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Program Title (English)　:Nanomechanical device for detection and control of spin current
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1. 概要（Summary）

In this work, we have fabricated an ultra-sensitive nanomechanical resonator with integrated non-local spin valve structure. The obtained sensitivity of the resonator is 1.42 × 10^{-17} N for the fundamental mode and 1.68 × 10^{-18} N for the torsional mode, which indicates the fabricated resonator is able to detect spin relaxation by torque measurements.

2. 実験（Experimental）

【利用した主な装置】

赤外線顕微鏡、エッチングチャンバー、Vapor-HF etching

【実験方法】

First, the electrode pads were fabricated using an electron beam (EB) lithography system and a lift-off process. Second, the spin-valve structure was prepared by means of the undercut resist mask and shadow evaporation technique. Then, the permalloy (Py) and the Cu layer was formed by EB evaporation. The resonator structure was patterned by a dual beam focused ion beam (FIB) / scanning electron microscopy (SEM) milling system. Then, the silicon oxide layer was etched and the resonator structure was released from the substrate by HF vapor-phase etching. Finally, electrical contacts between the fabricated NEMS device and the PCB were made by wire bonding.

3. 結果と考察（Results and Discussion）

An attonewton-sensitive torsional resonator with a spin valve structure has been fabricated based on a top-down fabrication process. The minimum detectable forces of the fabricated resonator are 1.42 × 10^{-17} N (fundamental mode) and 1.68 × 10^{-18} N (torsional mode), which are much smaller than expected magnitudes of spin relaxation forces generated in the spin valve structure. We believe that the fabricated nanomechanical resonator will be a suitable tool for detection and control of spin signal in spintronics.

Fig. 1 SEM image of Si resonator with integrated non-local spin valve structure.

5. 論文・学会発表（Publication/Presentation）

(1) Yong-Jun Seo, Yuki Shiomi and Eiji Saitoh, “Ultrasensitive Si Nanowire Probe for Force Detection”, The AIMR International Symposium, Feb, 21-24 (2016), Sendai, Japan.

(2) Yong-Jun Seo, Kazuya Harii, Ryo Takahashi, Hiroyuki Chudo, Koichi Oyanagi, Takahito Ono, Yuki Shiomi, and Eiji Saitoh, “Fabrication of nanomechanical resonator with non-local spin valve structure for spin detection and control” MEMS2017, Jan (2017) 22-26.