

coupled below the ferroelectric temperature  $T_{FE} = 28$  K. While below  $T_{FE}$  it is known that Tb-spins are induced to order with  $\tau^{Tb} = \tau^{Mn}$ , below 7 K we find that  $\tau^{Tb}$  and  $\tau^{Mn}$  lock-in to rational values of  $3/7 b^*$  and  $2/7 b^*$ , respectively, and obey the relationship  $3\tau^{Tb} - \tau^{Mn} = 1$ . We explain the novel matching of Tb and Mn wave vectors within the frustrated ANNNI model coupled to a periodic external field produced by the Mn-spin ordering. The  $\tau^{Tb} = \tau^{Mn}$  behavior is recovered when Tb magnetization is small, while the  $\tau^{Tb} = 3/7$  regime is stabilized at low temperatures by a peculiar arrangement of domain walls in the ordered state of Ising-like Tb spins. Our phase diagram not only reproduces the experimentally observed value of  $\tau^{Tb}$  but also explains magnetic ordering for R-spins that is realized for R = Dy and Ho.

Keywords: magnetic perovskite materials, magnetic phase transitions, ferroelectricity

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#### Structure of Sr and Ti codoped LaAlO<sub>3</sub> perovskite

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Rare-earth aluminates, LnAlO<sub>3</sub> (Ln is abbreviated for lanthanide metals such as Ln = La, Ce, Pr, Nd, Pm, Sm, Eu and Gd) are known to possess excellent dielectric properties. In particular, the sintered samples of (La<sub>1-x</sub>Sr<sub>x</sub>)(Al<sub>1-x</sub>Ti<sub>x</sub>)O<sub>3</sub> perovskite-type solid solution have higher quality factors than that of LaAlO<sub>3</sub>, peaking Qf=165000 MHz at  $x = 0.2$ <sup>1)</sup>. This paper aims at clarifying the structure-property relation in the solid solution. Single crystals of  $x=0.005$  and  $0.20$  were grown by the floating-zone method<sup>2)</sup> and examined by the single-crystal x-ray diffraction method. The crystals possessed weak but significant intensities at the reciprocal lattice points forbidden for the space group  $R-3c$  which is commonly assumed for the rhombohedral distortion of the perovskite as in LaAlO<sub>3</sub>. The present study revealed that the crystals ( $x=0.005$  and  $0.2$ ) belong to  $R-3$  which accommodates two crystallographically independent octahedral sites for Al(Ti). Ti atoms are preferentially concentrated on the larger Al(Ti)O<sub>6</sub> octahedra. The selective distribution of Ti provides in the  $R-3$  structure a less distorted Al(Ti)-O-Al(Ti) bond angle than that in  $R-3c$ . This is consistent with the physical property that the Sr and Ti codoped compounds have higher Qf than the pure LaAlO<sub>3</sub>. Discussion will be given on the reasons why the symmetry of Sr and Ti codoped crystals differs from the pure LaAlO<sub>3</sub><sup>3-4)</sup>, the end member of the 'solid solution'.

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#### Mobile oxygen form and structural stability of La<sub>1-x</sub>Sr<sub>x</sub>FeO<sub>3-y</sub> perovskites

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Using thermogravimetry with mass spectrum analysis, low and high-temperature X-ray powder diffraction La<sub>1-x</sub>Sr<sub>x</sub>FeO<sub>3-y</sub> solid solutions with perovskite-related structure were investigated. From -190 °C and up to room temperature under heating of samples in vacuum perovskite structure preserved. Oxygen loss under heating of samples ( $0 \leq x \leq 1$ ) in air and in vacuum ( $x < 0.75$ ) under temperature of synthesis (1200 °C) leaved the structure unaltered, however, resulted in increase of unit cell volume. Heating in vacuum of compositions  $x \Rightarrow 0.75$  resulted in vacancies-ordered phase formation. These structural changes (increase of unit cell parameter, oxygen vacancies ordering) are reversible and reoxidation leads to restoring of initial oxide parameters in process of cooling down in air or in a second heating in air of "vacuum-processed" samples. Loss of oxygen for initial samples under heating and reoxidation process for "vacuum-processed" samples occurred at the same temperature about 400 °C. Amount of emitted oxygen under heating in vacuum and in helium atmosphere increased as compared with those of realised under heating in air.

Keywords: perovskites, high-temperature X-ray diffraction, mobile oxygen form

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#### X-ray study of the impact of a weak electric field on the domain structure in PbTiO<sub>3</sub> thin films

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Thin films of PbTiO<sub>3</sub> (PTO) deposited on SrTiO<sub>3</sub> (STO) single crystal (001) faces have been studied by SR X-ray scattering to investigate domain size and orientation as a function of film thickness and the impact of a weak electric field. The nearly perfect lattice match between cubic STO and the *ab*-plane of tetragonal PTO ensures that the polar PTO *c*-axis will be well aligned in the growth direction of the film, favouring the formation of *c*-oriented domains. Thin films of PTO in the thickness range 207-24.5 Å deposited by RF magnetron sputtering on insulating STO substrates were studied, using a sample holder allowing the application of an electric field, about 4000 V/cm, onto the sample along the polar axis. In order to study the field effects on the domain structure, scans of reflections  $0\ 0\ l$ ,  $h\ 0\ l$  and  $0\ k\ l$  were made without field, with field, and again without field after a period with the field turned off. Reconstructions of the diffuse scattering display a surprising complexity which is different for various film thicknesses. The field effects are most prominent for the thickest film (50 uc). Before exposure to the field the major part of the diffuse intensity describes an annular ring relating the average period of the