Seminar

Date & Time: Wednesday May 21st and 28th, 10:30-12:00

Venue: Kyushu University（https://www.kyushu-u.ac.jp/ja/campus/ito/）
Building West 2, 2F, Room 209

Thermodynamic applications of magnetism I & II

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In magnetic materials, a huge number of spins exist at high density. Nearly a century has passed since the so-called magnetic refrigeration, an attempt to thermodynamically apply such spin degrees of freedom to form a heat cycle, was proposed. Historically, magnetic refrigeration based on the magnetocalorimetric effect developed as a technology for generating cryogenic temperature, and is currently used in the limited fields, such as the generation of ultra-low temperatures, which is difficult with gas refrigeration, and in space applications. On the other hand, gaseous refrigeration is widely used in general-purpose refrigeration technologies such as air-conditioning, refrigerator-freezer, and even natural gas liquefaction, which are essential in modern society. However, a challenge in air-conditioning and refrigeration is that the global warming potential of refrigerant gases is more than a thousand times higher than that of CO_2. In addition, the efficiency of gaseous refrigeration decreases as the temperature at which it is generated lowers, due to its principle, so the efficiency is extremely low in cryogenic refrigeration such as liquefaction of natural gas and hydrogen. Against this social background, in recent years, research and development for the practical application of magnetic refrigeration at room temperature and cryogenic applications has been actively pursued from both the material and system sides. In this seminar, the principles of magnetic refrigeration, the characteristics of the refrigeration cycle (Carnot cycle and active regenerative magnetic refrigeration cycle), the basic type of materials and systems required to realize them will be reviewed, and also the concept and current status of material development and of system development will be introduced. As specific examples, research on room temperature magnetic refrigeration (~300 K) using the permanent magnet, magnetic refrigeration for hydrogen liquefaction (~20 K) using the superconducting magnet, and generation below 1 K by multi-stage adiabatic demagnetization will be introduced, and I hope to provide an opportunity to consider together with you the challenges and prospects for practical applications.

Bio

Akiko T. Saito is a Chief Reseacher at National Institute for Materials Science (NIMS). She began her career as a researcher at Toshiba R&D center, having a background in solid state physics, her work focuses specifically on the magnetic materiales such as cryogenic regenerator materials, GMR spin-valve head, magnetic refrigeration technology for cryogenic to room temperature applications. By applying magnetic specific heat to cryogenics, she contributed the innovation of the performance of GM refrigerators and the spread of MRI. During this research, she got a doctor degree from Tokyo Institute of Technology. Recently, magnetic refrigeration using magnetocaloric materials has been her favorite activity through AIST and NIMS. These days, hydrogen liquefaction based on magnetic refrigeration has been demonstrated in a lab-scale trough JST Mirai Pj.

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