Observation of Griffiths-Phase like behaviour in polycrystalline $LaFe_{0.5}Mn_{0.5}O_3$

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Transition metal perovskite with generic formula ABO_3 remained to be a potentially functional material since last few decades having a wide range of applications. Nowadays partially doped (both A and B site) comes up with intriguing features which bring out rich physics. Particularly rare earth Manganites is an interesting compound in this series with unique properties like spin reorientation, colossal magnetoresistance (CMR), Metal-Insulator Transition (MIT), spintronics applications. Griffiths Phase(GP) is one of the interesting behaviour observed in the doped manganites. The underlying reason for manganites to exhibit GP behaviour is the inheritance of quenched disorder. We report the magnetic study of pure $LaFe_{0.5}Mn_{0.5}O_3$ polycrystal prepared by solid state reaction in air. It crystallizes in orthorhombic structure ($Pnma$) with $\chi^2 = 1.79$ without the presence of any secondary phases. Magnetic measurements reveal Griffiths Phase like behaviour in half doped Orthomanganites $LaFe_{0.5}Mn_{0.5}O_3$ in the range 276 K to 314 K having antiferromagnetic Neel temperature 276 K ($\theta_{CW} = -27K$), which was further confirmed by modified Curie Weiss behaviour($\chi^{-1} = (T/T_C^R - 1)^{1-\lambda}$), using power-law susceptibility exponent (λ)[1]. Generally, GP arises due to quenched disorder where small ferromagnetic clusters form having short-range magnetic order. Magnetization is a non-analytic function of H and T in the GP region[2]. Inverse susceptibility vs Temperature behaviour shows a sharp downturn around Neel temperature where Curie Weiss law is not fitting and this is a primary indication of Griffiths Phase[3]. Above the onset temperature of GP ($T_G = 314K$) Curie Weiss law, as well as the analyticity in magnetization, are restored again. The ferromagnetic clusters are being ordered with the application of magnetic field and susceptibility also increases as evidenced from inverse susceptibility vs Temperature behaviour at different magnetic fields(100 Oe, 500 Oe, 10 kOe). Non-analyticity also being suppressed with the application of magnetic field. In order to have further confirmation, $\mathrm{Log}_{10}(\chi^{-1})$ vs $\mathrm{Log}_{10}(T/T_C^R - 1)$ plot was also taken. Linear fitting at Griffiths Phase(GP) and Paramagnetic(PM) regions give the value of the susceptibility exponents (λ_{GP}=0.99 and $\lambda_{PM} = 0.09$), indicating a strong presence of Griffiths Phase[4].The presence of dominant ferromagnetic behaviour at a lower temperature is evidenced from the spontaneous magnetization (M_S) obtained from Arrot plot at different isotherms.

References:

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