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Contribution of rare-earth-substituted Yttrium Iron Garnet for the spin-Seebeck effect

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The most prevalent thermoelectric generator is based on the conventional Seebeck Effect. But recently another category of thermoelectric generator, Spin-Seebeck thermoelectric generator (STE generator), is closely watched [1][2][3]. The STE generator has a very simple structure with a ferromagnetic insulator layer and a paramagnetic metal layer as shown in Fig.1.Therefore the STE generator could be produced in easier process compared to the conventional thermoelectric generator, and the production cost is expected to be lower. Furthermore there is a potential for a high ZT value because we are able to select materials for the ferromagnetic layer and the paramagnetic metal layer independently to avoid restriction of the Wiedemann-Franz law.

The STE generator is very attractive because of the possibility of a low production cost and a high ZT value. But it is not in practical use on the actual status due to the low spin-Seebeck coefficient (V/K). In this study, we investigated the effect on the spin-Seebeck coefficient by substituting the element of the ferromagnetic layer with rare-earth materials. The R:YIG layers (R=La, Ce, Pr, …etc) were prepared with the MOD method[4]. And the spin-Seebeck voltage*1 and the spin-pumping voltage*2 were measured on each material. We found that, as the Yb substitution rate increases in Yb:YIG, the spin-Seebeck voltage increases and the spin-Pumping voltage decreases (Fig.2, Fig.3). On the presentation we will discuss about the spin-Seebeck Voltage improvement by the R substitution based on these results.

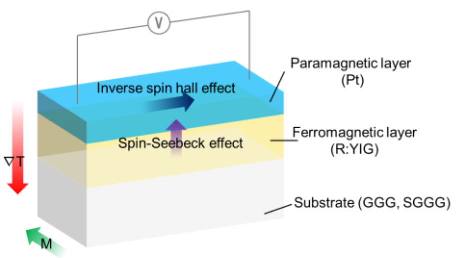

Fig.1
The structure of Spin-Seebeck thermoelectric generator

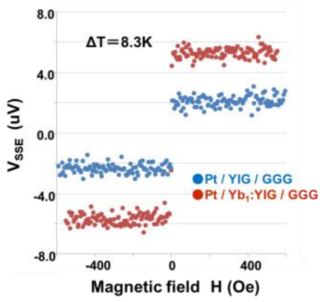

Fig.2
Spin-Seebeck Voltage of Pt/YIG and Pt/Yb:YIG

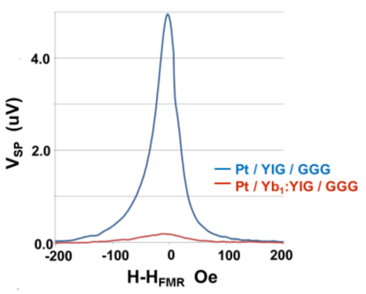

Fig.3
Spin-Ponmping Voltage of Pt/YIG and Pt/Yb:YIG

[1] K. Uchida, et al., Nature 455, 778 (2008)
[2] K. Uchida, et al., Nature Mat, 9, 894 (2010)
[3] A. Kirihara, et al., Nature Mat, 11, 686 (2012)
[4] T. Ishibashi, et al., J. Appl. Phys., 97, 06516 (2005)

*1 the voltage induced by the spin-Seebeck effect
*2 the voltage induced by ferromagnetic resonance (FMR)