

Realization of Quantum Size Effects in Rocksalt-Structured MgZnO/MgO Multiple Quantum Wells Grown by Mist CVD

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Rocksalt (RS)-structured MgZnO alloys have ultrawide bandgap energies up to 7.7 eV [1]. Our group has grown RS-MgZnO epitaxial films by the mist chemical vapor deposition (mist CVD) method. Observation of near-band-edge cathodoluminescence (CL) peak at 187 nm at 300 K [2] paves a way for vacuum ultraviolet light source application. We have developed an alternating precursor supply system [3] to fabricate RS-MgZnO/MgO multiple quantum well (MQW) structures [4]. The MQWs showed smooth surfaces comparable to single layers, and excellent interface flatness and periodicity were confirmed. Present study reports on well thickness dependence to discuss quantum size effects.

Magnesium acetate tetrahydrate and zinc acetate dihydrate were used as metal-organic precursors. The Mg molar fraction in source solution was fixed at 0.86. A mixed solvent of deionized water and acetic acid with a volume ratio of 4:1 was used. All layers were grown at 720°C with O₂ carrier and dilution gas flow rates of 4.0 slm and 0.5 slm, respectively. 20-period MQW structures were grown by fixing the barrier thickness of 10 nm, and by varying the nominal well thicknesses as 0.5, 1, and 3 nm.

As shown in Fig. 1, MQWs show atomically-flat surface morphology with root mean square (RMS) roughness of less than 1 nm. Figure 2 shows CL spectra at 300 K. The spectrum for the RS-Mg_{0.85}Zn_{0.15}O single-layer film [5] is also shown for comparison. As indicated by the solid symbols, CL peak energy exhibited a distinct blueshift by thinning the well layer thickness. The blueshift is well reproduced by 1D Poisson–Schrödinger calculation [6]. The results indicate the presence of the quantum size effects.

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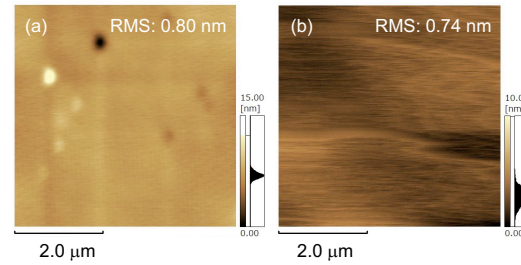


Fig. 1. Surface AFM images of RS-MgZnO/MgO MQWs with nominal well layer thicknesses of (a) 1 nm and (b) 3 nm.

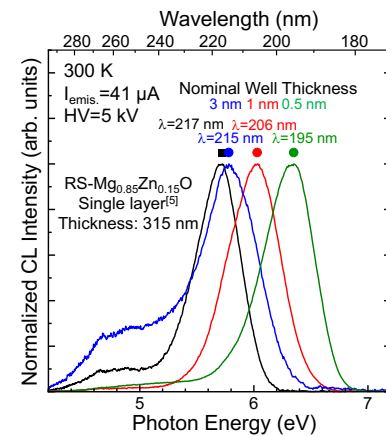


Fig. 2. CL spectra at 300 K for MQWs and RS-Mg_{0.85}Zn_{0.15}O single layer film [5]. Solid symbols indicate CL peak positions.

Supplementary Pages (Optional)

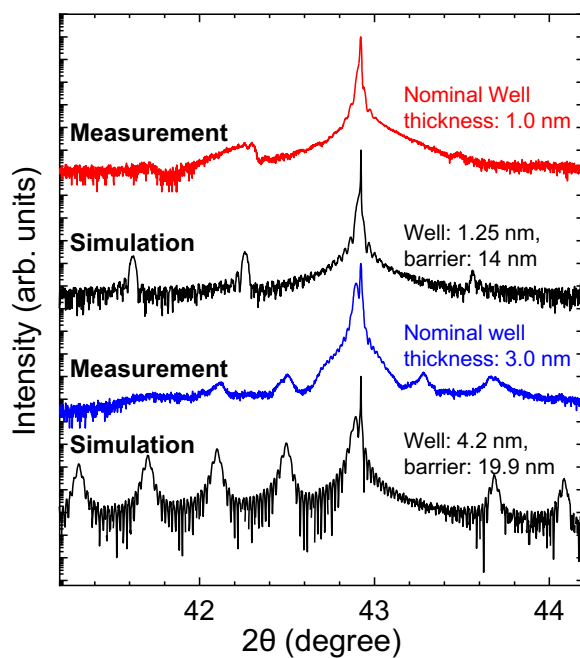


Fig. S1. Measured and simulated XRD θ -2 θ patterns of 20-period RS-Mg_{0.85}Zn_{0.15}O/MgO MQWs.

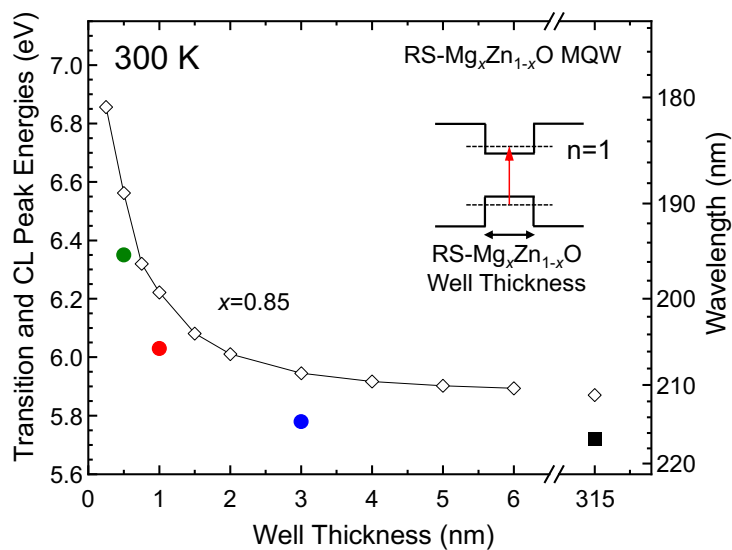


Fig. S2. CL peak energies of MQWs at 300 K as a function of well thickness. The solid line indicates the transition energy calculated by using 1D Poisson-Schrödinger solver [6].