Towards the magnetic fridge

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Researchers at the University of Cambridge have discovered a material that gives a whole new complexion to the term 'fridge magnet'. When this alloy is placed in a magnetic field, it gets colder. Karl Sandeman and his co-workers think that their material - a blend of cobalt, manganese, silicon and germanium - could help to usher in a new type of refrigerator that is up to 40 percent more energy-efficient than conventional models.

Given how much energy is consumed by domestic and industrial refrigeration, that could have a significant environmental payoff. Sandeman describes the work at the Institute of Physics Condensed Matter and Materials Physics conference at the University of Exeter, on Friday 21 April.

The 'magnetic fridge' envisaged by the Cambridge team would use a phenomenon called the magnetocaloric effect (MCE), whereby a magnetic field causes certain materials to get warmer (a positive MCE) or cooler (a negative MCE). Although the effect was discovered more than 120 years ago, it is only recently that magnetocaloric materials have been known with the right properties for use in everyday refrigeration. But several factors have so far prevented such applications.

For one thing, some of the materials - typically metal alloys - that show the strongest MCE contain the element gadolinium, which is very expensive. And some of the best potential alternatives contain arsenic, raising health concerns.

Sandeman and colleagues have now found a material that is neither toxic nor costly, and which generates significant cooling at around room temperature. The key to the magnetocaloric behaviour is a sudden change in the magnetic state of the compound - a so-called magnetic transition. The material is magnetic because it contains metal atoms that themselves act like tiny bar magnets. As it is warmed up from subzero temperatures, there comes a point where these atomic magnets abruptly change the way in which they are lined up. This switch occurs at different temperatures when the material is placed in a magnetic field. So applying such a field can trigger the magnetic transition, and the resulting realignment of atomic magnets can then cause the material to lose heat and become colder - in other words, it shows a negative MCE.

Such a material could act as a heat pump for refrigeration. Applying the magnetic field triggers cooling; then the field is switched off and the material absorbs heat from its surroundings, cooling them down. Once that has happened, the field is switched on again and the cycle repeats, each time sucking more heat from the surroundings.

Sandeman and colleagues say that their new magnetocaloric material is particularly attractive because it can be tuned - depending on the strength of the applied magnetic field, as well as the way the substance is synthesized - to work over a wide temperature range, making it potentially suitable not just for a kitchen fridge working at room temperature but for other cooling applications at higher or lower temperatures. The Cambridge team are now developing a spin-off company, Camfridge Ltd, to bring their new materials system to real applications.

Source: Institute of Physics