# β-$FeSi_2$ の熱電特性向上の為の Co 添加量の最適化

## Optimization of Co addition amount to enhance thermoelectric properties of β-$FeSi_2$

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β-$FeSi_2$, having orthorhombic crystalline structure with *Cmca* space group, has been classified as a potential candidate for thermoelectric (TE) application due to its environmental friendliness, good thermal stability, and low cost [1]. Ur and Redzuan *et al.* reported that the maximum the *ZT* of Co-doped β-$FeSi_2$ was 0.06 at 600 K and 0.085 at 1073 K, respectively, [2,3]. In this work, we study on the effect of Co doping on the scattering mechanism and the optimization of its concentration to the TE performance of β-$FeSi_2$. β-$Fe_{1-x}Co_xSi_2$ ($0 \le x \le 0.06$) samples were fabricated by arc-melting and followed by heat treatment at 1423 K for 3 hours and annealing at 1113 K for 20 hours. The Seebeck coefficient and electrical resistivity was measured by ResiTest-8300 and homemade measurement system. The thermal conductivity was measured by power conversion efficiency measurement system (PEM-2, ULVAC-RIKO). At 300 K, as shown in Fig.1, with increasing x from 0 to 0.06 in β-$Fe_{1-x}Co_xSi_2$, the electrical resistivity ($\rho$) decreases from 7.23(7) to 0.008 Ω.cm due the increase in carrier concentration ($n_H$) from $6.3(9)\times10^{16}$ $cm^{-3}$ to $1.0(0)\times10^{19}$ - $3.8(8)\times10^{20}$ $cm^{-3}$, respectively. The highest value of carrier concentration is found in x=0.02 sample and it is saturated at this point. In addition, the Seebeck coefficient $|S|$ of the non-doped sample is 127 μV/K and that of Co-doped samples decrease from 371 to 145 μV/K as increasing Co, due to the increase in carrier mobility($\mu_H$). As a result, the highest *ZT* =0.087 at 670 K is achieved in x = 0.03 owing to the significant enhancement in power factor and the slight reduction in thermal conductivity, where its optimum $n_H$ at 300 K is about $1.0(4)\times10^{20}$ $cm^{-3}$.Therefore, the thermoelectric properties of β-$Fe_{1-x}Co_xSi_2$ can be optimized at x=0.03 and carrier concentration about $1.0(4)\times10^{20}$ $cm^{-3}$ with the maximum *ZT* =0.087 at 670 K owing to the improvement in power.

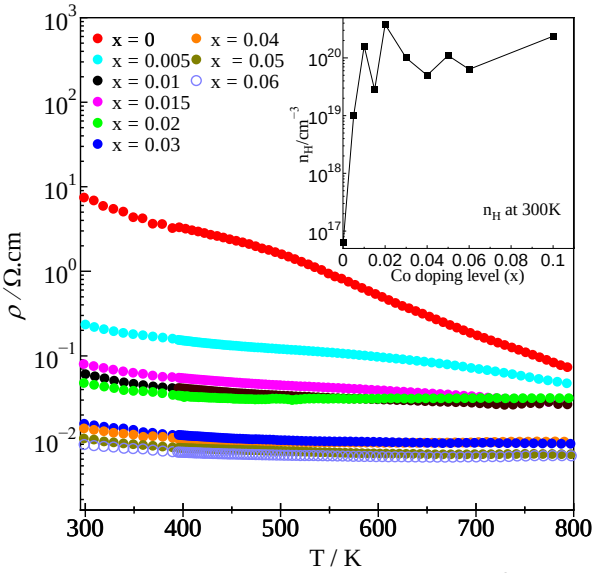


Fig.1 Temperature dependence of $\rho$

**References**

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