MAR07-2006-007018

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

Predictable and New Physics and Potential for Applications of Organic-based Magnets[1]

ARTHUR J. EPSTEIN, Department of Physics and Department of Chemistry, The Ohio State University, Columbus, OH 43210-1117

As discussed by Joel S. Miller in the previous talk, magnets utilizing organic groups with essential spin have been reported since the mid-1980's. Though initial organic-based magnets had magnetic ordering temperatures (T_c's) below 5K, organic-based magnets now have T_c's to above 400K. In addition to magnetic phenomena already known for conventional transition metal and rare earth magnets, organic-based magnets feature unique phenomena enabled by the shape and internal electronic structure of the organic molecules. Examples are illustrated with experimental results for magnets based on tetracyanethylene, [TCNE], which as an anion has spin ½. For example, chains with spin containing molecules having relatively strong exchange within a chain and weak dipolar interaction with neighboring chains can have an unusual fractal ground state with unusual dynamics leading to 'coercive fields' approaching 3 tesla. In contrast to conventional magnets, the internal electronic structure of the molecules that make up a molecule-based magnet can be excited by light of the appropriate wavelength. This leads to changes of the spin state of the molecule and/or changes in the exchange interaction between molecules, opening up the concept of reversible light control of magnetism. Examples will be given from the $M^{++}[TCNE]^{-}_{x}$ (x$\sim$2) (M = Mn, V) materials systems. Finally, we explore the new phenomena enabled by $V^{++}[TCNE]^{-}_{x}$ (x$\sim$2), a material with T_c up to 400K and for which films may be prepared using low temperature CVD. It is a semiconductor (room temperature resistivity and activation energy similar to silicon) and magnetization M(H,T) and coercive field are controlled by chemical composition. Magnetoresistance to 32 tesla supports that $V[TCNE]_2$ is a "half-semiconductor" with fully spin polarized valence and conduction bands of interest for spintronics applications.

[1]This work has had the continued support by the US DOE Office of Basic Energy Sciences (Grant Nos. DE-FG02-86ER45271 and DE-FG02-01ER45931, and AFOSR (Grant No. F9550-06-1-0175).