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Synthesis of nanostructure ZnO thin film by magnetron sputtering under parallel confined magnetic field at low temperature

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Zinc oxide (ZnO) thin film is prepared on polymer and glass substrate by a planar magnetron sputtering system with facing magnetic field in which magnetic fields are confinedplasma between the targets. Magnetic field is varied by distant control between facing magnets. The substrate is placed outside the confined plasma region for preventing heat radiation from the heated target surface to the substrate and energetic particles such as Zn,O atoms bombarding in a primarily normal direction to the target surface. In addition, the film bombardment by energetic sputtered particles can be avoided to prevent the damage of polymer substrate. The film is successfully synthesized without any damage of polymer at low temperature less than 90℃. The electrical and optical properties of ZnO film are investigated using sheet resistance meter and UV-visible spectroscopy, respectively. In addition, XRD analysis reveals that partial pressure of O_2 and H_2 affects the crystal orientation and microstructure of the ZnO thin films. The sputtering gas composition is observed to be an important controlfactorto determine the structural properties of the ZnO films. The film structure change with plasma parameteris analysizedby monitoring with an optical emission spectroscopy. The grain size increases from 17.5 nm to 20.5 nm as increasing oxygen flow rate, because the oxygen vacancy concentration decreased. In addition, the grain size increases from 18.0 nm to 20.5 nm with hydrogen flow rate change at same film thickness. An oxygen vacancy is supposed todonate two free electrons for conduction, but highly oxygen deficient films show reduced optical transmittance from 86% to 57%, lower optical band gap from 3.37 to 3.11 eV. The transmittance of the films is controlled with optimization of oxygen and hydrogen flow rate. The paper discusses on behavior of ZnO film with various properties by control of process parameters in confined magnetron sputtering discharge at very low temperature less than70℃.

Keywords
ZnO film
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