11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Influence of the grain size in the improvement of the crystalline quality of epitaxial $Zn_{0.9}Mn_{0.1}O$ thin films grown by pulsed laser deposition.

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Abstract – $Zn_{0.9-x}Mn_{0.1}$ thin films were prepared by pulsed laser deposition (PLD) on (0001)-oriented sapphire substrates. The polymeric precursor method was used to synthesize the powders constituting the ablation targets. $Zn_{0.9-x}Mn_{0.1}$ films ablated from these targets showed excellent epitaxial growth with a full-width at half-maximum (FWHM) ~ 0.07°. Interestingly, the $Zn_{0.9-x}Mn_{0.1}$ films displayed well defined hysteresis magnetic at room temperature which would point out to the presence of ferromagnetic order in the compound. Probably, the cleanliness offered by the polymeric precursor method to prepare ceramic-type polycrystalline compounds with nonometric particle size plays an important role in the crystalline quality of the films.

Pulsed laser deposition PLD is a method that allows for growing thin films up to several thousand angstroms thick [1]. A PLD system uses short laser pulses to vaporize a target material to be deposited as thin films on a substrate. Short laser pulses offer the advantage of congruent evaporation asserting thus that stoichiometry is preserved during mass transfer from the target to the substrate. In spite of the facility to grow thin films by PLD, the theoretical aspects of the process are not fully understood. Certainly, the interaction between the incident laser and target material is quite complex. Theoretical calculations have predicted for the possibility of ferromagnetic phenomenon in transition metal (TM)-doped ZnO even at room temperature [2,3]. Because ZnO also has well-known piezoelectric and electro-optic properties, the incorporation of ferromagnetism in ZnO can lead to a variety of new multifunctional phenomena. However, this prediction is confirmed only in several groups based on their measurements of magnetic properties for TM-doped ZnO thin film samples [4]. The controversial results seem to come from either the low quality or the poor reproducibility of thin film. Here, it is necessary to investigate the factors of growth parameters that enhance ferromagnetic ordering in Mn–Zn–O systems. In thiswork, PLD was used to grow $Zn_{0.9}Mn_{0.1}O$ thin films on (0001)-oriented saphire substrates. The ZnO targets were prepared by pressing powders synthesised by polymeric precursor method. It seems that the nanometric character of the powders plays an important role in the improvement of the crystalline quality of the films ablated from these targets.The films were characterized after their structural, morphological, optical and magnetic properties. X-ray diffraction analysis showed excellent crystallinity with an FWHM ~ 0.07°. SQUID measurements displayed well defined magnetic hysteresis at room temperature.

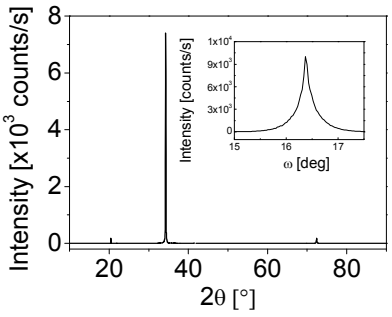

Figure 1: XRD pattern of a $Zn_{0.9}Mn_{0.1}O$ film deposited on an Al_2O_3 substrate by PLD. Inset: ω-scan of the same film.

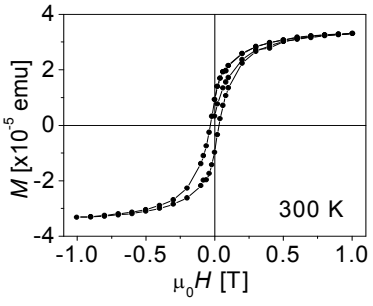

Figure 2: Hysteresis loop measured on a $Zn_{0.9}Mn_{0.1}O$ film on Al_2O_3 substrate at 300 K.

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