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

Title of Project : Research on the high frequency spintronics

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Research Area : Applied solid state physics
Keyword : (S) Spintronics

【Purpose and Background of the Research】

Recently, not only a charge-flow but also a spin-flow in solids started to be controlled. In this study, we establish a systematic understanding of high frequency spintronics, which has basis on the excitation of precession of a magnetization in a frequency range from GHz to THz.

【Research Methods】

1. High performance spin-torque oscillator

(a) Clarification of a mechanism giving a oscillation linewidth

From real time measurements of the oscillation signals, an origin of the oscillation linewidth will be clarified.

(b) Clarification of a coupled oscillation

By investigating effects of an external high frequency signal or a mutual coupling, we reveal a mechanism of the coupled oscillation operation.

(c) Development of over 50GHz oscillator and its characterization technique

Coupling between optical mode in multilayer to the injected current will be investigated. We develop a characterization method in over 50GHz range in collaboration with Prof. Rasing of Radboud University.

2. Investigation of an ultra-high sensitive field sensor

From observations about oscillation amplitude, phase fluctuation, and response to an external field, we clarify a performance of the spin-torque oscillator as an ultra-high sensitive field sensor.

3. Ultra-high sensitive spin-torque diode

Non-linear response of the magnetization to the spin-current and effects to the diode effect will be investigated. Detection limt of the spin-torque diode signal from very small magnetic objects will be investigated.

【Expected Research Achievements and Scientific Significance】

Establishment of a systematic understanding of high frequency spintronics, which has basis on excitations of precession of a magnetization in a frequency range from GHz to THz is expected.

From the knowledge a spin-torque oscillator with a high output power, high-Q, and over 50GHz operation, a spin-torque diode with high sensitivity, which surpasses that of semiconductor diodes, will be realized. Also highly sensitive nano-scale magnetic sensor, which may detect a stray field from paramagnetic particles will be realized. Further, a principle to detect a single spin will be clarified.

The results are expected to provides a new principle of the information storage and considerable influences to chemistry, biophysics, medical science, etc.

【Publications Relevant to the Project】

[1] H. Kubota, A. Fukushima, K. Yakushiji, T. Nagahama, S. Yuasa, K. Ando, H. Maehara, Y. Nagamine, K. Tsunekawa, D. D. Djayaprawira, N. Watanabe, and Y. Suzuki, "Quantitative measurement of voltage dependence of spin-transfer torque in MgO-based magnetic tunnel junctions", Nature Physics 4, 37-41 (2008).

[2] A. M. Deac, A. Fukushima, H. Kubota, H. Maehara, Y. Suzuki, S. Yuasa, Y. Nagamine, K. Tsunekawa, D. D. Djayaprawira and N. Watanabe, "Bias-driven high-power microwave emission from MgO-based tunnel magnetoresistance devices", Nature Physics Vol 4. No 8. 803-809 (2008).

[3] A. A. Tulapurkar, Y. Suzuki, A. Fukushima, H. Kubota, H. Maehara, K. Tsunekawa, D. D. Djayaprawira, N. Watanabe & S. Yuasa, "Spin-torque diode effect in magnetic tunnel junctions", Nature, Vol 438, 339 (2005).

【Term of Project】 FY2011-2015

【Budget Allocation】 165,700 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.suzukiylab.mp.es.osaka-u.ac.jp/