Seminar: Atsufumi Hirohata

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Heusler Alloys for Spintronic Devices

Biography

Dr. Atsufumi Hirohata is Professor at the Center for Science and Innovation in Spintronics at Tohoku University (since October 2023). He previously served as Senior Professor in Nanoelectronics at the University of York after joining in 2007. His research spans over 15 years in spintronics, from magnetic-domain imaging to spin-current interference devices. He previously held research positions at RIKEN, Tohoku University, and MIT, contributing to spin-current transistors, epitaxial full-Heusler alloys, and phase-change memory technologies. He earned his PhD in Physics from the University of Cambridge in 2001 and completed earlier degrees at Keio University.

He has published over 150 refereed papers and 6 book chapters, with 36 patents filed. His work appears in leading journals including Nature Materials, Nature Electronics, and Physical Review Letters. He has delivered over 150 invited talks worldwide and has been highly active in the IEEE Magnetics Society, serving as President (2023–24). He also serves on several editorial boards. His current research focuses on spin operators and half-metallic film growth for next-generation spintronic devices.

Abstract

In spintronics, magnetic tunnel and giant magnetoresistive junctions have been commonly used for magnetic recording, memories and sensors [1,2]. These junctions typically consist of a CoFeB/MgO/CoFeB trilayer. They satisfy the endurance required for nanometric fabrication and GHz operation. For further improvement in their performance, namely their magnetoresistance ratios, Heusler alloys can be an ideal candidate due to their half-metallicity.

Here a Heusler alloy is an ideal vehicle for the development of a new magnetic materials as it covers almost the entire scope of magnetic properties, starting from ferromagnetism and antiferromagnetism to ferrimagnets, spin-gapless semiconductors and topological insulators. Although their crystallinity is important to exhibit these magnetic properties, some alloys can be robust against minor atomic substitution and distortion. This means by forming a crystalline foundation for a Heusler alloy, the corresponding magnetism can be controlled by the compositions, i.e., the total number of electrons contributing transport in a unit cell.

In this presentation, a range of Heusler alloys and their device applications will be reviewed to demonstrate their importance in spintronics. Recent outcomes using machine learning will also be discussed for the search of new Heusler alloys [3].

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References

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