Graduate Program in Spintronics Seminar

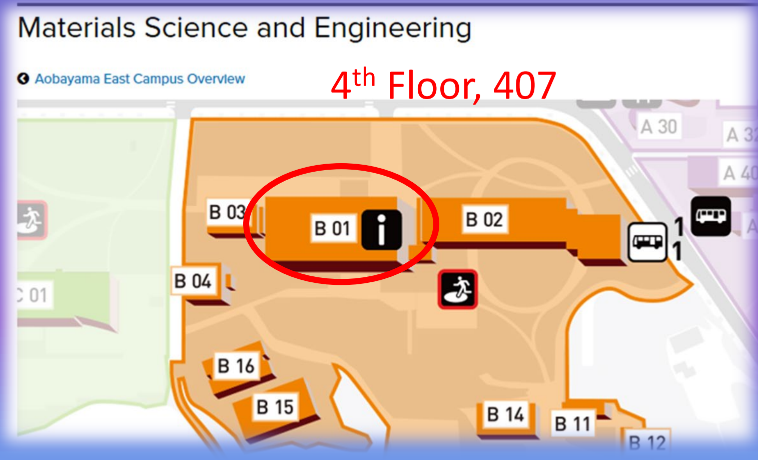
Spin current and spin-orbit torque in magnetic heterostructures

1:00-3:00 pm
Friday, July 19 2019

Room 407, Education and Research Building[B01]
School of Engineering,
Aobayama East Campus, Tohoku University

Professor Byong-Guk PARK
Department of Materials Science and Engineering,
Korea Advanced Institute of Science and Technology (KAIST)

[School of Engineering, Aobayama East Campus]



Inquiries: GP-Spin Office
spin.all[at]grp.tohoku.ac.jp
Phone: 0222-795-3657 / 5716

Spin current and spin-orbit torque in magnetic heterostructures

Byong-Guk Park
Department of Materials Science and Engineering, KAIST

In magnetic heterostructures such as non-magnetic metal (NM)/ferromagnet (FM) bilayers or FM/NM/FM trilayers, a spin current can be generated by a transverse charge current via spin-orbit interaction. The spin current exerts a torque on the FM layer, which is known as spin-orbit torque (SOT), manipulating the magnetization direction. SOT has gained much attention because it allows for efficient switching of perpendicular magnetization as well as high-speed domain wall motion.

In the first part, I present the results of the spin current generation in magnetic heterostructures, focusing (i) how to enhance the magnitude of spin current and (ii) how to manipulate the spin polarization direction of spin current. We demonstrate the enhancement in the spin current by controlling the resistivity of an NM Pt layer and by introducing a Ti interfacial layer at Pt/CoFeB structures. Moreover, we report that the spin polarization direction of spin current can be tuned in FM/NM/FM trilayer structures.

In the second part, I will discuss the issues on the SOT for device applications. I present the all-electrical deterministic SOT switching of perpendicular magnetization using antiferromagnet or FM/NM/FM trilayer. The former generates an effective magnetic field through the exchange bias, and the latter generates a spin current of out of plane spin polarization. Then, I will talk about a spin logic device based on a combination of voltage-controlled magnetic anisotropy and SOT. This shows the SOT-switching current is effectively controlled by an electric field in a non-volatile manner, facilitating complementary logic operations.