SOLIDIFICATION OF EUTECTIC BiSn ALLOY DROPLETS IN DROP TUBES

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1. Introduction

Drop tubes are alternative methods used to obtain a short microgravity environment for rapid containerless solidification studies of several material types [1-3]. The material used in this work was the eutectic alloy $Bi_{57}Sn_{43}$ (wt. %) commonly used for solder and fuse purposes. BiSn is a non-toxic alloy that has replaced compounds of lead and cadmium in restricted environments.

2. Experimental

The solidification experiment was performed in the LAS/INPE 3m drop tube in order to process samples of the eutectic alloy $Bi_{57}Sn_{43}$, prepared from bismuth (99.998 at.%) and tin (99.9999 at.%). A quartz ampoule with a small hole at one end (L = 180 mm and ϕ_{hole} = 200 μm) is placed inside the drop tube furnace and contains 1g of the eutectic material. The drop tube is evacuated to a pressure bellow 5 Pa and then filled with 53 kPa of nitrogen to assist the heat dissipation during the fall of the ejected droplets. The furnace is heated up to 255°C and turned off. When the temperature reached between 144-145°C (temperature near the alloy melting point), nitrogen gas at a pressure of 70 kPa is released at the upper end of the quartz ampoule causing the material to fall in spherical droplets form.

3. Results and Discussions

Droplets of $Bi_{57}Sn_{43}$ with diameter in the range of 100 to 850 μm were obtained (Figure 1a) presenting an irregular eutectic microstructure (Figure 1b). The result is consistent with the conductive heat transfer theory [3] provided that the droplet diameter is below 900 μm (Figure 1c). Figure 1d shows a complex regular eutectic microstructure obtained at 1g (Earth's acceleration gravity).

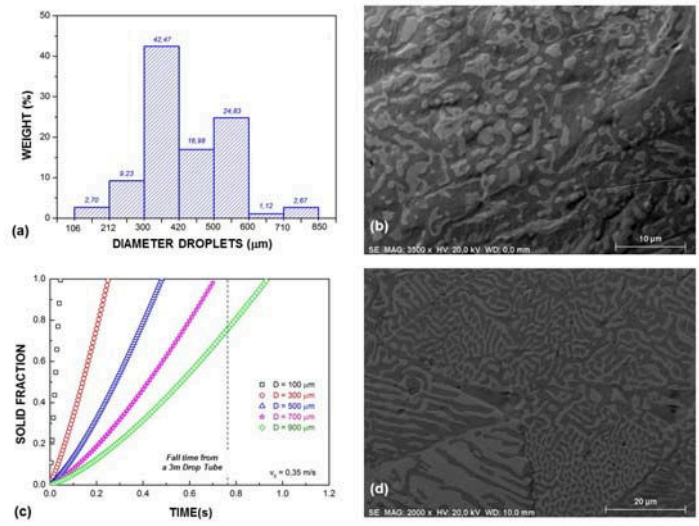

Fig. 1. (a) *histogram of the droplets size distribution;* **(b)** *SEM image of droplets investigated in this work solidified in μg, the white phase is bismuth-rich solid solution and the dark phase is tin-rich solid solution.;* **(c)** *solid fraction versus time for different diameters of samples; and* **(d)** *SEM image of droplets investigated in this work solidified in 1g.*

4. Conclusion

BiSn eutectic alloy droplets with diameters ranging between 100 and 850 μm are obtained using the LAS/INPE 3m drop tube. Microstructural analysis shows that the droplets solidified in μg consist of irregular eutectic microstructure, whereas the material solidified at 1g are constituted by complex regular eutectic microstructures. The conduction heat transfer model was consistent with the experimental results.

5. References

[1]- R. C. Toledo, *et al,* Materials Science Forum, **660-661**, 587-592, (2010).
[2]- R. C. Toledo, *et al*, Materials Science Forum, **727-728**, 1633-1637, (2012).
[3]- R. C. Toledo, *et al*, Microgravity Science and Technology, **26**, 119-124, (2014).

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