LT-SOFC and magnetic cooling at Risø-DTU

Nini Pryds

Fuel Cells and Solid State Chemistry Department
Risø National Laboratory for Sustainable Energy
Technical University of Denmark - DTU

Nini.pryds@risoe.dk

Abstract

The Fuel Cells and Solid State Chemistry Department at Risø DTU is among the world's research leaders in solid oxide fuel cells (SOFCs) – a technology for clean and efficient conversion of chemical energy (in the form of, e.g., natural gas, hydrogen, biogas, ammonia or methanol) into electricity and heat. In addition we have activities within a number of related topics in functional ceramics, including high-temperature electrolysis, oxygen and hydrogen separation membranes, electrochemical flue gas purification and magnetic refrigeration.

In the present talk I will concentrate on our activity within the area of low temperature SOFC and magnetic cooling. Due to the low ionic conductivity for SOFC electrolytes, SOFCs usually work at temperatures of as high as ~750-850 °C. However, as the temperature is reduced, the ionic conductivity significantly decreases. To overcome this problem one may either develop new materials which show high ionic conductivity at low temperature or use very thin film electrolytes to reduce the ionic resistance. This reduces the ohmic resistance of the electrolyte and increases the power density of the fuel cell and as a result, a thin-film SOFC can operate at lower temperatures. Some preliminary results in this area will presented.

Magnetic refrigeration is a promising technology for energy efficient and environmentally friendly cooling. The technology uses magnetic materials as the active components and non-volatile fluids, e.g. water, for heat transfer. When magnetic materials are subjected to an external magnetic field, their temperature rises when the field is then removed the temperature decreases. This changes of the temperature upon magnetization and demagnetization is used to generate cooling. The magnetisation/demagnetisation cycle is reversible and the efficiency of the entire cooling cycle may be as much as 60% greater than for conventional compressor based refrigerators. The Fuel Cells and Solid State Chemistry Department at Risø, DTU has been working on magnetic refrigeration since 2001. The project focuses on the crucial challenges for the technology: Development and synthesis of better ceramic materials, development of cheap, high-field permanent magnets, and design and optimisation of the entire refrigerator system. The goal of the project is the construction of a prototype of a magnetic refrigerator using magnetocaloric ceramics and permanent magnets. Some of the results in this area will be presented.