Advanced quantum materials for efficient eco-friendly magnetic refrigeration

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Résumé

In recent years, magnetocaloric materials have attracted a worldwide interest from both scientists and industrials owing particularly to their potential utilization as solid refrigerants in more efficient and clean cooling systems [1]. Based on the magnetocaloric effect (MCE), magnetic refrigeration enables us to fully suppress the hazardous HFCs, CFCs and HCFCs-based refrigerants usually used by conventional refrigerators, while offering a high thermodynamic efficiency [1]. The magnetocaloric material is a key parameter for the development of this emergent technology. Aiming to find alternatives to magnetocaloric materials containing a large amount of rare-earth elements, more interesting compounds such as LaFe13-xSix, MnFeP1-xAsx and La1-xAxMnO3 have been reported over the last two decades [1]. Several research groups are now focusing on the optimization of their physical, mechanical and chemical properties as well as the evaluation of their performance in functional devices. However, the gap to be bridged in going from fundamental research on materials to their integration in competitive magnetocaloric devices is highly challenging. In fact, the considered candidates must meet a series of requirements before their practical utilization. They must show large magnetocaloric effect over a wide temperature range, strong mechanical and chemical stabilities, negligible hysteresis losses, high thermal conductivity, high electrical resistance, safe and cheaper constituent elements and, reasonable production costs. Therefore, the discovery of new "super magnetocaloric materials "combining all these characteristics would be a breakthrough in the field.
It is also worth noting that the most majority of research works in relation with magnetocalorics are dedicated to bulk materials. However, the nanoparticles and thin films approaches would enable new useful magnetocaloric architectures and could pave the way for specific applications in spintronic devices, in chemistry, biology and medical science.

In this presentation, we will discuss recent progress in magnetocaloric materials, from both fundamental and practical points of view. Interesting routes for the design of efficient materials and systems will be given. Finally, we will present our recent results regarding the magnetic and magnetocaloric properties of some selected double perovskites and other oxides including both bulk forms and thin films [2].

M. Balli, S. Jandl, P. Fournier, A. Kedous-Lebouc, *Advanced materials for magnetic cooling: fundamentals and practical aspects*, Applied Physics Reviews, 4 (2017) 021305.

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D. Matte, M. de Lafontaine, A. Ouellet, M. Balli, and P. Fournier, *Tailoring of the magnetocaloric effect in La2NiMnO6 thin films*, to appear in Phys. Rev. Applied (2018).