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過冷却液体 Fe-Cu 合金の液相―液相分離挙動

Phase Separation Phenomena of Liquid Fe-Cu Alloys in Supercooled Liquid State

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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 this alloy is quenched from liquid state, a macroscopic 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. Nagayama also make Fe-Cu powders by using atomization furnace with short drop tube, the same shape of spherical sample was observed. This phase separation attracts many interests, whoever, the mechanism cannot be revealed because the measurement of the temperature measurement of small particle is quite difficult. Recently, we applied the gas-jet levitation method for the observation of this phase separation. As you know, the sample size of gas-jet levitation is around 2 mm which is sufficiently large for the temperature measurement by pyrometer. In this report, we show our latest results and discuss the relation between the sample temperature and the formation of multi core sphere.

2. Experiments and Results

2.1. Observation apparatus

The conical nozzle made from sintered boron nitride was placed in a glove box filled with purified argon gas. Two sets of laser diode whose max. power was 200W, two single color pyrometers, and video camera, was placed around the conical nozzle. Successive temperature data were recorded in a PC through data logger. The power of laser can control via a remote terminal, the sample temperature can be change with the observation of sample status. In usual case, the sample temperature was elevated higher than liquidus temperature, then the laser was cut off, and the cooling curve of sample temperature was recorded. The detail of our apparatus will be described by Murata in poster session.

2.2. Results and discussion

Figure 1 shows the typical cooling curve around the solidification temperature. Many of exothermic signal were observed. Each signal can be identified the temperature of phase change at the phase diagram, which was described by Fujiwara in the JASMAC 33[2].

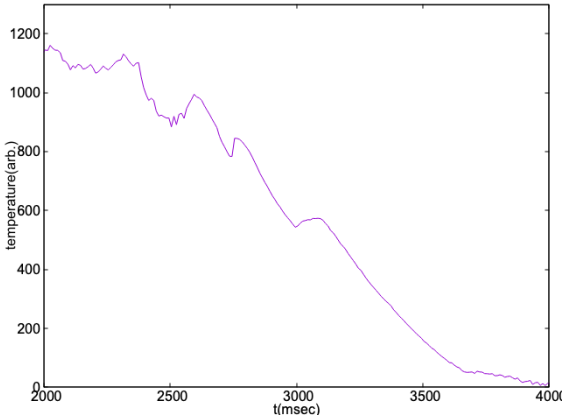

Figure 1. Typical cooling curve of Fe-Cu alloy at solidification.

Figure 2 shows the wide variety of solidification texture those are solidified in same conditions. Currently, the difference of modes of solidification cannot be identified from the cooling curves, now, detail analysis is in progress to reveal the nature of this phase separations.

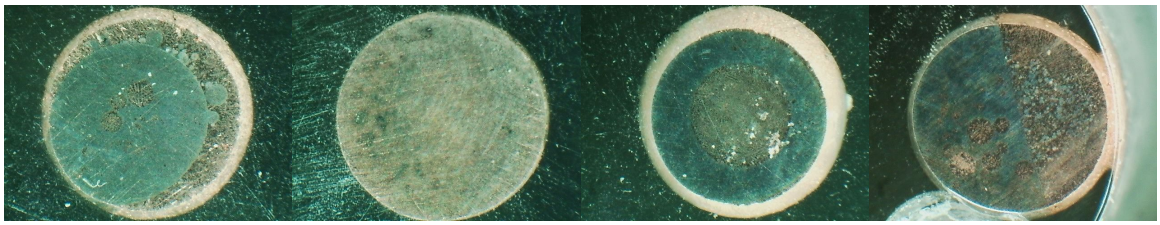

Figure 2. Wide variety of texture of Fe-Cu alloy. These are solidified in same conditions.

For the understanding a metastable phase separation of system with miscibility gap, model fluid experiments were performed. A water-phenol solution which is one of popular solution with miscibility gap is installed between glass plate and fixed in the aluminum holder. The sample was rapidly cooled from the holder, the temperature gradient can be made in the liquid sample. During the cooling, liquid-liquid phase separation occurred in the vicinity of holder and many droplets of phenol rich solution were formed. After that, droplet rush into the center of solution, coalescence each other, then it formed large droplet. The movie was uploaded to youtube[3]. The solidification mechanisms will be discussed in our 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).
3) Video was uploaded at youtube, https://youtu.be/ixvCQRu9bjo

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