씨앗층의 후-열처리가 산화아연 나노구조의 구조적 광학적 성질에 미치는 영향

Effects of post-annealing ZnO seed layers on structural and optical properties of ZnO nanostructures

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초 록 : ZnO nanostructures were grown by the hydrothermal method on ZnO seed layers post-heated in the range 350–500 ° C. The effects of the post-heated ZnO seed layers on the structural and optical properties of the ZnO nanostructures were investigated by scanning electron microscopy (SEM), X-ray diffraction (XRD) spectroscopy, and photoluminescence (PL) spectroscopy. The average grain sizes in the ZnO seed layers increased with increasing post-heating temperature, and nano-fibrous structures were observed on the surface of the ZnO seed layers post-heated at 450 ° C. The ZnO seed layers post-heated in the range 350–500 ° C affected the residual stress, lattice distortion in the ZnO nanostructures and the intensity, positions, and full widths at half maximum of the 2-theta and PL peaks in the XRD and PL spectra for the ZnO nanostructures.

1. 서론

ZnO has attracted considerable attention, because it exhibits a hexagonal wurtzite structure with a direct wide band gap of 3.37 eV and a large exciton binding energy of 60 meV at room temperature (RT). Therefore, it is a promising material for short-wavelength optoelectronic devices, such as short-wavelength light-emitting diodes, RT ultraviolet (UV)-lasing diodes, solar cells, and piezoelectric and optoelectronic devices. Because of the excellent optical characteristics and good electrical performance of ZnO, the growth and characterization of ZnO nanostructures are expected to become important areas of study for applications of ZnO nanostructures in various technologies. In this study, the ZnO seed layers were prepared using sol-gel spin-coating on Si (100) substrates. The seed layers were post-heated at 350, 400, 450, and 500 ° C and then the ZnO nanostructures were grown using the hydrothermal method on the post-heated ZnO seed layers. The effects of the post-heat-treatment of seed layers on the structural and optical properties of the ZnO nanostructures were investigated.

2. 본론

Figure 1 (a)–(d) show SEM images of the ZnO seed layers post-heated at (a) 350, (b) 400, (c) 450, and (d) 500 ° C, and Figs. 1 (e)–(h) show SEM images of the corresponding ZnO nanostructures grown on them. Remarkably grain size of all the ZnO seed layers except those post-heated at 450 ° C increased with increasing post-heating temperature: The surface of the ZnO seed layers post-heated at 450 ° C exhibit nano-fibrous structures. In general, the change in the surface morphology might be due to crystal reconstruction during post heating at relatively high temperatures, which provides sufficient thermal energy for the atoms and molecules to migrate throughout the crystal structures. Therefore, the molecules in the ZnO seed layers can merge together between similar crystalline phases. From Figs. 1 (e)–(h), it is clear that the various morphologies of ZnO nanostructures depend on the morphologies of the ZnO seed layers. Except for the grain sizes in the nanostructures grown on the ZnO seed layers post-heated at 450 ° C, the grain sizes in the other nanostructures increased and the surface morphologies of the nanostructures changed with increasing ZnO seed layer grain size.

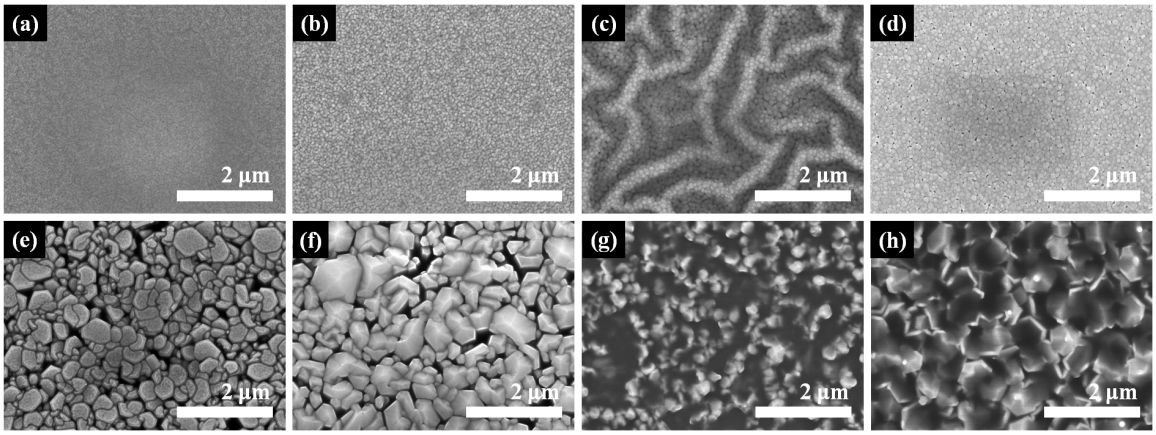

Fig. 1. SEM images of ZnO seed layers post-heated at (a) 350, (b) 400, (c) 450, and (d) 500 ° C and (e)-(h) those of corresponding ZnO nanostructures grown on them.

3. 결론

ZnO nanostructures were grown using the hydrothermal method on ZnO seed layers post-heated in the temperature range 350-500 ° C. The effects of the ZnO seed layers post-heating temperatures on the structural and optical properties on the ZnO nanostructures were investigated. The grain size increased with increasing ZnO seed layer post-heating temperature, and in particular, the surface morphology of the ZnO nanostructures grown on the ZnO seed layers post-heated at 450 ° C was changed. In addition, the stress and lattice constants for the ZnO nanostructures grown on the ZnO seed layers post-heated at 450 ° C were the closest to those observed for strain-free ZnO, and the NBE peak became dominant and exhibited the smallest FWHM. Hence, the ZnO seed layers post-heated at various temperatures affected the structural and optical properties of the ZnO nanostructures, and the crystallinity of the ZnO nanostructures grown on the ZnO seed layers post-heated at 450 ° C was observed to be the best.

참고문헌

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