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Crystal structure, magnetic and dielectric behavior of h-LuMn$_x$O$_{3\pm\delta}$ ceramics (0.95 ≤ x ≤ 1.04)

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Lattice constants, magnetic properties and dielectric behavior of h-LuMn$_x$O$_{3\pm\delta}$ solid solution ($0.95 \leq x \leq 1.04$) of bulk ceramic samples prepared by the solid state reaction method were studied to determine the role of stoichiometry changes on the crystalline structure and magneto-electric coupling. It is found that increasing of Mn content results in reduction of cell volume of h-LuMn$_x$O$_{3\pm\delta}$ ceramics mostly due to shrinkage of a-axis length. The antiferromagnetic interactions of Mn^{3+} ions weaken with cell volume contraction. A weak ferromagnetic contribution appeared in all samples and extends up to the Neel temperature, T_N. Irreversibility in temperature dependent magnetic measurements already reported for stoichiometric compositions of hexagonal $RMnO_3$ oxides appears for all h-LuMn$_x$O$_{3\pm\delta}$ samples right below Neel ordering transition. An increase of magnetic coercive field and magnetization on cooling below T_N in samples is observe in field dependent magnetization and rises as x increases. In addition to the antiferromagnetic ordering transition at T_N, two anomalies of the temperature dependent magnetic susceptibility and dielectric constant are identified below T_N, centered at 69 K and 31 K respectively, being probably due to inhomogeneity of the crystalline structure inside ceramic grains. Changes of the dielectric constant at T_N can be attributed to magneto-electric coupling in the off-stoichiometric hexagonal LuMn$_x$O$_{3\pm\delta}$ lattice. The behavior of the dielectric relaxation follows a thermally activated mechanism with activation energy values characteristic of polaron hoping.

Keywords: multiferroic, hexagonal $LuMnO_3$, vacancy, magnetoelectric coupling

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