NAPLES, ITALY 23-27 JUNE
DSL2025 NAPLES
21st International Conference on Diffusion in Solids and Liquids

ABSTRACT

Gadolinium-Oxide Nanoparticles for Cryogenic Magnetocaloric Applications

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The demand for eco-friendly technologies we are facing in recent years is the impetus for the development of advanced energy-efficient systems and devices. It is expected that conventional technology based on gas expansion will be soon replaced by a fundamentally different principle exploiting magnetocaloric effect (MCE). MCE is related to magneto-thermodynamic phenomenon, i.e. a temperature change induced in a material by the variation of applied magnetic field. The main advantage of nanoparticles over the bulk materials stems from wider options for tuning the characteristics of the refrigerant material. While the change of working temperature, refrigeration capacity or phase transition character in bulk materials can be induced almost exclusively by chemical composition, in the case of NPs, size, shape, capping layer or dilution of nanoparticle system affect those qualities.

In presented work, The series of advanced nanocomposites consisting of Gd2O3 nanoparticles (NPs) embedded into periodic porous SiO2 matrix have been investigated with respect to their structural and magnetocaloric properties. By means of small angle neutron scattering and transmission electron microscopy, regular nanopores organized in the cubic or hexagonal superlattice have been documented. All of the examined systems have exhibited extraordinarily high values of magnetic entropy change (up to 70 J kg−1 K−1) at low temperatures with the absence of thermal hysteresis, indicating their perspective utilization in cryogenic refrigeration. Profound analysis of magnetic entropy change data via scaling laws has been applied to the nanocomposite materials for the very first time.