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Advanced spintronic materials based on ordered alloys

Materials used for spintronic devices should satisfy the following requirements like high spin polarization, leading to high efficiency in spin injection and high magnetoresistance, high magnetic anisotropy, leading to perpendicular magnetization and thermal stability of magnetization at reduced dimension and proper damping constant, leading to the optimization of the influence of spin transfer torque. It would be best to find a universal material that satisfies all these requirements; however, it is not easy. Starting from a material that satisfies one of each, usually, the way to extend the function by some modification of the material or to combine those materials might be adopted. We are interested in ordered alloys for spintronics, because some of ordered alloys show excellent functionalities such as high spin polarization and high magnetic anisotropy, and they are promising for the application to spintronics. Our group has been working on half-metallic Heusler alloys with high spin polarization, and demonstrated high CPP-GMR, which will be promising for the application to read heads in HDD. $Co_2MnSi/Ag/Co_2MnSi$, $Co_2FexMn_{1-x}Si/Ag/Co_2FexMn_{1-x}Si$ and $Co_2FexMn_{1-x}Si/Ag\text{-}Mg/Co_2FexMn_{1-x}Si$ epitaxial-layered structures were prepared by sputtering, and fabricated into pillar-shape by EB lithography for CPP-GMR measurements. The maximum MR ratio and the areal resistance change (ΔRA) obtained up to now are 62 % and 25 mΩ•μm2, respectively. CPP-GMR devices with half-metallic Heusler alloys also show high performance as spin torque oscillators (STOs) because of their low magnetic damping. A very high Q value of 4000 has been obtained with a power output of 10 nW.

Figure 1: Importance of ordered alloys for spintronic devices.

Biography

Koki Takanashi received his BS, MS, and Ph.D. degrees in Physics from the University of Tokyo. After postdoctoral research at Tohoku University, he joined the faculty there and is now a Professor and the Director of the Institute for Materials Research at Tohoku University. In 1994-1995 he was an Alexander von Humboldt Research Fellow at the Forschunszentrum Jülich in Germany. He has published over 350 papers and has receive numerous awards, including the Outstanding Research Award (2004, Magnetic Society of Japan), Outstanding Paper Award (2009, Japan Society of Applied Physics), Masumoto Hakaru Award (2011, Japan Institute of Metals). Professor Takanashi was the leader of a national project in Japan: "Creation and Control of Spin Current" (2007-2011). His research interests include magnetism and magneto-transport in nanostructures, magnetic materials for spintronics, and spin current phenomena.

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