Improved multiferroic properties of Nb doped $BiFeO_3$

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Pure $BiFeO_3$ (T_N = 370 °C and T_C = 826–845 °C) exhibits poor ferroelectric (high electrical conductivity) and weak ferromagnetism. In this study, up to 1% Nb^{5+} was introduced to replace Fe^{3+} (B-site doping) since it could disturb the nearly antiparallel spin ordering of the adjacent Fe^{3+} ions responsible for cycloidal (spiral) spin structure. On the other hand, the pentivalent Nb cations will compesate the negatively charged defects and consequently reduce the electrical conductivity.

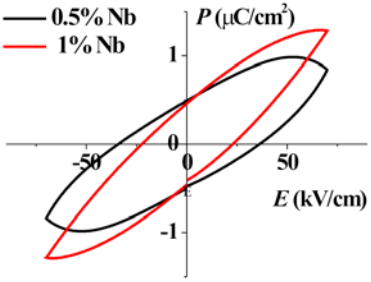

Figure 1 Hysteresis loops of $BiFeO_3$ samples doped with 0.5 and 1 % Nb at 70 kV/cm.

Unlike pure $BiFeO_3$, the sample with 1% Nb exhibits hard magnetic behaviour due to its high coercive magnetic field of ~7460 Oe (at H = 50 000 Oe). The ferroelectric response for the sample with 0.2 % Nb was unstable above 40 kV/cm, while at 70 kV/cm only the sample with 1 % Nb showed a regular ferroelectric response with remnant electrical polarization of 0.5 μC/cm^2 and coercive electrical field of 22.2 kV/cm. Thus, by doping with Nb, both magnetic and ferroelectric properties of $BiFeO_3$ were improved.