NATURE OF MAGNETISM IN THE MOLECULAR SEMICONDUCTOR COBALT PHTHALOCYANINE ($C_{32}H_{16}CoN_8$): LOW TEMPERATURE, HIGH MAGNETIC FIELD INVESTIGATIONS.

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Transition metal doped phthalocyanines (TMPc, TM = Mn, Fe, Co, Ni and Cu) are molecular semiconductors with potential applications in electro-optic and spintronic devices [1,2]. The TM atoms form linear chains along the b-axis (Fig.1). A recent report [2] on β-CoPc based on the temperature dependence (8 K to 310 K) of magnetization (M) in magnetic field H = 70 kOe suggested it to be a linear chain magnet.

Here we report results from detailed investigations of the magnetic properties of two powder samples of β-CoPc covering wider temperature range of 0.4 K to 300 K and in H up to 90 kOe. X-ray diffraction of the samples confirmed the β-phase and SEM showed needle-like (plate-like) morphology for the samples from Sigma-Aldrich (Alfa-Aesar). Magnetically, both samples are quite similar, the M vs. T data in H = 10 kOe fitting the Curie-Weiss (CW) law above T > 3 K yielding θ = 2.5 K, μ = 2.16 μB per Co^{2+} and g = 2.49 for spin S = ½ (Fig.2). Below 3 K, the data deviates from the CW law yielding a peak in M near 2 K (Fig.2). Also, the data from 0.4 K to 300 K fits well with the prediction of the Bonner-Fisher model for S = 1/2 AFM Heisenberg chain [3] yielding the Co^{2+}-Co^{2+} exchange constant J/k_B = 3 K ($H = J \Sigma \mathbf{S_i} \bullet \mathbf{S_{i+1}}$).

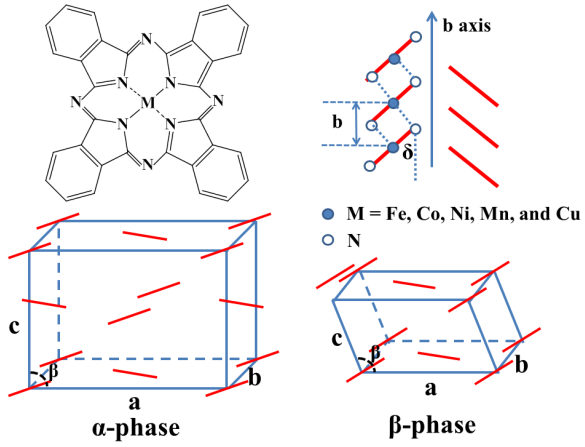

Fig. 1. Molecular model, unit cells, and molecular arrangement of α- and β-TMPc.

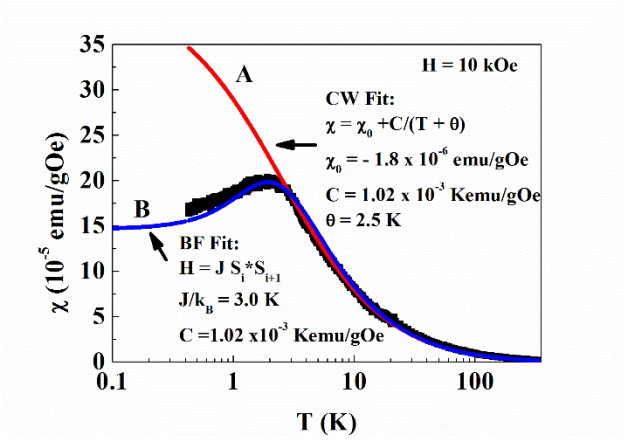

Fig. 2. Magnetic susceptibility χ vs. temperature T with H = 10 kOe. Solid line A and B are fits to the Curie-Weiss law and the Bonner-Fisher model, respectively.

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