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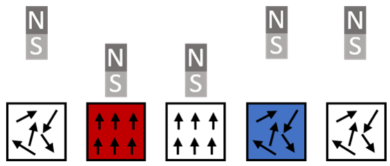
Stop humming sounds in your kitchen with magnetic refrigeration

Refrigeration systems have a long tradition: over 2000 years ago people had already started building so-called ice-houses to store ice from the winter that could be used during warmer periods. The developments that lead to modern refrigerators started in the 1700s when simple pumping systems came into use. What we have in our kitchens nowadays are so-called vapour compression refrigerators. Have you ever heard a constant humming sound in your kitchen before? This sound is most certainly coming from your refrigerator. As it cools our food, heat is transported from the inside of the fridge to the outside. This works based on the simple principle of temperature changes of a cooling agent: when it is compressed the vapour heats up and when it is allowed to expand it cools down. Besides the humming sound of the compressor that might be slightly annoying, typical cooling agents are hydrocarboflurides or ozone-depleting chemicals, which are not eco-friendly.



Schematic image of the magnetic refrigeration principle.

Over the last few years, researchers have been investigating alternative methods to reduce the use of environmentally unfriendly gases and improve the efficiency of these cooling systems. One such method is called magnetic refrigeration. Here, the underlying physical principle by which heat is transported from the inside of a fridge to the outside is the magnetocaloric effect. This concept describes the temperature change of a material caused by a change in an external magnetic field, as shown in the Figure. Applying a magnetic field to a material will force the magnetic moments (depicted as arrows) to align with the external field, similar to the needle of a compass. This process is accompanied by an increase in temperature of the material as it takes up heat from the surroundings, just like in vapour compression refrigerators. The heat from the material can then be transported away by an eco-friendly cooling agent such as water. Removing the magnetic field lets the magnetic moments relax, which cools down the material even further. From this cooled state, the material can again absorb heat from the refrigerator inside, repeatedly passing through the cooling cycle.

The magnetocaloric cooling principle is already used for experimental research but is also promising for everyday usage in common refrigerators. However, to establish such magnetic refrigeration, we first need to find a suitable magnetocaloric material – one for which the magnetocaloric effect is maximal between room temperature and the temperature we want to achieve inside the fridge. A promising alloy that is currently under investigation is MnCoSi. Physicists have found that the performance of MnCoSi for this purpose depends highly on the structural properties of the material. One example is the effect of strain on the cooling power of MnCoSi. This thesis work is a systematic study of how strain is induced into the structure during the production process. It shows that the structure of MnCoSi and the strain are very sensitive to the production parameters and methods. This is necessary to understand to better tailor the properties of MnCoSi for use in magnetic refrigeration. Thus, this work does not only contribute to the development of a more environmentally friendly cooling system but would also remove the humming sounds from our kitchens.

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