가스 유입량이 기상이동법으로 금 나노박막위에 성장된 산화아연 입자에 미치는 영향

Influence of gas flow on structural and optical properties of ZnO submicron particles grown on Au nano thin films by vapor phase transport

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초 록: ZnO submicron particles were grown on Au-catalyzed Si substrate by a vapor phase transport (VPT) growth process under different mixture gas ratio at growth temperature of 900°C. The structural and optical properties of the ZnO submicron particles were investigated by field-emission scanning electron microscopy (FE-SEM), X-ray diffraction (XRD), and photoluminescence (PL). The ZnO submicron particles could be clustered with the O_2/Ar mixture gas ratio(%) higher than 10%, and it was mainly determined by the gas ambient. Particularly, when the O_2/Ar mixture gas ratio was 30%, it was observed the ZnO submicron particles with diameters in the range of 125 to 500 nm and the narrowest full width at half maximum (FWHM) of XRD and PL spectra with 0.121° and 92 meV, respectively. It was found that the structural and optical properties of the ZnO submicron particles were improved with increasing the O_2/Ar mixture gas ratio through the XRD and PL spectra.

1. 서론

Zinc oxide (ZnO) is wide band gap (3.37 eV) II-VI semiconductor with a hexagonal wurtzite structure and a large exciton binding energy of 60 meV. ZnO has attracted much attention due to a number of advantages it presents in comparison with GaN for example, e.g., larger excition binding energy, availability of large are a substrates for homoepitaxy etc. And also, ZnO is potential suite of oxide-based candidate materials suitable for UV/blue light-emitting devices such as short wavelength light-emitting diodes in optoelectronics devices of nanoscale dimensions, owing to its direct wide band gap. The ZnO has been prepared by several techniques, such as pulsed laser deposition (PLD), atomic layer deposition(ALD), radio frequency(RF) magnetron sputtering, plasma-assisted molecular beam epitaxy(PA-MBE), chemical vapor deposition(CVD), and vapor phase transport(VPT). Among these techniques, the VPT method has been demonstrated to be a facile method because of its own advantages, including simple apparatus requirement and controllable synthesis. And also, although a number of growing methods have been reported on the preparation of ZnO particles, the preparation of ZnO particles by VPT has been less investigated. In a previous study, we demonstrated the optical properties of ZnO submicron particles grown by VPT. We found that the excitonic properties of the ZnO submicron particles grown on sol-gel spin-coated ZnO seed layers had bulk-like characteristics instead of a nanocrystalline structure. But, in this study, we used the Au-catalyst layer on Si substrate in place of sol-gel spin-coated ZnO seed layers to study the structural and optical properties of the ZnO submicron particles. The ZnO submicron particles were synthesized on Au-catalyzed Si substrate by VPT, using a mixture of ZnO and graphite powders as source material under the various O_2/Ar mixture gas ratio.

2. 본론

Figure 1 shows the RT PL spectra of the ZnO submicron particles. And the inset shows the intensity of the

near-band-edge (NBE) peaks. All cases showed NBE emission, which were generated by the free-exciton recombination at about 3.26 eV. The cases of 20 and 30% O_2/Ar mixture gas ratio showed dominant NBE peak and the intensity of NBE peak increased with increasing the O_2/Ar mixture gas ratio(i.e.10~30%). Except for 30% O_2/Ar mixture gas ratio, the broad deep level emission(DLE) were showed at about 2.96 eV(blueemission), which are usually attributed to the lattice defects related to oxygen vacancy(V_o). As the O_2/Ar mixture gas ratio was increased, the broad DLE peak gradually disappeared. It was mean that the defects (i.e. origin of DLE) were decreased with increasing the O_2/Ar mixture gas ratio in the ZnO submicron particles. And the NBE peak also gradually enhanced with increasing the O_2/Ar mixture gas ratio. Particularly, for 30% O_2/Ar mixture gas ratio, the NBE peak was very strong because it was grown in the miniature tube where O_2 was rich (i.e. the narrow and one sealed tube reactor could provide sufficient O_2 for growing the ZnO submicron particles.).

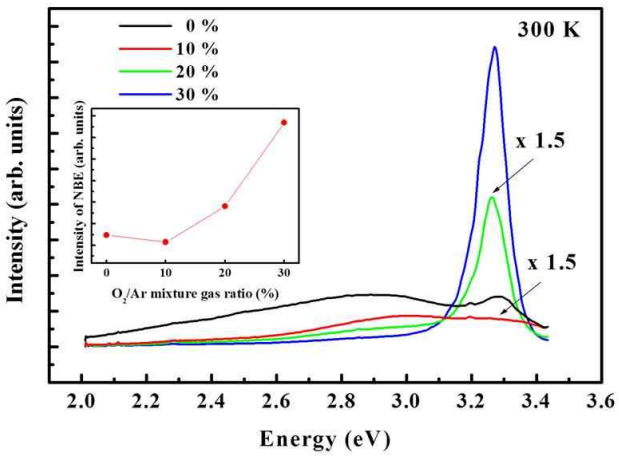

Fig. 1. The RT spectra of the ZnO submicron particles. And the inset shows the intensity of the near-band-edge (NBE) peaks.

3. 결론

ZnO submicron particles have been synthesized on Au-catalyzed Si substrate with various ratio of mixture gas, 0, 10, 20, and 30% O_2/Ar mixture gas ratio, at growth temperature of 900 ℃ by a VPT growth process using a double-tube reactor configuration. The ZnO submicron particles exhibit different morphologies, such as hexahedral and round-plate shape and their grain size in the range of 125 to 500 nm. ZnO submicron particles can be clustered with the O_2/Ar mixture gas ratio(%) higher than10%, and it is mainly determined by the gas ambient. It is found that the structural and optical properties of ZnO submicron particles were improved with increasing the O_2/Ar mixture gas ratio through the XRD and PL spectra. Particularly, when the O_2/Ar mixture gas ratio was 30%, it was observed the narrowest FWHM of X-ray diffraction and photoluminescence spectra with 0.121° and 92 meV, respectively. And also, the PL intensity ratio of the samples increased from 0.458 at 10% to 37.97 at 30% with increasing the O_2/Ar mixture gas ratio. Hence, the ZnO submicron particles with high crystallinity were obtained when the O_2/Ar mixture gas ratio was 30%.

참고문헌

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