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Imaging and modelling the Spatio-temporal Dynamics of First-Order Spin Transitions in Spin-Crossover Single Crystals.

K. Boukheddaden[1], N.E.I Belmouri[1], H. Fourati[1], S. Triki[2], Y. Singh[1], M. Ndiaye[1], N. di Scala[1].

[1]Université Paris-Saclay, GEMAC, UMR CNRS 8635, 45 Avenue des Etats Unis, 78035, Versailles, France.
[2]Université de Brest, CNRS, CEMCA, 6 Avenue Victor Le Gorgeu, C.S. 93837, 29238 Brest, Cedex 3, France.

Abstract

Imaging the spatiotemporal dynamics[1] of spin transition (ST) materials by optical microscopy (OM) at the scale of one single crystal has recently emerged as a highly efficient method allowing a deep understanding of their cooperative macroscopic transformation between the low-spin (LS) and high-spin (HS) states. In this communication, we will show some typical examples[2] (see Fig. 1) of real time transformation of ST single crystals exhibiting first-order transitions with well-defined front interfaces. The velocities, shapes and orientation of the HS/LS interfaces will be discussed in relation with the macroscopic shape of the crystals and the structural transformations of the unit cells. Under light, the ST solids display photo-induced phenomena through LIESST (Light-Induced Excited Spin-State Trapping) effect. When this process competes with thermal relaxation, Light-Induced Thermal Hysteresis (LITH) effect is obtained. Both of these phenomena and their spatiotemporal properties will be characterized by OM[3]. Finally, we will demonstrate that light irradiation[4] can be used as a relevant stimulus leading to control the front interface as well as to select the nucleation point[5] at which the spin transition can be triggered, while the latter effect is usually a stochastic process in thermal transitions. Overall, the spatiotemporal properties of the nucleation, growth and propagation of the spin domains will be discussed and their modelling will be presented.

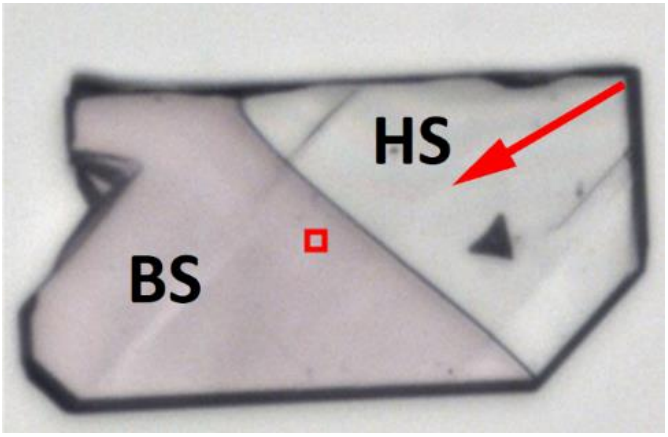

Figure 1. OM imaging of the interface propagation along the HS to LS transition in a single crystal of the compound $\{Fe(2pytrz)_2[Pd(CN)_4]\}.3H_2O$ exhibiting a hysteretic incomplete spin transition.

References

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Biography

The author is a full Professor of Physics since 2005 in Versailles's University. He is a solid state physicist, expert of equilibrium and nonequilibrium aspects of phase transitions in molecular solids, including spin-crossover systems, Prussian Blue analogs, charge transfer solids (mixed valence) and photo-luminescent hybrid organic-inorganic for which he studied the correlation between their optical and structural properties. The author has also an expertise in real time optical microscopy imaging of phase transitions, and in theory of spatiotemporal dynamics of thermally- or optically-induced first-order phase transitions, using elastic models, Monte Carlo simulations, Molecular Dynamics and reaction-diffusion approaches. He was awarded his PhD in Solid State Physics in 1993 from the University of Pierre et Marie Curie (Paris VI), France. He published more than 260 papers. His H-index is ~ 40 on WOS.

Email: kamel.boukheddaden@uvsq.fr