NATURE OF MAGNETISM IN THE MOLECULAR SEMICONDUCTOR COBALT PHTHALOCYANINE (C\textsubscript{32}H\textsubscript{16}CoN\textsubscript{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 \( \theta = 2.5 \) K, \( \mu = 2.16 \) \( \mu_B \) per Co\textsuperscript{2+} and \( g = 2.49 \) for spin \( S = \frac{1}{2} \) (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\textsuperscript{2+}-Co\textsuperscript{2+} exchange constant \( J/k_B = 3 \) K (\( H = J \sum S_i \cdot S_{i+1} \)).

\[ \text{Fig. 1. Molecular model, unit cells, and molecular arrangement of } \alpha- \text{ and } \beta-\text{TMPc.} \]

\[ \text{Fig. 2. Magnetic susceptibility } \chi \text{ vs. temperature } T \text{ with } H = 10 \text{ kOe. Solid line A and B are fits to the Curie-Weiss law and the Bonner-Fisher model, respectively.} \]


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