 60 meV permits excitonic recombination well above room temperature, making ZnO and ZnO/ZnMgO quantum structures particularly promising for future optoelectronics. Sapphire and silicon are typical substrates for growth of ZnO/ZnMgO structures, however, the large lattice mismatch between ZnO and Al_2O_3 or Si substrates is an inevitable difficulty for the growth of the high quality ZnO-based structures. Using crystalline ZnO as substrate allows for bypassing the mismatch issue, as good quality differently oriented crystalline ZnO substrates are commercially available.

In this work we present studies of double well quantum structures of ZnO/ZnMgO with Mg contents up to 22% grown on non-polar m-side crystalline ZnO by MBE. Measurements of temperature dependence of photoluminescence (PL) and decay times of PL from quantum wells were performed. Cross-sectional Scanning Electron Microscopy (SEM) and low temperature cathodoluminescence (SEM-CL) imaging was employed in order to find out where particular emissions come from: from the ZnMgO barrier or the quantum wells. The PL experiments allowed to determine the energies of the localized excitons in the quantum wells as well as binding energies of free exciton in the QWs. It is shown that localization energies of excitons may reach up to 100 meV. Measurements of decay kinetics showed that decay time of free exciton PL increases with temperature, which allows to conclude that recombination of free excitons in QWs is purely radiative, which stands in agreement with theoretical description proposed by Feldman et al. [1]. On the other hand, analysis of the decay time of localized excitons suggests that at temperatures above 50K recombination is governed by non-radiative processes. At room temperature the emission from QWs dominates the PL spectra which suggests that optical devices based on excitonic emission from QWs are feasible.

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[1] J. Feldman, G. Peter, E.O. Goebel, et al., Phys, Rev. Lett., **59**, 20 (1987)