Magnetic characterization of Zn(II)-Ln(III) based Single Molecule Magnets (SMMs)

Introductory part, Abstract: In order to fully characterize the dynamic magnetic properties of a wide number of SMMs, magnetization curves in a full cycle pulsed magnetic field were studied. This technique allows us to observe open hysteresis loops that are often undetectable with conventional measuring methods.

The SMMs studied in this period at IMR were previously characterized by the common alterning current (ac) magnetic measurements. This technique allows us obtaining relaxation times (τ) at different temperatures and, subsequently effective energy barriers (U_{eff}) and τ_0 values. However, in our case due to the limitations of our instrument, these τ values were obtained for high temperature ranges, over 10.0 K, a fact that becomes a problem when willing to study the quantum tunnelling regime (QTM), around 2 K.

A possibility to overcome this situation is to measure conventional hysteresis loops at low temperatures. However, it is well known that for low symmetry systems, the QTM is usually so strong that open loops are barely observed.[1] Thus, magnetization curves in a full cycle pulsed magnetic field were studied. These pulses are so strong and fast that even SMMs with strong QTM display open hysteresis loops, which allows us to compare similar compounds' behaviour in the low temperature range.

For instance, Fig. 1 shows open loops for compounds **1-4**. These coordination compounds are Zn_2Dy_2 based tetranuclear systems with very similar core structures. They all contain a flexible Mannich H_4L ligand with coordinating phenoxo, methoxy and amine groups (inset of Fig. 1 displays the structure of **1**, the other compounds are derivatives of it).

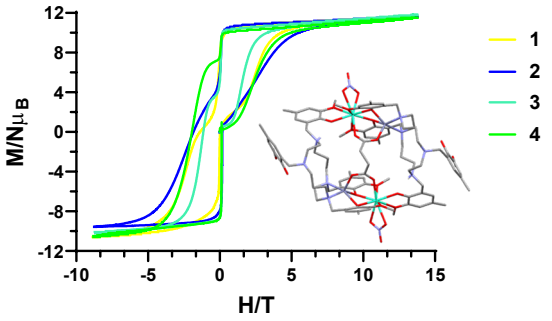

Fig. 1 Pulsed-field magnetization curves at 0.4 K. Inset: Molecular structure of **1**.

The first coordination sphere has been subtly modified by replacing the chelating nitrate with other ligands with different electron donating capacity.

As observed in the figure, the steps occurring close to zero field differ from one to another, which clearly indicates that the modifications introduced in the structure are notably affecting the tunnelling regime.

Additionally, another family consisting of nine Zn(II)Dy(III) based compounds varying the bridging dicarboxylate was studied by the same technique. Apart from obtaining interesting information regarding the low temperature QTM, some of the systems displayed two thermally activated relaxation mechanisms (identified by two sets of maxima in the ac measurements), which were then detected in the pulsed-field magnetization curves. As an example, Fig. 2 shows the presence of two peaks for compound **5** in the dM/dB vs B plots, in fair agreement with the behaviour observed in ac magnetic measurements (molecular structure of **5** is depicted in the inset of Fig. 2).

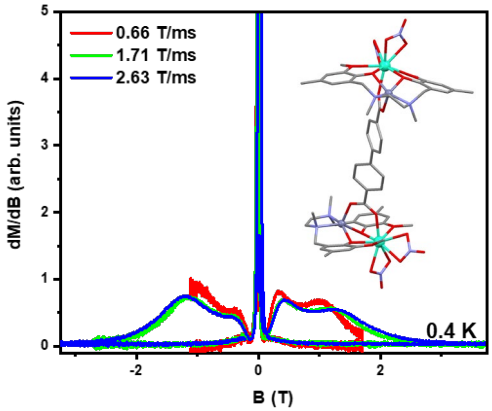

Fig. 2 Differential of magnetization for compound **5** measured at 0.4 K. Inset: Molecular structure of **5**.

It is noteworthy that apart from the mentioned systems many others have been studied during the stay at IMR. The data is currently being analysed and the results are expected to be published in the near future. This work was supervised by Prof. H. Nojiri and Dr. I. F. Díaz-Ortega.

References

[1] I. F. Díaz-Ortega, J. M. Herrera, T. Gupta, G. Rajaraman, H. Nojiri and E. Colacio, Inorg. Chem. 56, 5594 (2017).

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