Vacancy-driven magnetism of $GdMnO_{3+\delta}$ multiferroic compound

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Multiferroic $GdMnO_3$ compound orders antiferromagnetically below T_N = 40 or 44 K [1] and undergoes order-to-order magnetic phase transition into low temperature canted magentic phase at T_{lock}. Transition at T_{lock} is hysteretic and it occurs at 20 or 25 K during the heating, but at 15 or 20 K during the sample cooling [2]. The ferroelectricity can be observed if the magnetic field is applied along the *a*-axis (using description within the *Pnma* space group) [3], but some authors report the ferroelectricity also at zero magnetic field and in temperature range 5.1 – 7.5 K [2].
$GdMnO_3$ belongs to orthorhombically distorted, $GdFeO_3$-type perovskites. This family of compounds is naturally vacant, so the well-established general notation for these compounds is $ABO_{3+\delta}$. The physical properties can be very sensitive to δ. For example, in $LaMnO_{3+\delta}$ the magnetic ordering temperature varies from 139 K to 154 K, depending on δ [4]. The impact of δ to "$GdMnO_3$" physical properties was not studied yet, but we hypothesize and we will try to proof that the huge discrepancies in the literature are in fact the impact of δ on $GdMnO_{3+\delta}$ magnetism.
Three different samples were prepared by a vertical floating zone method. All growing conditions except for the preparation atmosphere were kept identical. The atmosphere was chosen to be O_2, air or Ar. The choice of the atmosphere resulted to different δ in the samples. All samples exhibit T_N in temperature range 41 – 43 K, but lower temperature anomalies differ substantially: Sample prepared in air exhibits an increase of zero-field-cooling magnetization (ZFC) with increase of temperature at 12.7(1) K and then the decrease at T_{lock} = 18.7(1) K. Sample prepared in Ar exhibits an increase of ZFC magnetization with increase of temperature at 7.5(1) K and decrease at T_{lock} = 23.4(1) K. Sample prepared in O_2 exhibits only very weak anomalies at 11.6 K and T_{lock} = 18.5 K. The anomaly at T_{lock} is connected with bifurcation of the ZFC-FCW curves for samples prepared in Ar and air. ZFC-FCW curves bifurcate at 26(1) K for sample prepared in O_2. All these facts can be considered as an experimental proof of our hypothesis. More detailed data analysis will be presented in the contribution.

References:

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