NEUTRON SCATTERING STUDIES OF YTTRIUM DOPED RARE-EARTH HEXAGONAL MULTIFERROICS

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ABSTRACT

Multiferroics are set of materials that exhibit both magnetic (ferro or antiferromagnetic) and ferroelectric order. Our studies focused on hexagonal $RMnO_3$ (R = Ho, Y, Dy and Er), where strong coupling has been observed in $HoMnO_3$ at the spin reorientation transition temperature between the P6'$_3$cm' and the P6'$_3$c'm magnetic phases. In contrast, $YMNO_3$ orders in only P6'$_3$cm', while both $ErMnO_3$ and $DyMnO_3$ order in the P6'$_3$c'm magnetic phase and show no sign of coupling. Understanding the transition between these magnetic phases may shed light on this coupling.

In order to study this transition, single crystals of $Ho_{1-x}Y_xMnO_3$, $Er_{1-x}Y_xMnO_3$ and $Dy_{1-x}Y_xMnO_3$ at different *x* compositions were grown. Magnetic phase diagrams extracted from elastic neutron scattering indicate that the P6'$_3$cm' to P6'$_3$c'm phase transition is controlled by multiple parameters. Inelastic neutron scattering measurements revealed quasielastic (QE) scattering in the P6'$_3$cm' phase centered on the Bragg peak corresponding to the P6'$_3$c'm phase and vice versa. We conclude that this scattering is due to short-lived fluctuations into the "wrong" magnetic phase at magnetic domain boundaries, indicating strong phase competition between both magnetic phases. The large easy-axis anisotropy in pure $HoMnO_3$ appears to suppress these fluctuations. Our proposed model helps to explain previous observations of QE and diffuse scattering and indicates the importance of anisotropy in the behavior of domain walls that are instrumental in controlling the magnetism in this system.