Magnetoelectric coupling in frustrated rare earth containing oxides

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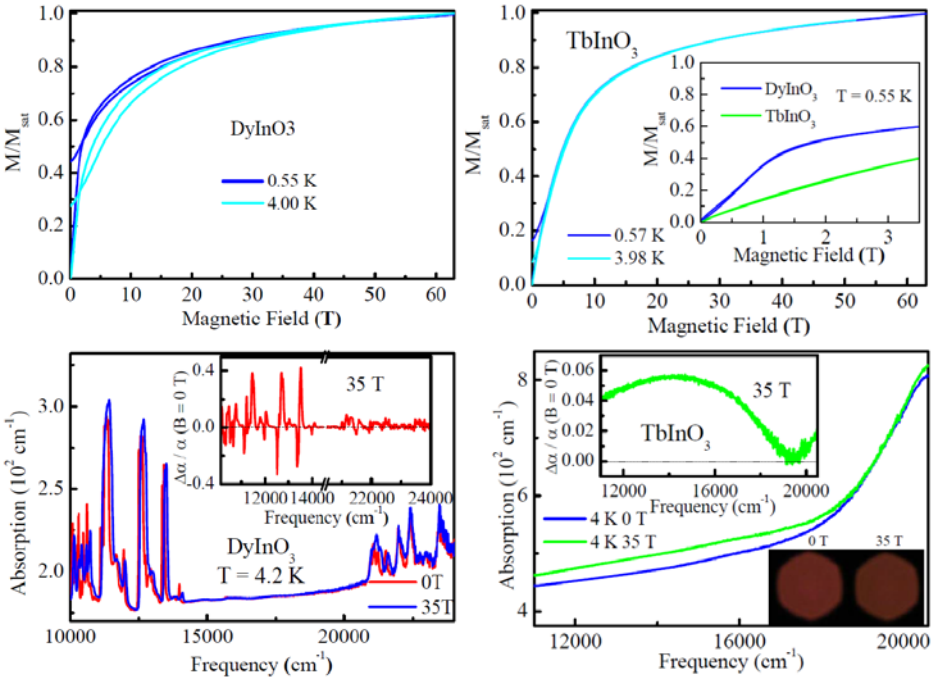
Introduction

Magnetoelectric coupling in materials like multiferroics, dilute magnetic semiconductors, and topological insulators has attracted a great deal of attention, although most work has been done in the static limit. Magneto-optical spectroscopy offers a way to investigate the dynamics of charge-spin coupling, an area where there has been much less effort. Our recent discovery that applied magnetic field drives a color change in α-Fe_2O_3 is an example of such an effect. More recently, we extended our work to include rare earth indium oxides like $DyInO_3$ and $TbInO_3$. These systems consist of frustrated rare-earth-containing hexagonal layers separated by a charge storage layer. Our interest in these compounds emanates from our search for large color change materials, and part of our design strategy is to couple strong frustration with a good chromophore like Mn introduced via chemical substitution. What is different in this work is our effort to couple magneto-optics with complementary magnetization measurements.



Summary of our magnetization and magneto-optics work on $DyInO_3$ and $TbInO_3$. Both are frustrated systems with ordering temperatures below 0.55 K. We have also measured $YInO_3$ and a number of substituted systems.

Results and Discussion

Inspired by the discovery of magnetochromism in hematite and motivated by the availability of a more promising physical system with which to bring together magnetic and optical properties, are investigating the combine magnetic and magneto-optical properties of several rare earth indium oxides. Our pulsed field magnetization work reveals saturation, an isospestic point in the Dy system, and ordering temperatures that are less than 0.55 K. In the $DyInO_3$, $TbInO_3$ and in a number of other compounds, we are using magneto-optical spectroscopy to probe the structure-property relationships associated with charge-spin coupling as summarized above. We are even beginning to photograph this effect.

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