Magnetic Ferroelectrics Bi,Pb-3d Transition Metal Perovskites

MASAKI AZUMA, KAZUHIDE TAKATA, TAKASHI SAITO, YUICHI SHIMAKAWA, MIKIO TAKANO, Inst. Chem. Res., Kyoto Univ., SEIJI NIITAKA, Mag. Res. Lab., RIKEN, ALEXEI BELIK, ICYS, NIMS, SHINTARO ISHIWATA, Dept. Appl. Phys., Waseda Univ. — Magnetic ferroelectrics attract much attention because of the possible application for the memory device and the fascinating coupling between magnetic and dielectric properties. A classical way to obtain a magnetic ferroelectric is to locate Bi$^{3+}$ or Pb$^{2+}$ ions and a magnetic transition metal ion on A and B sites of perovskite structure. The 6s$^2$ lone pair and the strong covalent character of Bi(Pb)-O bonds stabilize a noncentrosymmetric distorted structure. For example, BiFeO$_3$ and BiMnO$_3$ are established antiferromagnetic and ferromagnetic ferroelectrics, respectively. We have studied structure, magnetic and electric properties of Bi$M$O$_3$ with $M$=Cr, Co and Ni and PbVO$_3$ stabilized by high-pressure synthesis. BiCrO$_3$ is an antiferromagnetic ferroelectric with BiMnO$_3$ type structure. BiCoO$_3$ and PbVO$_3$ are found to have tetragonal PbTiO$_3$ type structures with expected polarizations of $\sim$100$\mu$C/cm$^2$. BiNiO$_3$ crystallizes in a triclinic structure where disproportionation into Bi$^{3+}$ and Bi$^{5+}$ takes place. We have also succeeded in preparing a designed ferromagnetic ferroelectric double provskite Bi$_2$NiMnO$_6$. In this compound, NaCl type ordering of Ni$^{2+}$ ($e^1_g$) and Mn$^{4+}$ ($t^3_{2g}$) leads to ferromagnetism with $T_C$=140 K.

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