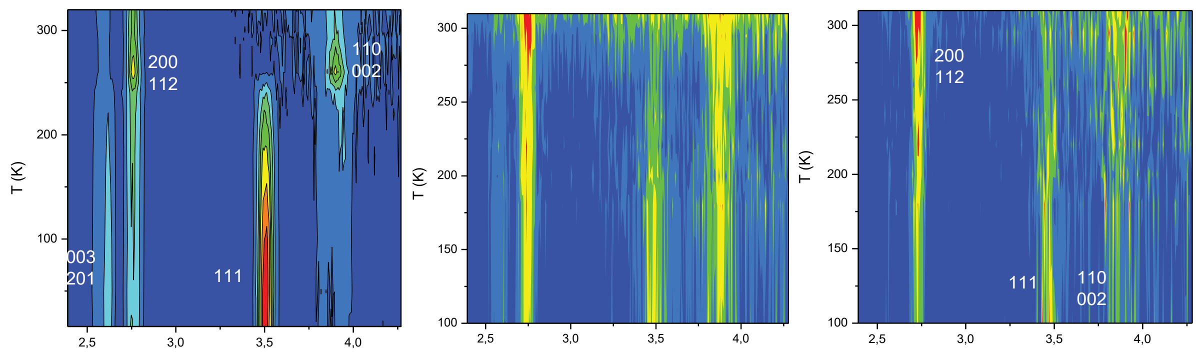
PRESSURE DEPENDENCE OF PHASE TRANSITIONS IN DOUBLE MANGANITE $PrBaMn_2O_6$

S.G. Titova[1], E.V. Sterkhov[1], S.V. Kichanov[2] and V.A. Sidorov[3]

[1]*Instutite of Metallurgy Urals Branch of RAS, Ekaterinburg, Russia*
[2]*JINR, Dubna, Russia*
[3]*Institute of High pressure Physics, Moscow, Russia*

E-mail: sgtitova@mail.ru

Double manganites $RBaMn_2O_6$ (R – rare earth) are built as a sequence of $RMnO_3$ and $BaMnO_3$ cubic perovskite cells in *c*-direction forming resulting tetragonal cell. In spite of ordinary manganites the temperatures of magnetic phase transition are much higher; that makes these materials perspective magnetoresistors, sensors, magnetocalorics *etc.* [1]. As for ordinary manganites the properties of double manganites are formed as a result of competition between the AFM superexchange and the FM double interaction in Mn-O subsystem. The temperatures of magnetic and electric phase transitions changes when type of *R*-element varies, so some size effect is present. The size effect may by tuned by applying of the external pressure, the pressure influence on magnetic and electric states of double manganites was not studied yet. We performed neutron diffraction in temperature range 50 – 320 K and pressure range 0 – 5.2 GPa for $PrBaMn_2O_6$ as magnetic and electric phase transitions for this compound were studied previously [2].
Neutron diffraction study was performed at DN-12 spectrometer (IBR-2 reactor) using the high pressure cell with sapphire anvils. The pressure was controlled using ruby fluorescence within 0.05 GPa accuracy. The external standard Al-LaB_6 was used for refinement of instrumental and profile parameters. Crystal and magnetic structure was refined by full-profile analysis with FullProf program.
Experimental diffraction patterns at external pressure 0, 3.1 and 5.2 GPa are shown in Fig. 1. Only without external pressure single phase ferromagnetic state was observed as an enhancement of diffraction line (200) at absence of AFM (111) line. External pressure leads to AFM state already at 320 K as an appearance of AFM (111) line (Fig. 1).



a) b) c)

Fig. 1. Neutron diffraction patterns for $PrBaMn_2O_6$ at external pressure 0 (a), 3.1 GPa (b), 5.2 GPa (c).

Calculated unit cell dimensions are shown in Fig. 2. At ambient pressure the structural phase transition with a jump of (*a*-*c*/2) ratio occurs at ~250 K attributing the metal-insulator transition [2]. At 3.1 GPa already at 320 K we observe high value of (*a*-*c*/2) ratio noted the insulating state.

