Heavy-element dependence of thermoelectric properties in Fe_2VAl thin films

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[Introduction] Heusler-type Fe_2VAl-based compounds consisting of non-toxic and abundant materials have been widely investigated as one of the most promising thermoelectric materials. Although its power factor reaches 5.5 $mWm^{-1}K^{-2}$ which is even larger than that of Bi_2Te_3-based thermoelectric materials, the figure of merit is still much less than unity due to the high lattice thermal conductivity of more than 20 $W m^{-1}K^{-1}$. As for that, we tried to reduce the thermal conductivity through two approaches, doping control using heavy elements and fabricating thin films which successfully decreased to 7.2 and 12.6 $Wm^{-1}K^{-1}$, respectively.[1,2] In the present study, we intended to enhance the thermoelectric properties by doping Ta in in the Fe_2VAl-based thin films, that is, by combining the both approaches.

[Experimental procedure] The thin film samples consisting of Ta-doped Fe_2VAl were prepared on the (100) surface of MgO single crystal substrates by means of the radio frequency magnetron sputtering technique. The out-of-plane XRD measurement along cross-plane direction and phi scan around MgO 202 and Fe_2VAl 404 reflections. The chemical composition of thin film was analyzed using electron-probe micro-analyzer. The electrical resistivity and thermal conductivity were precisely measured using conventional 4-probe method and pico-seconds time-domain thermo-reflectance method, respectively.

[Results and discussion] The figure definitely shows that Ta-doping leads to the remarkable reduction of thermal conductivity. Thus, we focused on the effect of Ta doping into Fe_2VAl-based thin films. In the presentation, the thermoelectric properties as a function of Ta content in Fe_2VAl thin films will be mainly discussed.

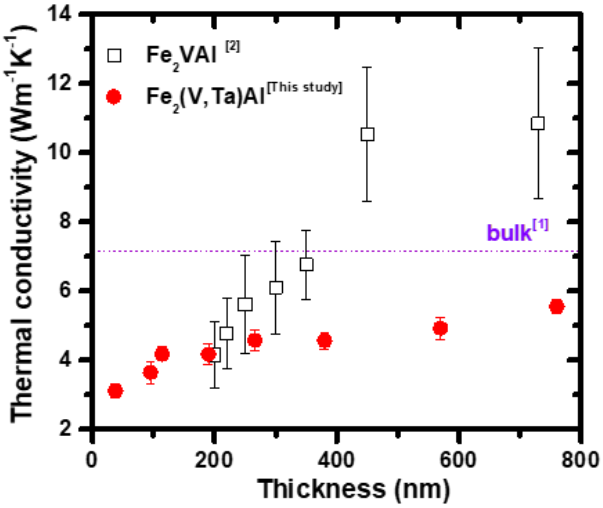

Figure. Thickness dependence of thermal conductivity for Fe_2VAl and $Fe_2(V,Ta)Al$.

References

1. Y. Terazawa et al., *J. Electron. Mater.*, **41**, 1348 (2011).
2. S. Hiroi et al., *Mater. Trans.* **57**, 1628 (2016).