実験報告書様式（一般利用課題・成果公開利用）

（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。）

CROSS TOKAI **Experimental Report** J-PARC	承認日 Date of Approval 2017/9/27 承認者 Approver Kazuhiko Soyama 提出日 Date of Report 2017/9/19
課題番号 Project No. 2016B0079 実験課題名 Title of experiment Study of the in-plane magnetic structure of neutron polarizing multilayer mirrors 実験責任者名 Name of principal investigator Ryuji MARUYAMA 所属 Affiliation Japan Atomic Energy Agency	装置責任者 Name of Instrument scientist Kazuhiko SOYAMA 装置名 Name of Instrument/(BL No.) SHARAKU (BL17) 実施日 Date of Experiment 16-22 March 2017

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

Sample A: Fe/Si multilayer of 30 bilayers with a thickness of 10 nm.

Sample B: Fe/Ge multilayer of 30 bilayers with a thickness of 10 nm.

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

Since a position sensitive detector was not open to users, the aim of the experiment was focused on the measurement of specular reflection using a single ^{3}He tube without position resolution.

The polarized neutron reflectivity measurements with polarization analysis were performed under an external field of 8.0 × 10^5 A/m, where the samples were magnetized to saturation. Measured and simulated profiles of A and B are shown in Fig. 1(a) and 1(b), respectively. The non-spin-flip reflectivity profiles were calculated by using the reflectance matrix and spin-density matrices. The model used to simulate the data assumed that each bilayer was equivalent. Each bilayer was modeled with four separate layers: the Fe component was divided into three separate layers with different nuclear SLDs; and one Si or Ge layer. The simulation demands that the Fe layers adjacent to the Si or Ge layers are less dense and non-magnetic, which can be attributed to interface effects such as inter-diffusion. The SLD of the Ge layer was estimated to be 3.2 × 10^2 fm/nm^{-3}, smaller by 13% than the value of the bulk (3.7 × 10^2 fm/nm^{-3}), although that of the Si layer was 2.1 × 10^2 fm/nm^{-3}, the same value as the bulk Si. The reduction in the SLD for the Ge layer resulted in

2. 実験方法及び結果（つづき） Experimental method and results (continued)

a smaller contrast in the SLD between the Fe and Ge layers for spin-down neutrons. Low reflectivity of R−− at the first Bragg peak in Fig. 1(b) was reproduced with this, which can contribute to the improvement in polarization when it is used as a polarizing supermirror. The scanning transmission electron microscope with energy-dispersive X-ray analysis revealed that Ar atoms diffusing into the Ge layer during the ion-beam sputtering process resulted in a reduction in its SLD and contributes to the SLD contrast of the Fe/Ge multilayer almost vanishing for spin-down neutons. Further study for the samples with different materials and sputtering conditions would lead to a comprehensive understanding of the interaction between the sputtering gas and growing layer.

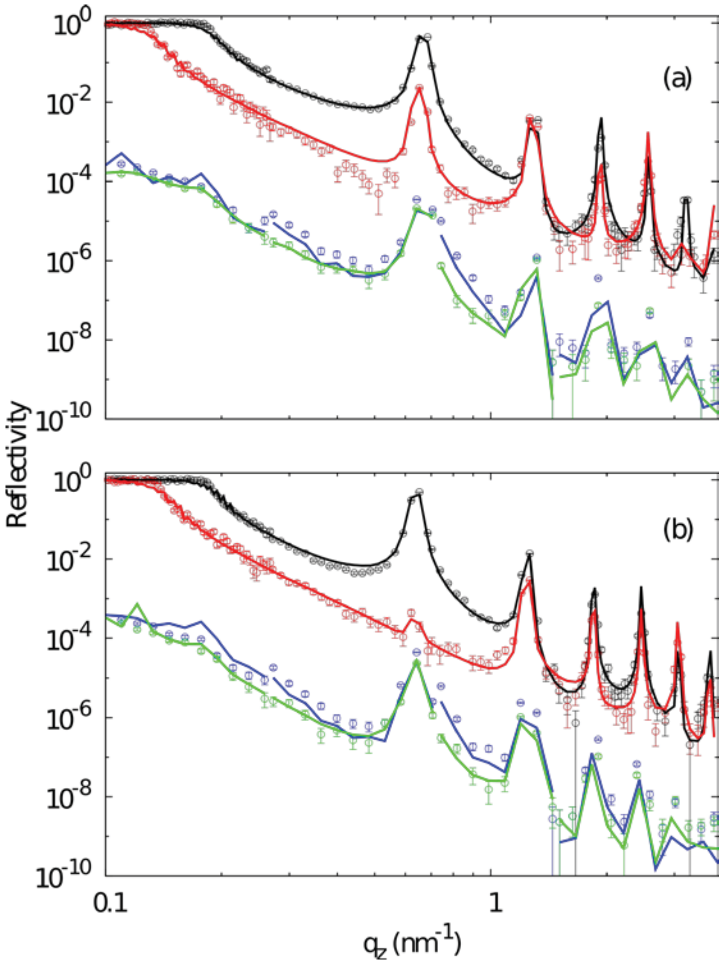

Figure 1: Polarized neutron reflectivity profiles of sample A(a) and B(b). The non-spin-flip reflectivities are shown in black (++) and ref (−−), whereas those with the spin-flip in blue (+−) and green (−+). The spin-flip profiles were scaled downby two orders of magnitude. The points and lines indicate the measured and simulated profiles, respectively.