

Hybridization of orbital moment and spin relaxation of Er³⁺ single-ion magnet in ferromagnetic matrix

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Single-molecule magnets (SMMs) attract great interest of specialists in the view of development of platforms for quantum computation and information storage [1, 2]. Typical SMM involves a magnetic ion incorporated in organic structure chemically designed to satisfy desirable symmetry of the ligand field. More or less strong coupling between an ionic spin and organic environment is provided due to spin-orbital interaction within the complex [3]. The Er³⁺ based complexes demonstrate relaxation typical for single ionic magnets (SIMs). Magnetic relaxation in Er³⁺ SIM in the presence of the ferromagnetic environment is analyzed. Incorporation of the [Er(HL)(L)]4CHCl3H2O complexes (L = DAPBH = 2,6-bis(phenylhydrazone)pyridine) to the ferromagnetic matrix consisting of PrDyFeCoB microparticles significantly changes magnetic relaxation in the Er³⁺ ions (Fig. 1 a, b).

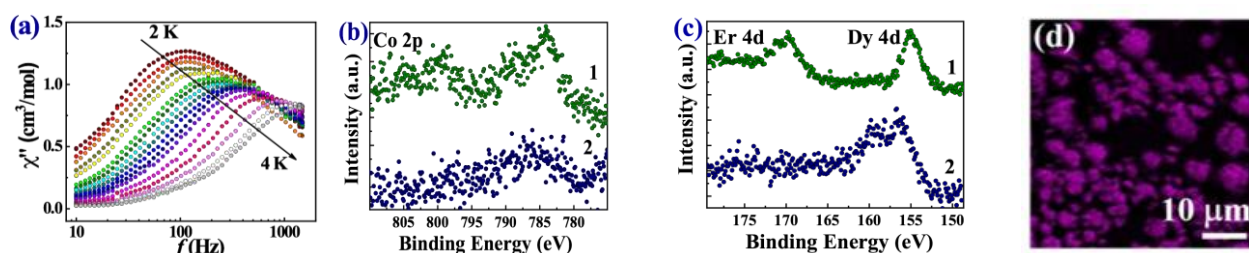


Fig. 1. a) Frequency dependences of out-of-phase χ'' magnetic susceptibilities in a composite pellet containing Er³⁺ complex incorporated in between ferromagnetic MPs array. b) Normalized core level XPS spectra of Co 2p, wide peaks confirms the mixed oxidation state of Co in SMM composite (1). c) High resolution XPS spectra of Er-4d peak and Dy 4d for SMM composite (1) and pure magnetic microparticles (2) d) EDX mapping of Co in composite material.

Internal magnetic field of the magnetized ferromagnetic matrix delays spin relaxation in the Er³⁺ complexes in the absence of the external magnetic field. Compaction of the Er³⁺ complexes with ferromagnetic microparticles (MPs) results in a composite material, in which magnetic relaxation is governed by Zeeman interaction of Er³⁺ spin with ferromagnetic microparticles possessing remnant magnetization at zero external field. Additional channel of microparticles effect on the magnetic relaxation is chemical interaction of the complexes with metallic surface of microparticles and corresponding orbital hybridization accelerating magnetic relaxation.

[1] M. Leuenberger et al. Nature 410 (2001) 789.

[2] E. Dvoretzkaya et al. J. Phys. Chem. Solids 157 (2021) 110210.

[3] T. Bazhenova et al. Magnetochemistry 6 (2020) 60.