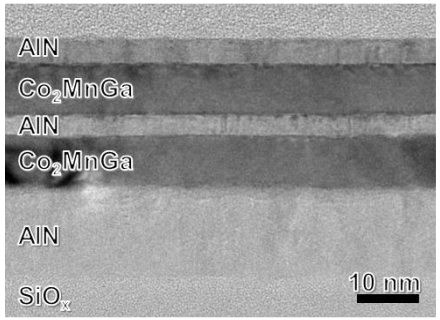
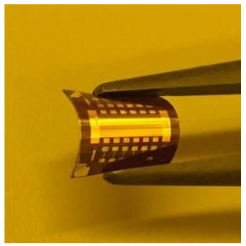
Tohoku Univ. Technology

Polycrystalline Heusler alloy thin film

Polycrystalline Heusler alloy film exhibiting performance comparable to that for a single crystal, which can be formed on a flexible substrate





↑ Example of realization on a flexible substrate (S_{ANE}~4μV/K)

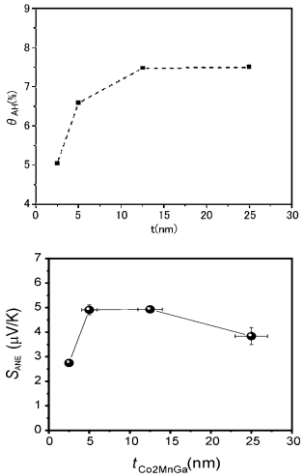
Overview

Co-based Heusler alloy such as Co_2MnGa or Co_2MnAl has attracted attention as candidate materials for high-sensitivity sensor and high-efficiency thermoelectric conversion element thanks to their large anomalous Nernst and Hall effects. In order to realize these excellent properties, it is thought that a single crystalline bulk material or a thin film grown on a single crystalline substrate is necessary. Thus, such single crystalline samples have been produced. Considering that those materials are applied to actual devices, it is necessary that a polycrystalline film, which does not use a single crystalline substrate, shows the property equivalent to those of single crystalline material.

This invention is able to provide a “polycrystalline Heusler alloy thin film" that does not require a single crystalline substrate, while showing the properties of anomalous Hall angle (θ_{AH}~7.5%) and anomalous Nernst coefficient (S_{ANE}~5μV/K) comparable to a single crystalline thin film. It can promote the control of crystal orientation and the improvement of crystallinity by sandwiching the polycrystalline layer with an insulating AlN layer.

Achievement of single crystalline level of θ_{AH} and S_{ANE} despite a polycrystalline film

Material	Sample type	Anomalous Hall angle θ_{AH} (%)	Anomalous Nernst coefficient S_{ANE} (mV/K)
Co_2MnGa	Bulk single crystal	> 10	6
Co_2MnGa	Single crystalline thin film	~ 10	6.2
Co_2MnGa	Single crystalline thin film	8.5	3
Co_2MnGa	Polycrystalline thin film	7.5	5



Product Application

- Thermoelectric conversion element that enables power generation from pipe drainage and indoor/outdoor temperatures
- Power generation by temperature difference between indoor and outdoor temperatures (temperature gradient)
- Realization of high-sensitivity sensor such as Hall sensor on a flexible substrate

Related Works

[1] Jian Wang, Yong-Chang Lau, Weinan Zhou, Takeshi Seki, Yuya Sakuraba, Takahide Kubota, Keita Ito, and Koki Takanashi “Strain-Induced Large Anomalous Nernst Effect in Polycrystalline Co_2MnGa/AlN Multilayers” Adv. Electron. Mater. 2101380-1-8 (2022).

IP Data

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