

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

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.

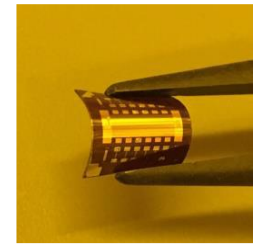
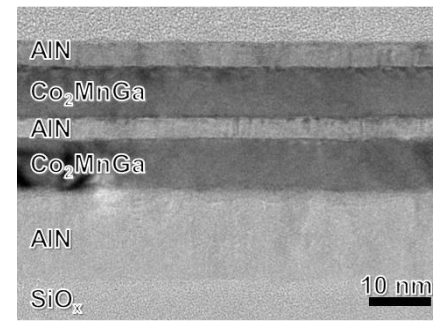
This invention is able to provide a "polycrystalline Heusler alloy thin film" that does not require a single crystalline substrate, while showing the properties of anomalous Hall angle ($\theta_{\text{AH}} \sim 7.5\%$) and anomalous Nernst coefficient ($S_{\text{ANE}} \sim 5 \mu\text{V/K}$) comparable 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.

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

IP Data

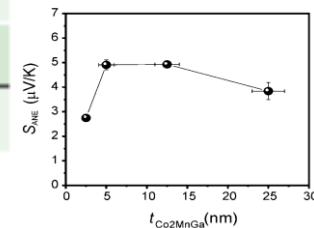
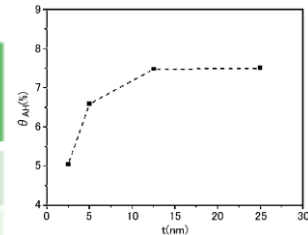
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↑ Example of realization on a flexible substrate ($S_{\text{ANE}} \sim 4 \mu\text{V/K}$)

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



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 $\text{Co}_2\text{MnGa}/\text{AlN}$ Multilayers" Adv. Electron. Mater. 2101380-1-8 (2022).

Contact