【Grant-in-Aid for Scientific Research(S)】

Science and Engineering (Interdisciplinary science and engineering)

Title of Project : Selective control of magnetic transition using pure spin current injection and development of innovative nanospin devices

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Research Area : Spintronics
Keyword : spin injection, pure spin current, phase transition

【Purpose and Background of the Research】

Spintronic devices operated by the combination between the nonvolatile properties and spin-dependent transports have various attractive properties such as low power consumption, minimum cell size, fast operation speed and infinite endurance time. Recent technological developments related to the spintronics enable us to fabricate magneto-resistive devices with the resistance change over 200 % at room temperature. However, the change is much smaller than that of semiconductor transistors, which is more than several orders of magnitude. Therefore, address selection transistors are still required for integrating spintronic devices. This means that the limits of the integration for the spintronic devices are also determined by the transistor size as in the semiconductor devices.

To solve this issue, we will develop an innovative spintronic devices with a resistance change of several orders of magnitude by utilizing the phase transitions related to electron spins in strongly-correlated systems. Efficient generation and manipulation techniques of pure spin current developed by the project leader enable to induce a large effective magnetic field on the strongly-correlated material. This enables to induce the spin-injection-induced phase transition such as metal-insulator transition and metamagnetic transition with the giant resistance change. This innovative demonstration strongly increase the performance of the spintronic device and create an innovative nanoelectronic devices.

【Research Methods】

We generate giant pure spin current using multi-terminal spin injection. Generated spin pure current is preferably absorbed nano-sized strongly-correlated systems because of the spin absorption effects and will induce the metamagnetic transition. Also, we develop a growth technique of high quality Mn-oxide/.Cu bilayer film and its nano-structured fabrication systems. Metal-insulator transition will be induced by using similar manipulation technique of the pure spin current. Finally, we will develop innovative devices such as three-terminal spin switching device and nano-sized magnetic-field generator.

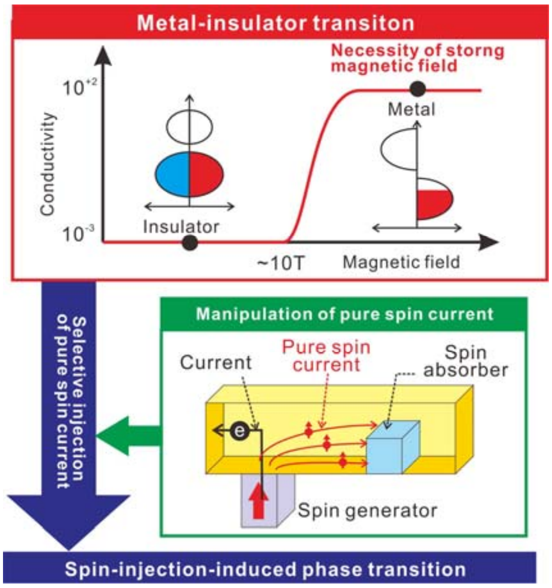

Fig. 1 Conceptual image of this project

【Expected Research Achievements and Scientific Significance】

The pure spin current without any electric flow enable us to perform an efficient spin injection into the strongly correlated system. An innovative method utilizing pure spin current can induce the magnetic transition efficiently and selectively. This demonstration will revolutionize the architecture design for nanoelectronic devices.

【Publications Relevant to the Project】

・S. Nonoguchi, T. Nomura, and T. Kimura "Nonlocal spin transports in nanopillar-based lateral spin valve" Appl. Phys. Lett. 100, 132401 (2012)
・S. R. Bakaul, S. Hu and T. Kimura, Large pure spin current generation in metallic nanostructures, Appl Phys A 111, 355–360 (2013)

【Term of Project】 FY2013-2017

【Budget Allocation】 119, 400 Thousand Yen

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