Relation between Absorption Edge and Exciton Transition in Rocksalt-structured MgZnO Films

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Rock-salt structured magnesium zinc oxide (RS-MgZnO) has been attracting attention as one of the ultra-wide bandgap semiconductors for emitters in the vacuum ultraviolet region. While the bandgap engineering is possible in the range of 2.45 to 7.78 eV, the shortest emission wavelength at room temperature remains at 6.63 eV (187 nm) even increasing the MgO molar fraction x up to 99%. Therefore, to get an insight into a way for shortening the emission wavelength, photoluminescence (PL) and photoluminescence excitation (PLE) spectra are comparatively shown in this study. RS-MgZnO films with x from 0.99 to 0.65 were grown on MgO (100) substrates by the mist chemical vapor deposition method. The atomic force microscopy images showed atomically-flat smooth surface morphology. The PL spectra at low temperature exhibited peak and shoulders associated with near-band-edge (NBE) emission and II-group vacancy or Al impurity-related trapped-hole centers. By setting the detection wavelength at the NBE emission, the PLE spectra revealed a peak at the excitonic transition energy along with a tail extending to lower energy. The PL spectra eventually showed the NBE emission at the lower-energy edge of the tail states. The results suggest that suppressing the trapped-hole centers as well as formation of the tail states are crucial for shortening the emission wavelength.