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Optical transition dynamics in ZnO/ZnMgO multiple quantum well structures with different well widths grown on ZnO substrates

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ZnO is a promising material for the application of high efficiency light emitting diodes with short wavelength region for its large bandgap energy of 3.37 eV which is similar to GaN (3.39 eV) at room temperature. The large exciton binding energy of 60 meV in ZnO provide provides higher efficiency of emission for optoelectronic device applications. Several ZnO/ZnMgO multiple quantum well (MQW) structures have been grown on various substrates such as sapphire, GaN, Si, and so on. However, the achievement of high quality ZnO/ZnMgO MQW structures has been somehow limited by the use of lattice-mismatched substrates. Therefore, we propose the optical properties of ZnO/ZnMgO multiple quantum well (MQW) structures with different well widths grown on lattice-matched ZnO substrates by molecular beam epitaxy. Photoluminescence (PL) spectra show MQW emissions at 3.387 and 3.369 eV for the ZnO/ZnMgO MQW samples with well widths of 2 and 5 nm, respectively, due to the quantum confinement effect. Time-resolved PL results show an efficient photo-generated carrier transfer from the barrier to the MQWs, which leads to an increased intensity ratio of the well to barrier emissions for the ZnO/ZnMgO MQW sample with the wider width. From the power-dependent PL spectra, we observed no PL peak shift of MQW emission in both samples, indicating a negligible built-in electric field effect in the ZnO/$Zn_{0.9}Mg_{0.1}O$ MQWs grown on lattice-matched ZnO substrates.