Nb-substitution effects in half-metallic double perovskite Ba_2FeMoO_6

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We studied systematic changes of the structural, electric and magnetic properties in half-metallic double perovskite $Ba_2FeMo_{1-x}Nb_xO_6$ with $0 \leq x \leq 1$. Here, the substitution of Nb^{5+} ($4d^0$) for Mo^{5+} ($4d^1$) is expected to diminish the spin-polarized carriers which play a key role in appearance of ferromagnetism above room temperature in the double perovskite. Polycrystalline samples were prepared by a conventional solid-state reaction method in reduced atmosphere of H_2(5%)/Ar. While crystal structure holds cubic $Fm\bar{3}m$ up to x=1.0, the lattice parameter at room temperature linearly increases with x. On the other hand, the Curie temperature T_C linearly decreases with x. No trace of the ferromagnetic order is observed above $x = 0.8$, which is accompanied by disappearance of metallic character in the ground state judging from divergence in resistivity toward 0 K. These results indicate the strong correlation between the itinerant electrons and occurrence of the ferromagnetic state. The decline of T_C, $dT_C/dx \sim 300$ K/Nb, is one order of magnitude larger than that for A-site substitutions of such as La and Na. In addition, T_C is almost insensitive to the Fe-substitution in the ferromagnetic region of $Sr_2Fe_{1+x}Mo_{1-x}O_6$.Therefore, the alternative order of Fe and Mo forms a peculiar platform for the ferromagnetism above room temperature.