Evidence of Incommensurate multiferroicity in the RMn_2O_5 series

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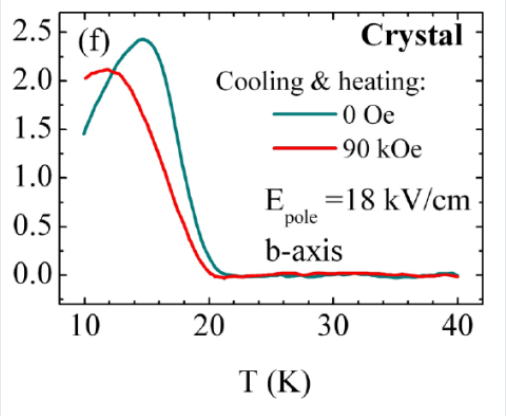
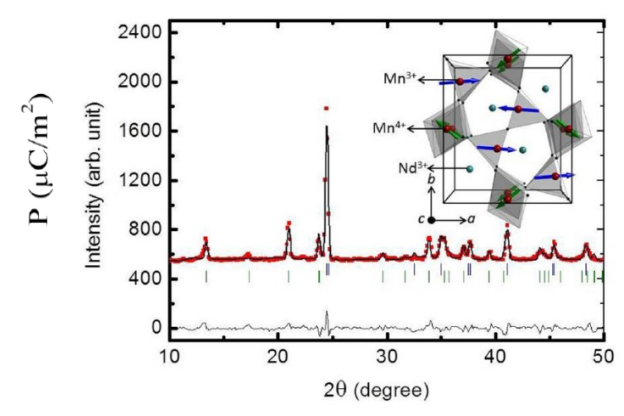
Recently, the RMn$_2$O$_5$ (R = rare earth, Bi, Y) multiferroics have drawn considerable attention, because of their magnetically induced ferroelectricity along with an extremely large magnetoelectric coupling. However the various members of the series do not behave similarly. Compounds with light rare earth (La, Pr) are not ferroelectrics while the one with heavy rare earths (Tb to Lu) are multiferroics. A crucial composition to understand the influence of the rare earth on the multiferroic properties is NdMn$_2$O$_5$ located between the nonferroelectrics and ferroelectrics.





Left: Powder neutron diffraction pattern and magnetic structure of $NdMn_2O_5$. Right: Electric polarization measured by depolarisation curent.

Here we report the results of dielectric permittivity, and electric polarization measurements along with an accurate description of the structural and microscopic magnetic properties obtained on NdMn$_2$O$_5$ from high resolution x-ray and neutron diffraction studies performed on large facilities and at the LPS. We show that NdMn$_2$O$_5$ is ferroelectric, although the magnitude of the polarization is much weaker than that of the other multiferroic members. The direction of the polarization is along the crystallographic *b* axis and its magnitude can be tuned with the application of a magnetic field. However, unlike the other multiferroic members of this series, the ferroelectricity in NdMn$_2$O$_5$ emerges in an incommensurate magnetic state. The present study also provides evidence in support of the influence of the rare-earth size on the magnetoelectric phase diagram.

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