Fabrication and Thermoelectric Properties of Freestanding $Ba_{1/3}CoO_2$ Single Crystalline Films

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Thermoelectric energy conversion technology has attracted attention as an energy harvesting technology that converts waste heat into electricity by means of the Seebeck effect. Conducting oxide-based thermoelectric materials that show a high figure of merit are promising because of their good chemical and thermal stability as well as their harmless nature compared to chalcogenide-based state-of-the-art thermoelectric materials. Among oxide thermoelectric materials, Ba1/3CoO2, a layered crystal, stands out as a highly promising candidate. It demonstrates a thermoelectric figure of merit (ZT) value of 0.55 at 600 °C in the in-plane direction under normal conditions. This ZT value is not only the highest among reliable measurements but also comparable to that of other well-known p-type thermoelectric materials such as PbTe and SiGe at 600 °C. [1,2] In order to practically use $Ba_{1/3}CoO_2$, bulk ceramics or single crystalline $Ba_{1/3}CoO_2$ is necessary. Here, we show that freestanding $Ba_{1/3}CoO_2$ single crystalline films are fabricated by peeling off the $Ba_{1/3}CoO_2$ epitaxial films from the substrate. (Fig. 1) We fabricated $Ba_{1/3}CoO_2$ epitaxial films and immersed them in 40 °C hot water for several ten minutes. After that, the $Ba_{1/3}CoO_2$ epitaxial film was spontaneously peeled off and floated on the surface of the water like seaweed. We measured and analyzed the crystal structure, chemical composition, and thermoelectric properties before and after peeling off, and realized that there was no significant difference. The present results would provide a useful way to fabricate freestanding oxide single crystalline films for thermoelectric.

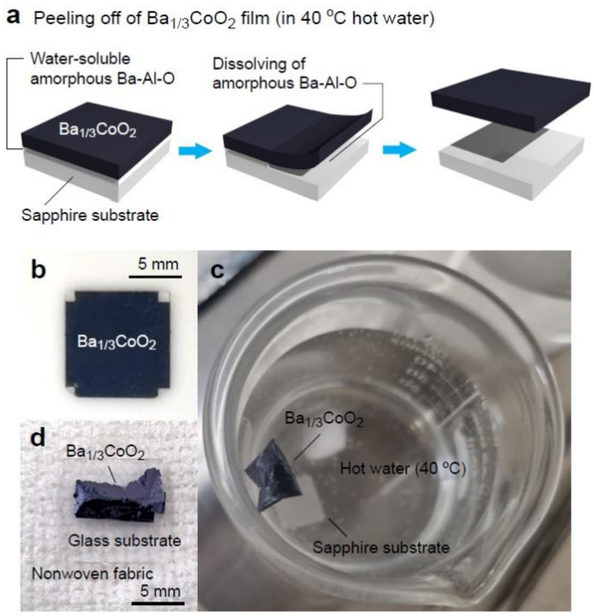

Figure | Fabrication of freestanding $Ba_{1/3}CoO_2$ single crystalline films. Peeling-off procedure of $Ba_{1/3}CoO_2$ epitaxial films.

References

[1] X. Zhang, Y. Zhang, L. Wu, A. Tsuruta, M. Mikami, H.J. Cho, and H. Ohta, ACS Appl. Mater. Interfaces 14, 33355 (2022).

[2] Y. Takashima, Y. Zhang, J. Wei, B. Feng, Y. Ikuhara, H.J. Cho, and H. Ohta, J. Mater. Chem. A 9, 274 (2021).