Realization of smooth surface and interface in Mist CVD growth of rocksalt structured-MgZnO/MgO MQWs

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Rocksalt (RS) structured-$Mg_xZn_{1-x}O$ alloys have bandgap energies ranging from 2.45 to 7.78 eV [1,2]. They are candidate materials for deep and vacuum ultraviolet light emitters. Our group has grown atomically flat single-crystalline RS-$Mg_xZn_{1-x}O$ films on (100) MgO substrates using the mist chemical vapor deposition (mist CVD) method [3]. The CL spectra at 300 K exhibited the shortest near-band-edge emission peak at 187 nm. The RS-$Mg_xZn_{1-x}O$/MgO for $x \geq 0.6$ was confirmed to have type-I band alignment by the X-ray photoelectron spectroscopy measurements [4]. This study reports on growths of RS-$Mg_xZn_{1-x}O$/MgO multiple quantum well (MQW) structures by the mist CVD method.

RS-$Mg_xZn_{1-x}O$/MgO MQW structures were grown on (100) MgO substrates at 725°C. Magnesium acetate tetrahydrate and zinc acetate dihydrate were used as source precursors. The x in the well layer was controlled by molar ratio of magnesium ($[Mg]^L = [Mg]/([Mg]+[Zn])$) in the source solution. The structure consisted of a 30-nm-thick MgO cap layer, 10 periods of MQW composed of 3-nm-thick RS-$Mg_{0.73}Zn_{0.27}O$ well and 10-nm-thick MgO barrier, and a 200-nm-thick MgO buffer layer.

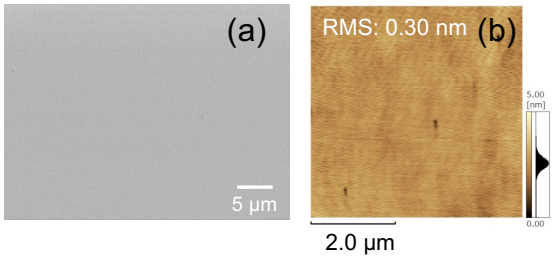

Fig. 1. (a) Surface FE-SEM and (b) AFM images of RS-$Mg_{0.73}Zn_{0.27}O$/MgO MQW grown on MgO (100) substrate.

As shown in Fig. 1, the structure exhibited atomically-flat smooth surface morphology with root mean square (RMS) roughness of 0.30 nm. The value is comparable to those obtained for the RS-$Mg_xZn_{1-x}O$ single layers [3]. As shown in Fig. 2, distinct observation of the +1st, 0th, -1st, and -2nd order satellite peaks implies realization of excellent interface flatness and periodicity. Furthermore, cross-sectional STEM image showed a well-defined layered structure with abrupt interfaces.

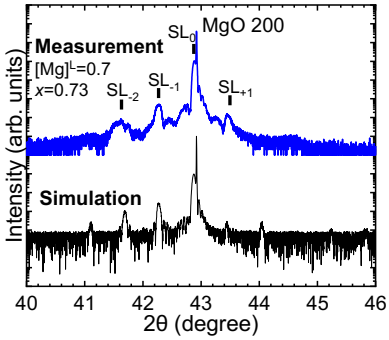

Fig. 2. Measured and simulated X-ray diffraction θ-2θ patterns near 200 diffraction peaks.

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Supplementary Pages (Optional)

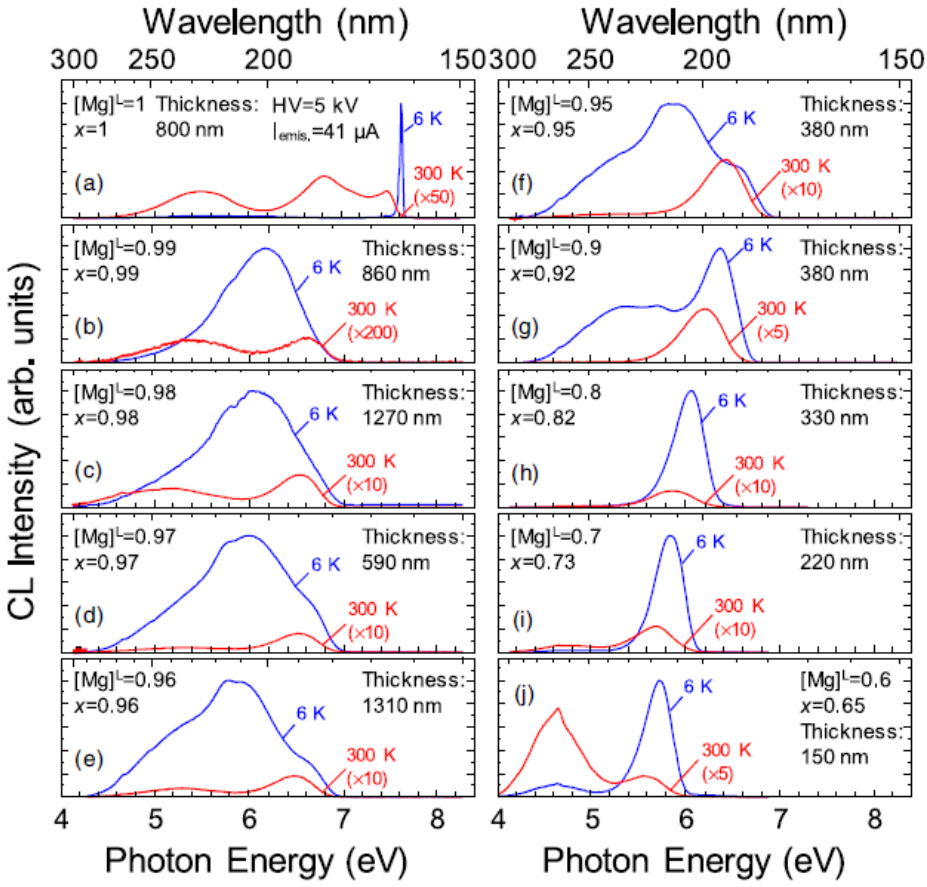

Fig. S1. CL spectra at 6 and 300 K of RS-$Mg_xZn_{1-x}O$ films grown on MgO substrates by the mist CVD method. As shown in (b), the spectrum of RS-$Mg_{0.99}Zn_{0.01}O$ at 300 K exhibited the shortest near-band-edge emission peak at 187 nm [3].