

ナノ狭窄構造によるスピン流の増大

Increase of spin-current in nano-constricted spin valves

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[Introduction] For the spin current devices, it is important to generate the large spin current in the ferromagnetic materials. It is generally considered that the larger volume of the magnetic material provides the larger spin current. On the other hand, it has been reported that the spin current flows like a vortex when the magnetization is twisted in the nano scale region ^[1]. In that case, we can expect the spin current enhancement near the nano-constricted region. Our purpose is to enhance the spin current generated by the heat flow in the nano-constricted region with twisted magnetization as shown in Fig.1. In this report, we fabricated the sample with such a structure.

[Experiment] The sample structure is Ta 5 nm/Ru 2 nm/IrMn 5 nm/Co₉₀Fe₁₀(A) 3 nm/Al 1.5 nm/O₂ X kL/Co₉₀Fe₁₀(B) 3 nm/Pt 5 nm as shown in the inset of Fig.2. Al-O layer was fabricated by the natural oxidation of 1.5 nm Al with O₂ exposure from 30 kL to 100 kL and the nano-constricted regions of Co₉₀Fe₁₀ should be formed in Al-O layer. It was annealed under the condition of 270 °C in a magnetic field of 4.1 kOe for an hour for pinning the Co₉₀Fe₁₀(A) magnetization. Since the Co₉₀Fe₁₀(B) magnetization is rotated by an applied field, the twisted magnetization is obtained in the nano-constricted regions of Co₉₀Fe₁₀. We confirmed the twisted magnetization by *M-H* curves.

[Result and consideration] The magnetic coupling between the bottom Co₉₀Fe₁₀(A) and the top Co₉₀Fe₁₀(B) depends on the area density of the nano-constricted regions of Co₉₀Fe₁₀ in Al-O layer, and which is controlled by the oxidation condition. When the oxidation is small, the area density of the nano-constricted regions of Co₉₀Fe₁₀ becomes high, and then the magnetic coupling field between Co₉₀Fe₁₀(A) and Co₉₀Fe₁₀(B) becomes large. For example, the magnetic coupling field was 100 Oe at O₂ exposure 35kL as shown in Fig.2. The twisted magnetization was obtained in the nano-constricted region when the magnetic field was from 100 Oe to 700 Oe which correspond to the magnetic coupling field and the Co₉₀Fe₁₀(B) pinning field by IrMn respectively. In the presentation, we will discuss the nano-constricted region effect on the magnitude of the spin current measured by using the inverse Hall effect in the Pt layer.

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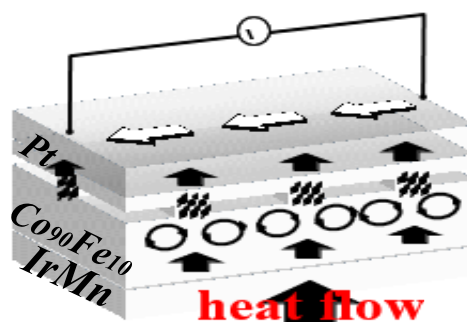


Fig.1 Nano-constricted region

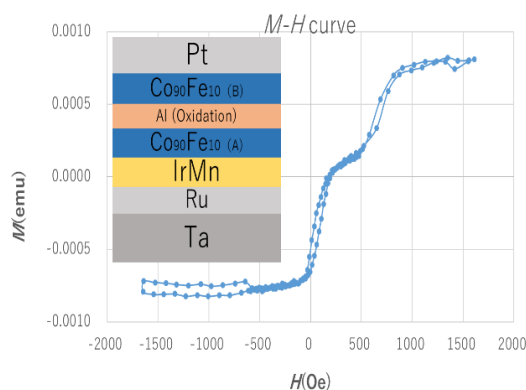


Fig.2 *M-H* curve(*X*=35 kL)