Interplay of Superconductivity and Spin Density Wave - Magnetism in PrFeAsO and Hole-doped \((\text{Pr}_{1-x}\text{Sr}_x)\text{FeAsO}\): Synthesis, Structure, Thermodynamic, Magnetic, Transport, Phonon properties and Pressure effect

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Hole doping in iron-pnictide (1111) PrFeAsO by substituting Pr\(^{3+}\) by Sr\(^{2+}\) creates superconducting \(\text{Pr}_{1-x}\text{Sr}_x\text{FeAsO}\) tetragonal \(P4_{/nmm}\) phases at room temperature. Sr doping facilitate hole transfer through Pr/Sr plane & FeAs layers. Hall-effect measurements at different magnetic field & temperature (+Ve \(R_H\)) confirms hole like charge carriers. Lattice constants \((a & c)\) increase monotonously with Sr/hole concentration. \(T_c\) \((\text{SC})\) varies from 12.5 K to 15.5K with a maximum of 15.5K at \(x = 0.22\) with (optimal doping) largest SC volume fraction. Temperature (1.7 K ~300K) & Magnetic field (1T ~7T)-dependent resistivity, magnetic susceptibility & specific heat been measured & calculated \(C_p/T\) \((J/mole-K^2)\) & entropy \((J/mole-K)\). Thermoelectric power \(S\) \((T)\) of PrFeAsO have W-like shape & smaller amplitude with much larger spread. \(p\)-drop (~150 K) has been identified with SDW/ lattice instability. Coexistence of SC & SDW behavior were observed & pressure effects on both being investigated by resistivity measurements under hydrostatic pressure up to 1.8GPa using piston-cylinder clamp cell device & compared with electron doped Sm\((O_{1-x} F_x)\) FeAs. \(T_c\) increases \((+/dT_c/dP)\) with pressure for under-doped \((\text{Pr}_{1-x}\text{Sr}_x)\text{FeAsO}\) similar to high-\(T_c\) cuprates & -Ve pressure effect on SDW temperature. The results suggest a symmetry between electron & hole-doping Fe-pnictide superconductors.

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