JASMAC
Conference of the Japan Society of Microgravity Appllication

OR-0705

液体 Sn-Pb 合金の相互および固有拡散係数同時測定における濃度分布解析

Concentration Analysis in Simultaneous Measurement of Interdiffusion and Intrinsic Diffusion Coefficient in liquid Sn-Pb Alloys

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1. Introduction

The concentration dependence of interdiffusion coefficient $\tilde{D}$ in liquid Sn-Pb was lower convex by using capillary reservoir method and analysis of Boltzmann-Matano method[1]. The values $\tilde{D}$ obtained by convection-free experiments through Boltzmann-Matano method were equivalent at $Sn_{50}Pb_{50}$ and lower at the Pb-rich side, while higher at the Sn-rich side compared with the predicted value by Darken's equation[2]. To investigate the tendency of detailed $\tilde{D}$, diffusion experiments were performed using $Sn_{25}Pb_{75}$ and $Sn_{75}Pb_{25}$[3]. As a result, the tendency of $\tilde{D}$ showed the lower convex like previous studies[1,2]. However, in these diffusion experiments, different concentration of intermediate cells was inserted, so it is necessary to obtain a concentration profile that takes into account the diffusion from intermediate cell. Therefore, the objective of this study is to investigate the analysis method for $\tilde{D}$ considering the concentration in the intermediate cell.

2. Experimental procedure

Figure1 shows the schematic illustration of a diffusion experiment by combining stable density layering and the Foton shear cell[3]. The diffusion couple consisted of $Sn_{90}Pb_{10}$ sandwiched between $Sn_{85}Pb_{15}$ and $Sn_{95}Pb_{5}$ (**Fig.1(a)**). Furthermore, to measure the intrinsic diffusion coefficient, the intermediate cell was contained at ^{124}Sn and ^{207}Pb. After heating and homogenizing, by inserting the intermediate sample, diffusion process started (**Fig.1(b)**). The diffusion time and temperature were 9000 s and 773 K, respectively. At the end of the diffusion time, the diffusion samples were divided into 20 samples and then cooled down (**Fig.1(c)**). Each sample was dissolved in mixture solution acid. Concentrations of Sn and Pb were measured using ICP-OES and them of ^{124}Sn and ^{207}Pb were measured using ICP-MS (**Fig.1(d)**).

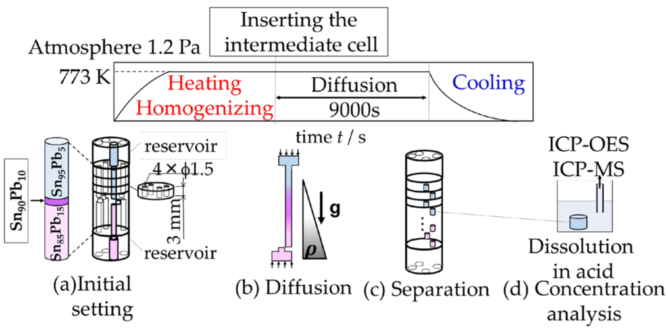

Fig 1 Schematic illustration of a diffusion experimental flow.

3. Results

Figure 2 shows the concentration profile of Sn as a representing interdiffusion experiment. A smooth concentration profile was obtained. **Fig 2** showed that the diffusion from the intermediate cell was roughly uniform on the both sides. In addition, $\widetilde{D}$ considering diffusion from intermediate cell was calculated from **Fig 2** with analysis by Sauer-Freise method and error function.

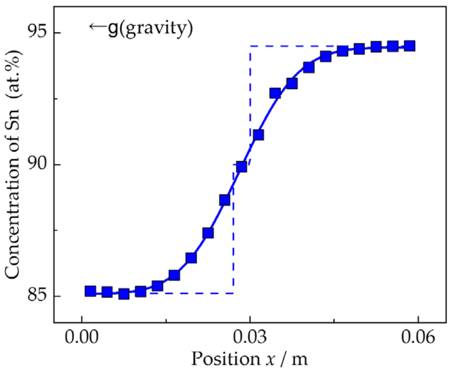

Fig 2 Concentration profile of Sn with a fitting curve using error function and the initial condition drawn with dotted line.

4. Discussion

It was possible that the diffusion center position might move because of the insertion of intermediate cell with different concentrations. Diffusion center position was able to be obtained by the Matano surface which balances the increment of concentration in the left and decrement in the right. Matano surface was calculated from a part of the calculation process of Sauer-Freise method. Matano surface in the initial condition was 27 mm and after experiment was 27mm. This result shows the analysis was able to take into account the diffusion from the intermediate cell.

The obtained $\widetilde{D}$ was almost constant value compared with using Darken's equation and intrinsic diffusion coefficients. These results were similar to the tendency of previous researches[2,3]. However, these values were higher than by using Darken's equation and self-diffusion coefficient.

5. Conclusion

The Matano surface agrees with the theoretical value when the diffusion from the intermediate cell is taken into account, and the analysis is appropriate. The obtained diffusion coefficient values are consistent with the previous researches.

Acknowledgement

This study was supported by financial support by Kimura Foundry Co., Ltd, Grant-in-Aid for Scientific Research(C) Grant number JP19K04990 and Grant-in-Aid for JSPS Research Grant Number JP20J14950 and conducted as a part of research project in 2019 for Research Assistant (Masato Shiinoki) in Kagami Memorial Research Institute for Materials Science and Technology, Waseda Univ.

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