OS2-4

微小重力下における Fe-60atomic%Cu 合金の相分離挙動

Phase Separation Phenomena of Liquid Fe-60atomic%Cu Alloys under the microgravity condition

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1. Introduction

Fe-Cu alloy is one of the popular peritectic alloys, which has a flat liquidus line around intermediate concentration range. It is known that when this alloy around intermediate concentration is quenched from liquid state, a macroscopic liquid phase separation occurs below the liquidus line. Recently, C. P. Wang et al. found that a curious phase separation in atomized Fe-Cu spherical alloys which was formed co-axial multi sphere[1)]. Nagayama also make Fe-Cu powders by using atomization with the use of a short drop tube, the same shape of spherical sample was observed[2)]. This phase separation attracts interest, however, the mechanism cannot be revealed because the measurement of the temperature of small particle is quite difficult. Recently, We proposed to the observation of the phase separations under microgravity condition due to the electrostatic levitation furnace, ELF, which is installed on the ISS. Microgravity experiments were performed successfully and the characteristic cooling curves were obtained. The metallographic structure of retrieved samples are investigated with the use of electron probe micro analyzer (EPMA). In this report, we show the quick review of the metallographic structure of Fe-60atomic%Cu sample.

2. Experiments and Results

2.1. Microgravity Experiments

For microgravity experiments with the use of ELF, spherical Fe-Cu alloys whose diameter were around 2mm were prepared via the gas-jet levitator coupled with laser diodes. Concentrations of samples were $Fe_{30}Cu_{70}$, $Fe_{40}Cu_{60}$, $Fe_{50}Cu_{50}$, $Fe_{60}Cu_{40}$, $Fe_{70}Cu_{30}$ in atomic percent, those were covered the intermediate concentration range of Fe-Cu alloys. Samples were installed in the sample holder of ELF and launched to the ISS. The sample was levitated in the chamber of ELF and heated by lasers. Retrieved samples were buried in resin and grind and polished each 50 micrometers via automatic polisher (Tegra-Pol 25, Struers). Its metalogical structure was observed by electron probe micro analyzer (EPMA-8050G, Shimadzu).

2.2. Results and discussion

Figure 1 shows the cooling curve around the solidification temperature under microgravity condition. A photo image of camera installed in the pyrometer was superimposed on the figure. We suspect that the first plateau was the signal of the solidification of Fe rich phase, which can be seen the time from 0.5 sec to 10 sec in figure 1.

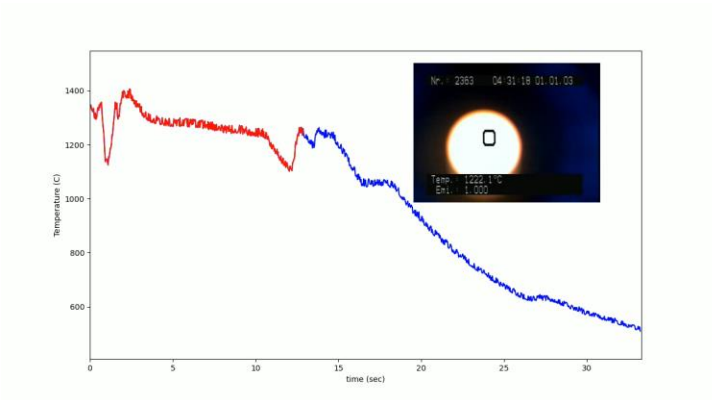

Figure 1. Cooling curve of $Fe_{40}Cu_{60}$ alloy at solidification.

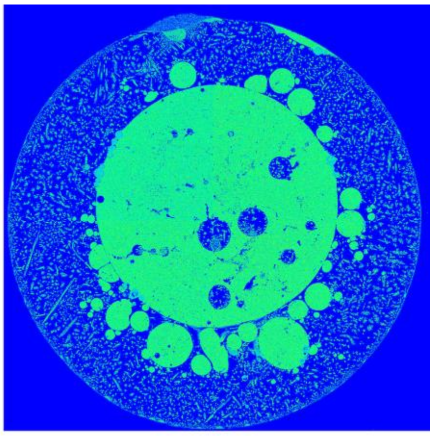

Figure 2. Result of mapping analysis of EPMA

The second plateau which can be seen the time from 17 sec to 18 sec can be regarded as the signal of the solidification of Cu rich phase. Exothermic signals at the time around 14 sec might be derived from solidification of small droplets or shells in the sample.

Figure 2 shows typical metallographic structure via mapping analysis of EPMA. Blue areas were the Cu rich phase whose concentration was 81.2mol%Cu. Many dendrites of Fe rich phase can be seen. Circular form of green areas were the Fe rich phases, those were distributed the center of spherical sample. The concentration of the largest Fe rich phase was 83.52mol%Fe and concentration of other Fe rich phases were almost same. The exothermic signals of cooling curve as mentioned above might be indicated the delay of solidification of each spherical area of Fe rich phase. In addition, thin Fe rich phase whose thickness was around one micrometer was observed at the surface of the sample. The detail of solidification process will be discussed in my presentation.

References

1) C. P. Wang, X. J. Liu, I. Ohnuma, R. Kainuma, K. Ishida, Science 297, 990(2002).
2) Y. Fujiwara, T.Masaki, Proceedings of JASMAC 33 (2021).