DIRECTIONALLY DEPENDENT MAGNETO-OPTICAL RESPONSE OF $(La_{0.4}Pr_{0.6})_{1.2}Sr_{1.8}Mn_2O_7$: UNDERSTANDING THE HIGH FIELD FERROMAGNETIC STATE

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Introduction

Chemical substitution is a valuable tool for the preparation of manganites with tunable physical properties. Here, we concentrate on the directional aspects of electronic structure changes that accompany the field-induced paramagnetic semiconducting to ferromagnetic metallic transition in the substituted double-layer compound $La_{1.2}Sr_{1.8}Mn_2O_7$.

Experimental

Polarized magneto-optical experiments were carried out at 4.2 K. The single-domain character of the tetragonal crystals allowed us to asses the directional aspects of this effect.

Results and Discussion

Figure 1 displays the magneto-optical response of $La_{1.2}Sr_{1.8}Mn_2O_7$ at 4.2 K. The strong electronic structure changes are attributed to modifications of the Jahn-Teller split Mn^{3+} d (e_g) orbitals. Domain reorientation takes place over a much large energy scale for H ⊥ c than for H || c, as evidenced by the size of the color change hysteresis effects. Based upon the strong similarity between the H ⊥ c data in the two different polarizations, we find that the high-field state of Pr-substituted $La_{1.2}Sr_{1.8}Mn_2O_7$ is homogeneous, at least from an optical properties point of view.

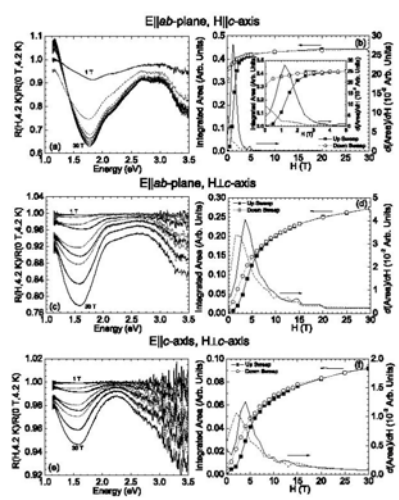

Figure 1: Reflectance ratio spectra and integrated area vs. field data of $La_{1.2}Sr_{1.8}Mn_2O_7$ at 4.2 K for several different polarizations and magnetic field directions. The magneto-optical response displays a substantial memory effect at this temperature, as evidenced by the large hysteresis effects.

Conclusions

We investigated the anisotropic magneto-optical response of $(La_{0.4}Pr_{0.6})_{1.2}Sr_{1.8}Mn_2O_7$ to reveal the microscopic nature of the field-induced paramagnetic semiconducting to ferromagnetic metal transition. The strong electronic structure changes are attributed to modifications of the Jahn-Teller split Mn^{3+} d (e_g) orbitals. The large CMR effect, unusual relaxation time behavior, and preferential orbital occupations observed in neutron scattering experiments are a consequence of field-induced changes in the separation of e_g levels, the details of which differ, depending on the direction of the applied field.

Acknowledgements

Support from the Materials Science Division at the U.S. Department of Energy (DE-FG02-01ER45885) is gratefully acknowledged.