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Editorial

Preface to the Proceedings of ICMM 2002

The VIIIth International Conference on Molecule-based Magnets, ICMM 2002, was held in Valencia, Spain, between October 5th–10th and provided an opportunity to reflect upon the worldwide growth as well as the challenges of the diversifying area of molecule-based magnetic materials. The recent developments reported at the meeting sample the liveliness and rapid evolution in this area. Thus, the scientific interest of chemists, which was initially mainly focused on synthesizing new molecule-based magnets possessing higher critical temperatures, has evolved towards the development of more complex materials with one or more specific properties, as well as towards the investigation of nanosized magnetic molecules, and to materials that processing aimed at applications.

In the work dealing with complex materials, there is a clear trend towards combining the magnetic behavior with other technologically important properties to develop bistable and multifunctional materials capable of hysteresis and switching phenomena. Remarkable examples that illustrate this concept were reported at the meeting. Worthy of mention are the materials where magnetism can be tuned by light (molecule-based photomagnetism). Such photoinduced magnetism has been studied in many different materials, primarily those with the Prussian blue structure, but also in the metal/organic magnet $Mn(TCNE)_2$. In addition to the 'light-tunable magnets', spin-crossover materials are another important class of bistable, switchable materials whose magnetic properties and color can be reversibly changed by light, temperature, or pressure, leading to promising applications as thermal displays, optical devices and pressure sensors. Significant advances were also reported in the design of extended networks based on these molecular bricks, which exhibit large cooperative effects. Finally, an emerging class of magneto-optical compounds are the chiral magnets, which may exhibit a coupling between optical activity and ferromagnetism. Coordination compounds of this kind showing 1D to 3D structural motifs were reported, although it remains to be demonstrated that these materials exhibit magneto-chiral dichroism, and that the magnetic structure of these materials is chiral. A different class of multifunctional materials that has also been strongly investigated which is magnetic conductors. Typically these molecular materials have a hybrid nature. They are formed by segregated layers of an organic donor molecule and inorganic magnetic counter-ions. The first examples of molecular materials involving the coexistence of ferromagnetism and metal-like conductivity have just been reported. The coexistence of ferromagnetism and superconductivity in a molecular material remains an open challenge for the future. Meanwhile, paramagnetic superconductors have been discovered that may exhibit novel physical phenomena, such as, for example, the observation of superconductivity induced by applying a magnetic field.

Another trend in the field deals with the design and physical study of new molecular nanoscale materials. Significant efforts have been devoted to obtaining single-molecule nanomagnets because they exhibit slow relaxation of the magnetization and resulting magnetic hysteresis analogous to that observed in bulk magnets, but with quantum effects. While the blocking temperature has yet to increase above liquid helium temperatures, new physical phenomena arising from quantum tunneling effects have been reported in these molecular clusters. Another important result has been the observation of similar magnetic bistability effects in chain compounds having Ising-type anisotropy. In these single-chain magnets, the hysteresis seems to be related to a cooperative behavior within the chain, without requiring inter-chain interactions.

As far as the applications of molecule-based magnets are concerned, some advances have been made in the processing of these materials, with a growing interest in exploring their benefits in molecule-based electronics, spintronics, information storage, quantum computing and other nanotechnologies. Thus, some magnets have been prepared as thin films, and attempts to control a supramolecular 2D organization of molecule-based magnets and single-molecule magnets have been reported using the Langmuir–Blodgett technique. The deposition/insertion of magnetic molecules on/into solid supports, as well as their observation using atomic force and magnetic force microscopies, have also been explored in order to obtain single-molecule-based magnetic quantum dots. Finally, an interest in thin films of molecule-based magnetoresistive materials in spintronics has been suggested.

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In all the above trends, one observes a clear evolution of the field from a need for basic physical tools, like magnetometry, to characterize *as-prepared* magnetic molecules and molecular compounds, to an increasing use of more sophisticated techniques, which include the use of neutrons, muons, solid state NMR, pressure and light effects, and so on. A further step in the involvement of physics methods is the interest in the new physical behavior that is emerging from the unique possibilities offered by molecular magnetic materials. The paradigm is the quantum tunneling effects associated with single-molecule magnets. These novel physical phenomena are motivating the interest of theoretical physicists and quantum chemists, both of whom are becoming more and more involved in Molecular Magnetism.

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Eugenio Coronado Miralles
University of Valencia,
Valencia,
Spain