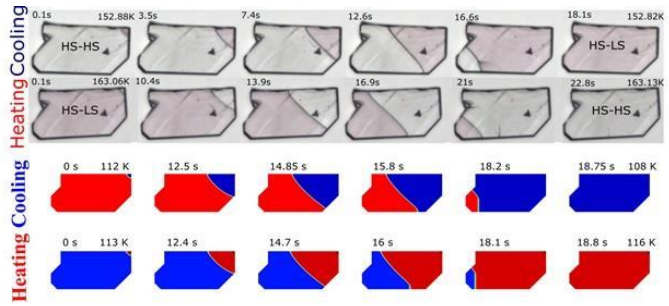
New paradigm in the spatiotemporal properties of spin-crossover single crystals: interface control and photo-induced effects

Kamel BOUKHEDDADEN [1]

[1]*Université de Versailles-Paris Saclay, Groupe d'Etudes de la Matière Condensée, UMR CNRS 8635, 45 Avenue des Etats Unis 78035, Versailles, France*

Abstract

Recent developments in techniques of visualisations and imaging allow tackling the problem of phase transition in a unique single crystal. The spin-crossover (SCO) materials, which are perfect prototypes of first-order transitions, combine at the transition between the low-spin (LS) and the high-spin (HS) states, changes in colour and size of the crystals in the concomitant way. They revealed to be excellent candidates for spatiotemporal studies of thermo- and photo-induced phase transitions on a unique single crystal. In this presentation, we will show several experimental examples of spin transitions measured on different types of single crystals, demonstrating the richness and the complexity inherent to these materials. In addition to their thermochromic character, SCO exhibit a volume change accompanying the spin transition, allowing an extra degree of freedom, complicating the measurements on one single crystal, which often jumps at the transition, due to the accumulation of elastic stress. However, systems exhibiting an incomplete hysteretic thermal transition revealed to be very robust and their resilient character made possible their imaging in both cooling and heating processes, without crystal damage. We then could observe well-defined transformation fronts[1-5] between macroscopic HS and LS phases. The shape, the orientation and the motion of the front interfaces (see Figure) will be discussed in detail on the videos of the spin transition. Moreover, at very low temperature (~10 K), under light, metastable photo-excited HS phase can be generated thanks to LIESST effect. Interestingly, the emerging photo-excited HS state is stabilized by the volume change accompanying the photo-transformation. This volume change, considered as problematic for equilibrium phase transition, is now an ally helping to obtain the photo-induced metastable phases. Finally, if time permits we will illustrate some of the developed models[6-9] allowing a fair description of these phenomena, notably the HS/LS front dynamics.



Recent Publications

1. *H. Fourati H. Fourati, E. Milin, A. slimani, G. Chastanet, Y. Abid, S. Triki and K. Boukheddaden, Phys. Chem. Chem. Phys. 20 (2018)10142-10154.*
2. *M. Paez-Espejo, M. Sy and K. Boukheddaden, J. Amer. Chem. Soc. 140 (2018) 11954−11964.*
3. *B. Benaicha, K. Van Do, A. Yangui, A. Lusson, M. Sy, H. Fourati, G. Bouchez, Carlos J. Gómez-García, S. Triki and K. Boukheddaden, Chemical Science 10 (2019) 6791-6798.*
4. *Fourati Houcem and Boukheddaden Kamel, Phys. Rev. B 101 (2020) 101, 224101*
5. *M. Sy and K Boukheddaden, J. Phys. Chem. C. 124, 51, (2020) 28093–28107*
6. *Y. Singh, H. Oubouchou, M. Nishino, S. Miyashita and K. Boukheddaden, Phys. Rev. B. 101 (2020) 054105*
7. *K. Affes, A. Slimani, Y. Singh, A. Maalej and K. Boukheddaden, J. Phys. Cond. Matt. 32 (2020) 255402.*
8. *M. Ndiaye, Y. Singh, H. Fourati, M. Sy, B. Lo and K. Boukheddaden, J. Appl. Phys. 129 (2021) 153901*
9. *M. Ndiaye, K. Boukheddaden, Phys. Chem. Chem. Phys. (2022) https://doi.org/10.1039/D2CP01285E*

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Biography

Kamel Boukheddaden completed his Ph.D in Physics in 1993 from the Université Pierre and Marie Curie in Paris, France. He was an Assistant Professor at the University of Versailles (1994), then Associate Professor in 1995. He became a full Professor in the same University in 2005. His main field concerns the thermo- and photo-induced phenomena in switchable molecular solids (spin-crossover, Prussian blue analogs and charge transfer solids). He is interested in both equilibrium and non-equilibrium properties of these molecular materials through direct visualization of the crystal transformation along their phase transition by means of optical techniques. His current work focusses on the control the front interfaces motion and the emergence of photo-induced self-organized structures. The modeling of these phenomena using statistical mechanics models based on spinelastic models associating Monte Carlo and Molecular dynamics simulations and/or reaction diffusion descriptions represent also specific topics of interest. K.B. has co-authored more than 240 papers in well recognized physics and chemistry journals, including 12 book chapters on physics and guest editions. His h-index is 47 with 7031 citations (GScholar, April 2022).

E-mail: kamel.boukheddaden@uvsq.f