Structural and optical properties of Yb-doped ZnO films deposited by magnetron reactive sputtering for photon conversion

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In this work we investigate the structural and electrical properties of Yb-doped ZnO films deposited by magnetron reactive sputtering from a Zn target. The main purpose is to study the electronic charge transfer between ZnO and the rare earth (RE) Yb for photon shifting and possible application for silicon based solar cells. In fact, RE are well known for their optical transitions involving the 4f shell. In particular, we are interested in RE emitting in the region between 500 and 1000 nm, where the spectral response of the solar cell is high. Trivalent Ytterbium ions Yb⁺³ exhibit luminescence at 980 nm, just above the band gap of silicon. The Yb-ZnO films were characterized by structural (XRD, RBS) and optical (Ellipsometry, photoluminescence) tools and techniques.

The XRD measurements of the as-grown Yb-doped ZnO films show a strong preferential orientation along the [002] direction, even when the substrate temperature during deposition is as low as 15°C. Rutherford back scattering (RBS) measurements show that Yb is uniformly distributed inside the ZnO matrix. Photoluminescence measurements show an intense peak at 980 nm even in as-deposited films. Both ZnO- and Yb-related PL increase after annealing at 700°C.