Keep Cool with Crystals: Crystals under Pressure for the Refrigeration of the Future.

Elen DUVERGER-NEDELLEC (Univ. Bordeaux, CNRS, Bordeaux INP, ICMCB, UMR 5026, FR),
Mehdi IDRISSOU (Univ. Bordeaux, CNRS, Bordeaux INP, ICMCB, UMR 5026, FR),
Nathalie DARO (Univ. Bordeaux, CNRS, Bordeaux INP, ICMCB, UMR 5026, FR),
Guillaume CHASTANET (Univ. Bordeaux, CNRS, Bordeaux INP, ICMCB, UMR 5026, FR),
Philippe GUIONNEAU (Univ. Bordeaux, CNRS, Bordeaux INP, ICMCB, UMR 5026, FR),
Michaël JOSSE (Univ. Bordeaux, CNRS, Bordeaux INP, ICMCB, UMR 5026, FR),
Mathieu MARCHIVIE (Univ. Bordeaux, CNRS, Bordeaux INP, ICMCB, UMR 5026, FR),
Patrick ROSA (Univ. Bordeaux, CNRS, Bordeaux INP, ICMCB, UMR 5026, FR).

Abstract

Refrigeration devices we use in everyday life (air conditioners, refrigerators, etc.) are responsible for 8% of global greenhouse gas emissions. An alternative to refrigerant gases would be the use of a technology based on a solid, easily handled and recyclable, and its mechanical response to a pressure/depression cycle [1]. Among these materials, known as barocaloric materials, molecular spin-crossover (SCO) compounds have been identified as having promising barocaloric potential [2,3]. Although obtaining these materials in single-crystal form is complex, large quantities of polycrystalline powder can be produced from non-critical, inexpensive, abundant, and non-toxic elements. However, using powder in a technological application is challenging. Being able to process it into a more compact form, in order to facilitate the handling of the material of interest, is therefore a prerequisite for technological development.

While Cool-SPS (Spark Plasma Sintering) pelletizing has been demonstrated on various model systems to produce compact, centimeter-sized monoliths of brittle compounds [4], only one study has been reported for a molecular spin-crossover (SCO) material [5] leading to resulting densities comprising between 80 and 90% of the density of the corresponding crystal structure. The densification via Cool-SPS of new molecular SCO compounds has been investigated within the framework of FROSTBIT project (First Regenerative Solid-State Barocaloric Refrigerator) and will be presented. The FROSTBIT project relies on these molecular pellets to develop a regenerative cooling device with the aim of producing a fully functional refrigeration prototype.

Figure: Pellets of molecular compounds for barocaloric refrigeration.

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