Enhancement of the anomalous Nernst effect in polycrystalline Co_2MnGa/AlN multilayers

○Jian Wang [1,2], YongChang Lau [1,2], Weinan Zhou [3], Takeshi Seki [1,2,3], Yuya Sakuraba [3,4], Takahide Kubota [1,2], Keita Ito [1,2], and Koki Takanashi [1,2,5]

IMR, Tohoku Univ. [1], CSRN, Tohoku Univ. [2], NIMS [3], JST PRESTO [4], CSIS, Tohoku Univ. [5]

E-mail : jian.wang.86@imr.tohoku.ac.jp

Thermoelectric generators that convert waste heat to electricity is regarded as alternative and environment-friendly technology for harvesting and recovering heat [1]. Apart from the conventional devices utilizing the Seebeck effect (SE), its ferromagnetic counterpart, the anomalous Nernst effect (ANE), has gained increasing interests with its potential to further improve the figure-of-merit, *ZT*, simplify a thermopile structure [2], and be applicable for heat sources with a non-flat surface [3]. However, the reported thermoelectric conversion efficiency of the ANE is too small to realize the potential applications. Although "single crystal Co_2MnGa" is a famous Heusler alloy exhibiting the large ANE thanks to its characteristic electronic band structure [4], it has not been examined yet whether "polycrystalline Co_2MnGa" also allows to achieve the large ANE or not. This is a crucial question for the practical applications. The previous study [5] suggests that the multilayering is also a promising way to enhance the ANE. Here, we report a giant ANE in a polycrystalline Co_2MnGa/AlN multilayer film.

The film stacking structure is $Si/SiO_2/AlN(20)/[Co_2MnGa(t)/AlN(5)]_{25/t}$ (t = 2.5, 5.0, 12.5, and 25.0, thickness in nm), which was fabricated by DC magnetron sputtering at room temperature followed by post-annealing at 500 ºC for 3 hours. Compared with the single layer with t = 25.0 nm, the multilayer sample with the Co_2MnGa layer sandwiched by the dielectric AlN layers showed much stronger (110) texture and sharp Co_2MnGa/AlN interfaces. The largest anomalous Nernst thermopower (S^{ANE}) of 4.9 ± 0.1 μV K^{-1} was achieved for the multilayer film with t = 12.5 nm while S^{ANE} was obtained to be 3.8 ± 0.4 μV K^{-1} for the Co_2MnGa single layer film with t = 25.0 nm. The results indicate that the large ANE output can be obtained even for the polycrystalline Co_2MnGa which is meaningful for practical application. There are three possible scenarios for explaining the enhancement of ANE in the multilayer samples: (i) the higher chemical ordering promoted by interface stress, (ii) the change of band structure of distorted Co_2MnGa grains, and (iii) composition variation via interdiffusion through the interface. The details will be addressed in the presentation. This work was supported by KAKENHI (18H05246) and CSRN.

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