

【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering I)



Title of Project : Creation of Spin Devices Based on Relativistic Effects

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Research Area : Engineering

Keyword : Spintronics

【Purpose and Background of the Research】

The present electronic devices such as transistors are based on electric field control of “charge” flow of electrons. Better performance with high speed switching and low power consumption was achieved by introducing quantum effects such as tunneling effect. For further development of electronics, it is required to utilize electrical control of “spin” of electrons as an information bit. Spatial manipulation of “spin” of electrons with high speed is difficult by using magnetic field. An electric field is transformed into a magnetic field by a relativistic spin-orbit interaction. The purpose of this project is to create new functional spintronic devices based on the spin generation, manipulation, and detection by utilizing the spin-orbit interaction.



Fig. 1. Development of Electronics.

【Research Methods】

1. Spin generation/injection
Spin polarized carriers will be generated by the Stern-Gerlach (SG) effect with spatial gradient of effective magnetic field induced by electric field controlled spin-orbit interaction. Spin injection into semiconductor will be performed with a ferromagnet/semiconductor interface. This is of crucial to make a spin-transistor.
2. Coherent control of spin by electric field
We will realize electric field controlled persistent spin helix (PSH) state by using two different spin-orbit interactions. The spin relaxation is suppressed in the PSH state.
3. Spin detection/selection
Spin Hall effect and SG spin filter induced by spin-orbit interaction will be utilized for electrical detection of spins. We will pursue new spin functional devices by the integration of spin generation, manipulation, and detection.

【Expected Research Achievements and Scientific Significance】

Relativistic electronics based on spin-orbit interaction will be realized by utilizing electric field controlled spin generation, manipulation, and detection. We will also contribute to the progress of academic research on relativistic quantum effect by clarifying the origin of spin-orbit interactions and the response of spins to electric field.

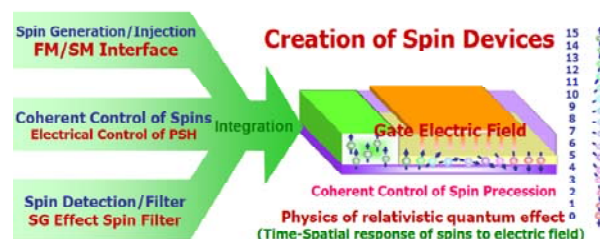


Fig. 2. Concept of Relativistic Electronics.

【Publications Relevant to the Project】

- Y. Kunihashi, M. Kohda, and J. Nitta, “Enhancement of Spin Lifetime in Gate-Fitted InGaAs Narrow Wires”, *Phys. Rev. Lett.* **102**, 226601 1–4 (2009).
- M. Scheid, M. Kohda, Y. Kunihashi, K. Richter, and J. Nitta, “All-Electrical Detection of the Relative Strength of Rashba and Dresselhaus Spin-Orbit Interaction in Quantum Wires”, *Phys. Rev. Lett.* **101**, 266401 1–4 (2008).

【Term of Project】 FY2010-2014

【Budget Allocation】 167, 000 Thousand Yen

【Homepage Address and Other Contact Information】

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