Hole-doping of Ca$_{1-x}$Na$_x$V$_2$O$_4$ ($x = 0 - 0.5$) With Zig-Zag Vanadium Chains

A. NIAZI, D.C. JOHNSTON, Ames Lab., Iowa State Univ., Ames, IA 50011, USA — CaV$_2$O$_4$ crystallizes in an orthorhombic $Pnam$ structure with $S = 1$ zig-zag V chains along the $c$-axis. In this low-dimensional, insulating system the triangular arrangement of V atoms with $J_1 \approx J_2$ leads to competing frustrating antiferromagnetic (AF) interactions. Our recent studies on powders and single crystals of CaV$_2$O$_4$ show long-range AF ordering at a Néel temperature $T_N \sim 75 - 78$ K (with a monoclinic distortion at $\sim 145 - 150$ K) and signatures of partial spin-freezing below 20 K. We have tried doping CaV$_2$O$_4$ into the metallic state by substitution at the Ca site to drive V into fractional valence states. We have succeeded in replacing Ca upto 50% by Na at 1200 °C. Powder XRD patterns of our Na-substituted samples are nearly single-phase CaV$_2$O$_4$-type, while the $c$-axis lattice parameter decreases sharply - Thus Na indeed substitutes for Ca instead of occupying interstitial positions. The room temperature resistance of Na-doped sintered pellets decreases significantly. High field ($H = 1$ T) dc magnetization measurements show a steep fall in $T_N$ while low field ($H = 100$ Oe) data suggest onset of spin-glass like behavior as the Na content increases. We shall present our results and discuss the evolution from a partially disordered AF insulator to a spin-glass.

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