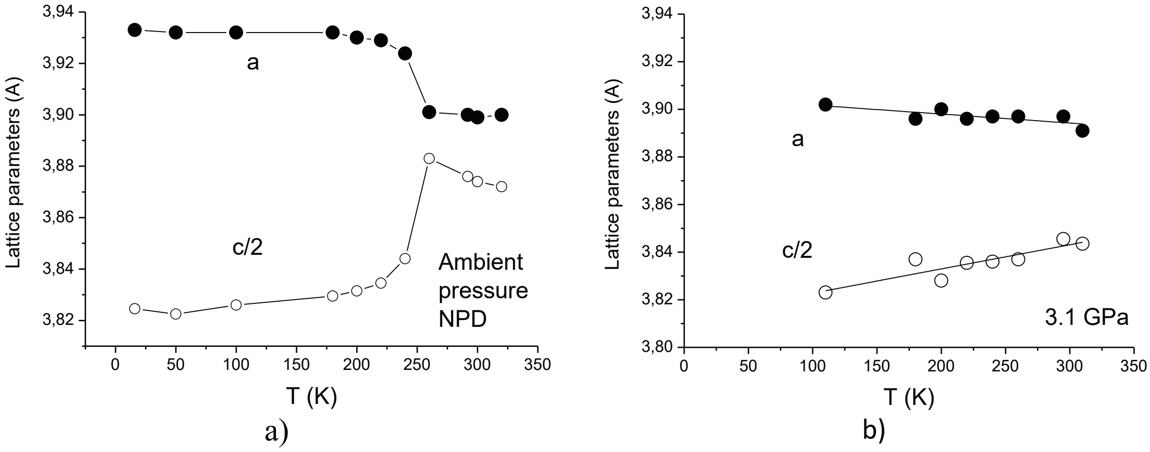


Fig. 2. Unit cell parameters (I4/mmm tetragonal structure) a and c/2 at ambient pressure (a) and 3.1 GPa (b).

For the same sample we measured ac-specific heat, magnetic susceptibility and electric conductivity in the pressure range 0 – 5 GPa (Fig. 3). The results show the presence of ferromagnetic conducting state at high temperature for all pressure values.

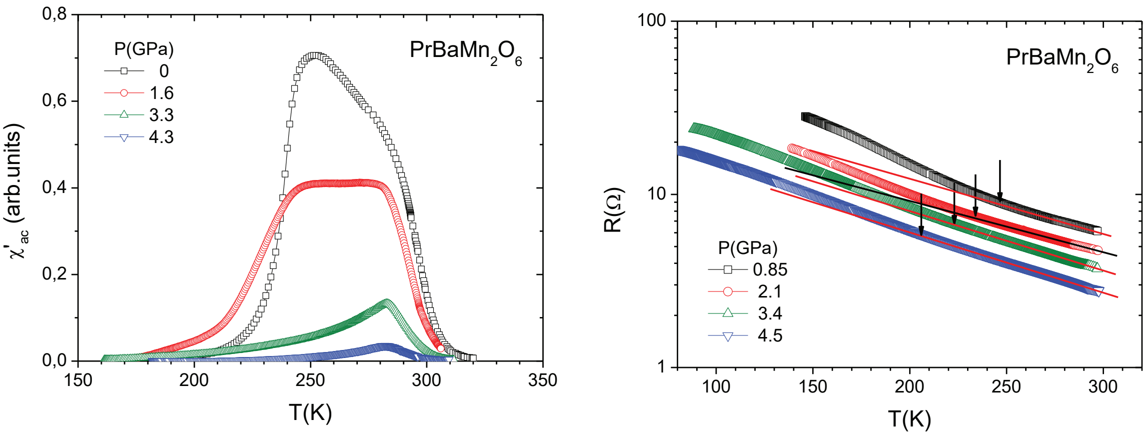


Fig. 3. Temperature dependences of magnetic susceptibility (left) and electric resistance (right) for $PrBaMn_2O_6$ at different external pressure.

We explain the results as a presence of ferromagnetic conducting clusters in antiferromagnetic insulator matrix at external pressure.

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[2] E.V. Sterkhov, N.M. Chtchelkatchev, E.V. Mostovshchikova, R.E. Ryltsev, S.A. Uporov, G.L. Pascut, A.V. Fetisov, S.G. Titova (2021). The origin of the structural transition in double-perovskite manganite $PrBaMn_2O_6$" Journal of Alloys and Compounds. 892, 162034.