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Giant magneto-resistance in epitaxial $(La_{0.7}Sr_{0.3}MnO_3)_{0.5}$: $(ZnO)_{0.5}$ nanocomposites

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Introduction

A great deal of research has been carried out in oxide material systems [1]. Among them, ZnO and $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) are of particular interest due to their superb optical properties and colossal magneto-resistive effect. Here, we report our recent results of magneto-transport studies in self-assembled, epitaxial $(ZnO)_{0.5}$:$(La_{0.7}Sr_{0.3}MnO_3)_{0.5}$ nanocomposite films [1].

Experimental

The epitaxial LSMO (70%)-ZnO (30%) phase-separated nanocomposites were prepared by rf magnetron sputtering on (001) $LaAlO_3$ single crystalline substrates. Electronic measurements of the transport properties were performed in a VTI cryostat in SCM2. Silver epoxy was used for making ohmic contacts to our oxide nanostructure samples.

Results and Discussion

The epitaxial LSMO (70%)-ZnO (30%) phase-separated nanocomposites were prepared by rf magnetron sputtering on (001) $LaAlO_3$ single crystalline substrates. X-ray diffraction analysis showed that the LSMO phase was cube-on-cube epitaxial on the substrate and the ZnO phase possessed a 11-20 texture. AC-STEM imaging and EDS chemical mapping were used to characterize these ZnO/LSMO composite films. Compositional analysis indicates mutual solubility between ZnO and LSMO, and compositional variation across the ZnO/LSMO interfaces. In our magneto-transport studies, a giant negative magneto-resistance was observed at low temperatures and high magnetic fields, reaching almost 700% at a magnetic field of 5 Tesla at 70K. This giant magneto-resistance decreases with increasing temperatures, to ~ 15% at 200K. We believe that this giant magneto-resistance is related to multiple-orientated ZnO pillars and a tree-alike 3D morphology in our ZnO/LSMO nanocomposites.

Conclusions

Our results show that epitaxial $(La_{0.7}Sr_{0.3}MnO_3)_{0.5}$: $(ZnO)_{0.5}$ nanocomposites are promising candidates for giant magneto-resistance applications, and may have import implications in spin transport properties in our ZnO/LSMO composite films.

Acknowledgements

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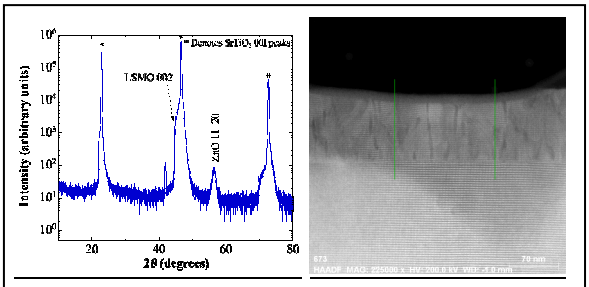
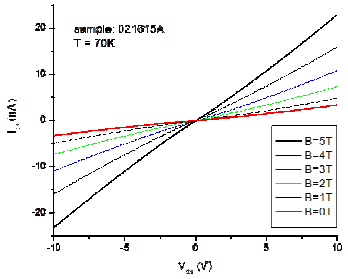
References

[1] J. Mannhart and D.G. Schlom, Science **327**, 1607 (2010).



Left: XRD results for a 100 nm thick film on 001-oriented SrTiO3. * denotes the 001-SrTiO3 peaks. Distinct LSMO and ZnO peaks are also shown.
Right: AC-STEM imaging is used to characterize the ZnO/LSMO composite films grown on STO and LAO substrates. The results show that the ZnO/LSMO films can be grown epitaxially on both substrates but microstructures of the films are highly dependent of the substrate used, and overall film composition, and growth temperatures.



Magneto-resistance measurements in one film of 70%LSMO and 30%ZnO prepared on (001) LAO substrate. A giant magneto-resistance was observed.