Organic materials for barocaloric cooling

Ground-breaking solutions for efficient cooling

Dr Xavier Moya and his collaborators have identified a new class of solid-state materials which can demonstrate cooling performance similar to that in commercially available products but without the environmental issues associated with liquid-vapour-phase cycles. This is expected to enable a new generation of cooling devices, from refrigeration to air conditioning. The team is now keen to collaborate with suitable partners for development of the technology.

Key Benefits

- Energy efficient solid-state materials – no volatile hydrocarbons
- Uses cheap compounds to manufacture
- Small pressure changes required
- Fast initial cooling at start-up

Dr Xavier Moya is a Royal Society University Research Fellow in the Department of Materials Science & Metallurgy. His research focuses on phase transitions in functional materials in which thermal, structural, magnetic and electrical properties display strong coupling.

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What problem do these materials solve?

Environmentally damaging CFCs were replaced in vapour-compression cooling systems by less efficient gases that have greenhouse effects comparable to CO_2. There are still issues with leakages and appliance end-of-life disposal due to the use of these gases, as well as lower efficiencies leading indirectly to increased carbon emissions. Solid-state coolants have the potential to solve all the problems with environmentally damaging gas leaks and inefficiency, but they come with their own challenges, outlined in the table below. The new class of materials identified by Dr Moya and his collaborators overcomes the limitations of solid-state coolants studied to date, having large entropy changes at temperatures close to room temperature even for small external pressure changes, and demonstrates low hysteresis across the cycle, providing a design which could be adapted to multiple cooling applications without significant technical challenges.

Applications

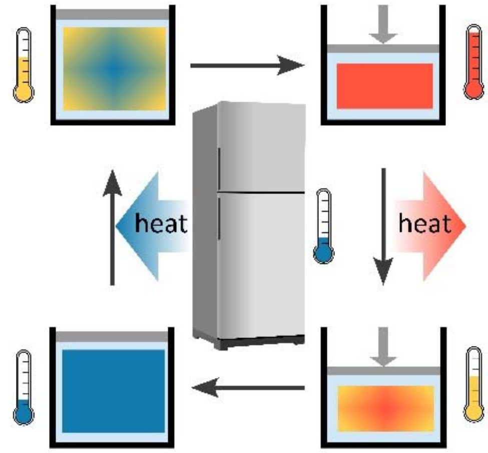
These materials may allow the design of more energy efficient refrigeration units and air conditioning units, compared to current state-of-the-art refrigeration technologies, but could also enable applications which are currently limited, such as seat cooling in automotive vehicles.

Other applications requiring cooling could also benefit from this new approach, which is potentially much smaller and less cumbersome than air and ground source cooling pumps, and which also could remove the need for large volumes of water and the corresponding problems of metal corrosion associated with water cooling in industrial processes. Many of these processes could be effectively cooled using system designs with these new materials.

Features of the new materials

In addition to the increased efficiency and performance capabilities, the new materials exhibit the following:

- Cheap synthesis from readily available materials
- Large entropy change at temperature close to room temperature with low hysteresis
- Small required pressure changes



Schematic of the barocaloric cooling cycle

Caloric Material	Problems
Magnetocaloric (magnetic field)	Requires large magnetic field, expensive materials
Electrocaloric (electric field)	Low thermal mass, thin films
Elastocaloric (mechanical stress)	Uniaxial stress & fatigue
Barocaloric (pressure)	Typically small entropy changes for high pressure changes, expensive materials

Comparison of different solid-state cooling approaches and materials

Next Steps

This technology is protected by a PCT application, WO2018069506. We are now looking for partners to help us develop the materials for a range of applications. Please contact us using the information on the front page if you would like to explore this opportunity.