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ELECTROCHEMICALLY SYNTHESIS AND MAGNETIC PROPERTIES OF SPIN TRANSITION COMPOUNDS

Guillermo Pozo[1], P de la Presa[2,3], R Prato[1], P Marin[2,3], J Fransaer[4] and X Dominguez-Benetton[1]
[1]VITO-Flemish Institute for Technological Research, Belgium
[2]Instituto de Magnetismo Aplicado, Spain
[3]KU Leuven, Belgium

Recently, a third fundamental state for magnetism (besides ferromagnetism and antiferromagnetism) was experimentally realized in a novel class of matter: the spin-liquid state, which was only possible after finding a way to synthesize herbertsmithite ($ZnCu_3(OH)_6Cl_2$). Here we introduce an electrochemically-driven method for synthesizing monodisperse nano-particles of $ZnxCu_{4-x}(OH)6Cl_2$ (in which x=1 for herbertsmithite, x=0 for clinoatacamite and 0.33<x<1 for paratacamite) at room temperature (18°C). The synthesis was carried out using a mixture of Cu^{2+} and Zn^{2+} ions as the metal precursors and O_2 (in air) as the oxidant gas through a gas-diffusion cathode. Zero-field-cooled (ZFC) and field-cooled (FC) mass magnetization (M) in a field of 7.98 kA/m, over the temperature range of 2 to 300 K, showed a small ferromagnetic ordering below Tc ~ 6 K that is accompanied by bifurcation of FC data that are assigned to an impurity phase. There was less difference between zero-field and field cooled susceptibility, when the stoichiometric coefficient on the interlayer site was 1, which support a less spin-glass behavior. We believe that the extracted ferromagnetic hysteresis at T=2 K was caused by an impurity phase. As the purity of the herbertsmithite nanoparticles is increased, a clear distinction of the quantum spin liquid state is expected.

BIOGRAPHY

Guillermo Pozo has completed his PhD in Chemical Engineering at the University of Queensland, Australia. He is currently a Marie Curie Research fellow working at the VITO-Flemish Institute for Technological Research, Belgium.

guillermo.pozo@vito.be

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