

Effect of Sr-Doping on Multiferroic Properties of $\text{Ca}_{1-x}\text{Sr}_x\text{Mn}_7\text{O}_{12}$

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Abstract : This study shows how sensitively and drastically multiferroic properties of $\text{CaMn}_7\text{O}_{12}$ get modified by isovalent Sr-doping, namely, in $\text{Ca}_{1-x}\text{Sr}_x\text{Mn}_7\text{O}_{12}$ for x as small as 0.01 and 0.02. $\text{CaMn}_7\text{O}_{12}$ is a type-II multiferroic, wherein polarization is caused by magnetic spin ordering. In this report magnetic and ferroelectric properties of $\text{Ca}_{1-x}\text{Sr}_x\text{Mn}_7\text{O}_{12}$ ($0 \leq x \leq 0.1$) are investigated. Samples were prepared by wet sol gel technique using their respective nitrates; powders thus obtained were calcined and sintered in optimized conditions. The X-ray diffraction patterns of all samples doped with Sr concentrations in the range ($0 \leq x \leq 10\%$) were found to be free from secondary phases. Magnetization versus temperature and magnetization versus field measurements were carried out using Quantum Design SQUID magnetometer. Pyroelectric current measurements were done for finding the polarization in the samples. Findings of the measurements are: (i) increase of Sr-doping in $\text{CaMn}_7\text{O}_{12}$ lattice i.e. for $x \leq 0.02$, increases the polarization, whereas decreases the magnetization and the coercivity of the samples; (ii) the material with $x = 0.02$ exhibits ferroelectric polarization P_s which is more than double the P_s in the un-doped material and the magnetization M is reduced to less than half of that of the pure material; remarkably (iii) the modifications in P_s and M are reversed as x increases beyond $x = 0.02$ and for $x = 0.10$, P_s is reduced even below that for the pure sample; (iv) there is no visible change of the two magnetic transitions T_{N1} (90 K) and T_{N2} (48 K) of the pure material as a function of x. The strong simultaneous variations of P_s and M for $x = 0.02$ strongly suggest that either a basic modification of the magnetic structure of the material or a significant change of the coupling of P and M or possibly both.

Keywords : ferroelectric, isovalent, multiferroic, polarization, pyroelectric

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