Photoluminescence of Zirconia's Films with VUV Excitation

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Using synchrotron radistion as a source of VUV excitation, we examined the phoyoluminescence (PL) of zrconia (ZrO_2) films prepared from zirconia's propoxide by the sol-gel method at high temperature. XRD results reveal that ZrO_2 films exhibit tetragonal, a mixture of tetragonal and monoclinic, and monoclinic phases at heating temperatures of 700, 900, 1100℃, respectively. Upon VUV excitation, PL of a ZrO_2 film in the tetragonal phase has a maximum at 390 nm, for which excitation is most efficient at 164 nm, near the energy gap of the tetragonal phase. PL emission in the monoclinic phase is characterized by a distinctive band at 475 nm, for which excitation is most efficient at 235 nm, near the energy gap of the monoclinic phase.

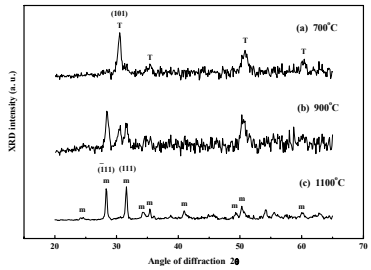

Figure 1(a) shows a XRD pattern of a film prepared at 700℃; the result indicates that at a sintering temperature 700℃ most ZrO_2 thin films crystallize to ZrO_2/Tetragonal. Whwn the thin film was formed at 1100℃, the patterm showning in Fig. 1(c) indicates a ZrO_2/Monoclinic structure. Figure 1(b) depicts the pattern of a thin film prepared at 900℃, this material is a mixture of ZrO_2/Tetragonal and ZrO_2/Monoclinic.

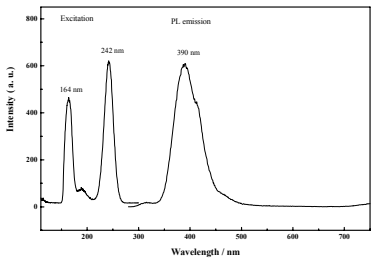

Figure 2 displays excitation and PL spectra obtained for a ZrO_2/Tetragonal film that was sampled at 700℃. The PL spectrum of this film exhibits a maximum at 390 nm, a shoulder at 415 nm, and two weak satellite features at 315 and 467 nm. Monitoring of the 390-nm emission band revealed that excitation at both 164 and 242 nm produced a large intensity. The observed 164-nm excitation band corresponds to an energy 7.56 eV, which is associated with the energy gap of the tetragonal ZrO_2 phase.

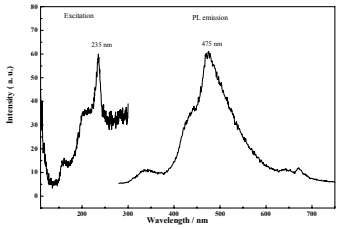

Figure 3 shows excitation and PL spectra of a ZrO_2/Monoclinic film prepared at 1100℃. The PL spectrum with excitation at 235 nm exhibits a maximum at 475 nm. Monitoring the emission at 475 nm reveals a strong excitation band at 235 nm. The energy gap of the monoclinic ZrO_2 is reported to be around 5.42 eV. The observed 235 nm excitation band corresponds to an energy 5.28 eV, near the energy gap of the ZrO_2 at monoclinic phase.

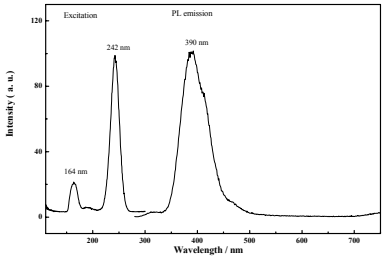

Figure 4 shows excitation and PL spectra for this film, which are similar to those of the ZrO_2/Trtragonal film. These spectra are thus associated with the tetragonal phase, but the ratio of excitation intensities at 164 and 242 nm is only ~0.20. A decreased proportion of the tetragonal phase in the ZrO_2/T+M film hence decreases the intensity of PL on excitation at 164 nm.The observed 164-nm excitation band corresponds to an energy 7.56 eV, which is associated with the energy gap of the tetragonal ZrO_2 phase.