Exchange Mechanisms in Long Range Ordered Thin Film Organic Magnetic Semiconductors

N. RAWAT, R. HEADRICK, M. FURIS, Physics Dept and the Material science program, Univ of Vermont, Burlington, VT, S. MCGILL, National High Magnetic Field Lab, Tallahassee, FL, L. KILANSKI, Physics of Semi-magnetic Semiconductors Group, IFPAN, Poland., R. WATERMAN, Chemistry Dept and the Material science program, Univ of Vermont, VT — Magnetic exchange mechanisms in crystalline thin films of Metal Phthalocyanines (M-Pc) are explored using Magnetic Circular Dichroism (MCD) and SQUID measurements up to 10 T and 2K. Long range ordered thin films of organo-soluble derivatives of Co-Pc and Mn-Pc were fabricated using solution processing technique. In the case of Mn-Pc, our measurements show enhanced hybridization of ligand \( \pi \)-electronic states with the Mn d-orbitals. MCD active states beyond 1 \( \mu \text{m} \) have been observed for the first time, providing crucial information on the orbital arrangements of MPc’s that result in competing (co-existing) long-range superexchange and indirect exchange reminiscent of RKKY. The evolution of Zeeman splitting of specific MCD-active states is very well described by enhanced effective \( \pi \)-electrons g-factors as large as 100, analogous to diluted magnetic semiconductors (DMS) systems. In Co-Pc MCD data indicates a weaker exchange interaction between delocalized charge carriers and d-like spin-polarized electrons, however SQUID measurements reveal magnetic ordering up to 180K. A comparison between Mn-Pc and Co-Pc and earlier results from the spin 1/2 Cu-Pc and their non-magnetic Zn-Pc counterpart, offers an interesting view on the role of long range order in magnetic interactions.

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