Magnetoelectric Functional Properties of Lanthanide Molecular Magnetic Materials

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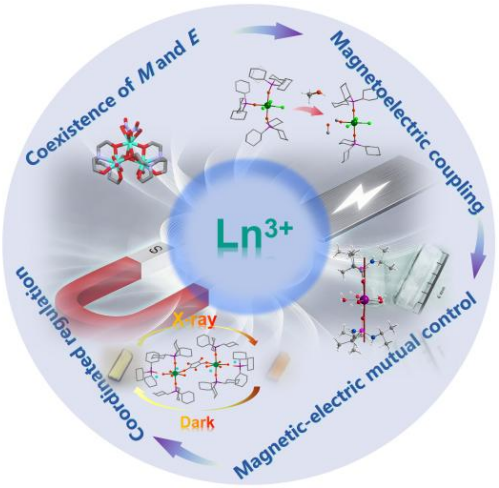
Abstract

Lanthanide-based molecular materials with tunable structures offer a promising platform for integrating magnetism and electricity.[1] Here, we present a series of dysprosium-based molecular materials with systematically studied magnetoelectric functionalities. Starting from triangular Dy_3 clusters, we achieve coexistence of magnetism and ferroelectricity.[2] By proposing a ligand substitution strategy, we break inversion symmetry to induce ferroelectricity, enabling controllable magnetoelectric coexistence and magnetodielectric effects. Building on this, direct magnetoelectric coupling is realized in a related structure, where electric polarization is modulated by a magnetic field and magnetic relaxation is controlled by an electric field.[3,4] By incorporating chiral and photoactive ligands, a binuclear polar Dy-based magnetic molecular material exhibits near-room-temperature pyroelectricity, reversible X-ray-induced photochromism, and tunable dielectric and magnetic relaxation. We further efficiently integrated pentagon-bipyramidal SMMs into a two-dimensional MOFs using photoactive BPy linkers. The resulting SMM-MOF exhibited photochromic behavior at room temperature upon UV irradiation, accompanied by accelerated relaxation dynamics.[5]

This work establishes a foundation for multifield synergistic control in lanthanide molecular materials, advancing their potential in low-power, high-density memory and spintronic devices.



The magnetic-electric functions of a series of Ln-based molecular magnetic materials

Recent Publications

1. Cheng, P. *Lanthanides: Fundamentals and applications*, Elsevier, (2023).
2. Wang, Y.-X., Ma, Y., Wang, J.-S., Yang, Y., Guo, Y.-N., Zhang, Y.-Q., Jin, K.-J., Sun, Y., Cheng, P. *Adv. Sci*. 9 (2022) 2202979.
3. Wang, Y.-X., Ma, Y., Chai, Y., Shi, W., Sun Y., Cheng, P. *J. Am. Chem. Soc*. 140 (2018) 7795–7798.
4. Wang, Y.-X., Su, D., Ma, Y., Sun Y., Cheng, P. *Nature Commun.* 14 (2023) 7901.
5. Wang, X.-Q., Geng, Y.-W., Wang, Z., Xie, C., Han, T., Cheng, P. *J. Am. Chem. Soc.* 147 (2025), 18044.

Biography

Peng Cheng obtained his B.Sc., M.Sc., and Ph.D. degrees from Nankai University in 1985, 1991, and 1994, respectively. Subsequently, he started his academic career at the same university and was appointed a full professor in 1996. From 1997 to 1999, he worked at Laboratoire de Chimie de Coordination du CNRS as a visiting professor and at Texas A&M University as a postdoctoral research fellow. Since 2007, he has been Cheung Kong Professor at Nankai University, where he currently works on functional coordination polymers and molecule-based materials. He has authored “Lanthanides: Fundamentals and applications” (Elsevier, 2023) and edited “Lanthanide Metal-organic Frameworks” (Springer, 2015).

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