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Magnetic resonance investigations of h-$YbMnO_3$

The hexagonal manganite $YbMnO_3$ exhibits a ferroelectric (FE) transition well above room temperature (T>900 K), while the antiferromagnetic (AFM) ordering takes place at much lower temperature (Neel temperature $T_N \approx 90$ K). Crystal structure of $YbMnO_3$ usually belongs to the hexagonal space group $P6_3cm$ [1]. Mn^{3+} ions form the plane triangular lattice and the magnetic ordering of Mn moments is determined by the in-plane AFM Mn-O-Mn superexchange, which is much stronger than the inter-plane Mn-O-Mn exchange.

In this work we study the physical properties of h-$YbMnO_3$ ceramic sample by X-ray, scanning electron microscopy and electron spin resonance (ESR) methods. The X-ray analysis of the synthesized manganite h-$YbMnO_3$ showed that the compound is in single-phase state and the structure of the sample belongs to the space group $P6_3cm$. The calculation of the relative peak intensities of the diffraction pattern showed that the positions of Yb filled to 0.89, and the positions of Mn ions are filled completely. The SEM image of h-$YbMnO_3$ ceramic sample shows that the morphology of the sample has a granular structure. The size of granules is in the range between 0.7 μm and 4.2 μm with the average value 1.8 μm.

At lower temperatures the line shape of magnetic resonance signal is strongly asymmetrical. As can be seen from Fig. 1 that the spectrum was contained two overlapping each other lines. The observed ESR absorption is well described by two single exchange-narrowed Lorentzian line in all X, Q, W -bands with resonance field H_{res} and half-width at half maximum ΔH. The effective g-values for first and second lines are at =120K $g_{eff}(1)\approx4.63$; $g_{eff}(2)= 2.005\pm0.006$ in X-band and $g_{eff}(1)\approx2.27$; $g_{eff}(2)= 1.992\pm0.006$ in W-band and at T=130K $g_{eff}(1)\approx2.12$; $g_{eff}(2)= 2.001\pm0.002$ in Q-band. The effective g-factors for second line

are equals in X, Q, and W-bands. These suppose on favor of interpretation that this signal refers to the paramagnetic resonance. The large difference between g-values of the first line in X-, Q- and W- bands tell about non paramagnetic nature of the first signal. From temperature dependencies of magnetization, resonance fields and intensity we conclude that first line corresponds to the ferromagnetic resonance signal whereas the second one has paramagnetic nature.

The nature of the ferromagnetic signal can be related with the deficit of ytterbium Yb^{3+} ions with respect to the manganese Mn^{3+} ions. Indeed, charge disbalance near the empty Yb^{3+} position initiates a mixed-valence states formation between neighboring Mn ions. Further, the double exchange interaction between Mn^{3+}-Mn^{4+} leads to the formation of ferromagnetically correlated nanoregion.

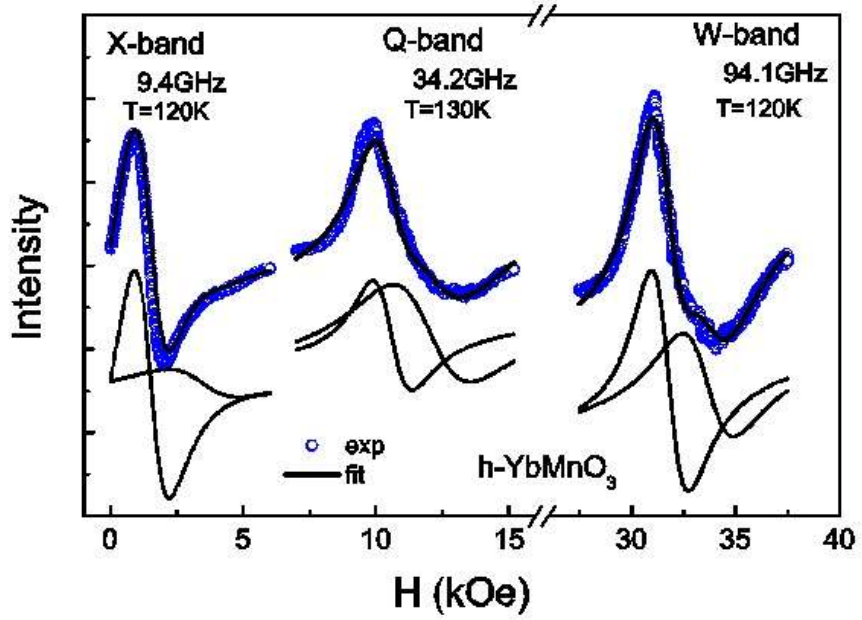

Fig.1. Magnetic resonance spectrum of h-$YbMnO_3$ in X-, Q-, W-bands. Symbols correspond to the experimental data, lines – fitting. Two Lorenzian lines in the lower part of the figure relate to ferromagnetic and paramagnetic components of resonance, respectively.

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