Al Composition Dependence of Seebeck Coefficient of Icosahedral AlCuFe Quasicrystal

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Icosahedral (i-) Al-Cu-Fe quasicrystals (Qcs) possess a specific phase area on ternary equilibria. Namely, their crystal structure exhibits the same diffraction pattern. Despite consist of the same elements and a similar crystal structure, the quasicrystals show different physical properties with varying compositions [1]. Kirihara and Kimura reported that the covalent bonding nature between Al and transition metal drives to the width change in a pseudogap [2], which can determine the physical properties such as the Seebeck coefficient. Therefore, Al composition dependence is worth being concerned with physical properties. In this study, we aim to understand the effect of Al composition variation on the Seebeck coefficient. The nominal composition of initial i-AlCuFe powders was $Al_{64.3}Cu_{23.8}Fe_{11.9}$ (Cu/Fe ratio= 2). The control of compositions among Al, Cu, Fe was utilizing the calcination at 973 K, whereas the oxidation tended to occur on Al. After several hours calcination, the Cu to Fe ratio maintained as 2, and the Al content slightly decreased from 64.3 at% to 62.7 at%. The peaks of the x-ray diffraction pattern, as shown in Fig 1.(a), correspond to the iQc phase and Al oxides phase after calcination. Fig 1.(b) shows the change in the Seebeck coefficient. As shown in Fig 1.(b), the loss of Al dominated the electron transportation behavior, which triggered the transition from P-type to N-type when Al content was less than 64 at%.

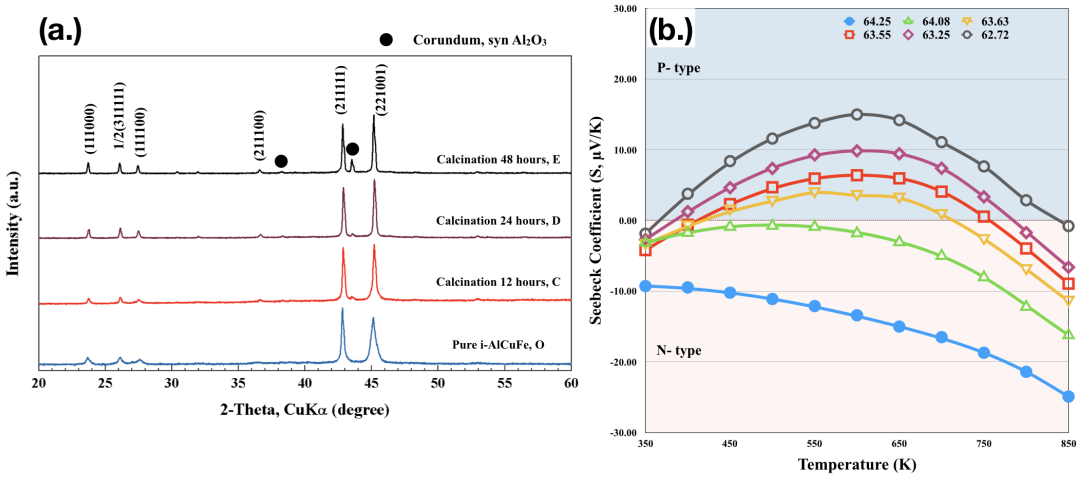

Fig.1: (a) X-ray diffraction patterns for i-AlCuFe and after calcination, (b) Seebeck coefficient of Qc composite with a different Al content.

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