STUDY OF SOLIDIFICATION OF PbSn EUTECTIC ALLOY IN CENTRIFUGE

FREITAS, F. E.[1]; TOLEDO, R. C.; AN, C. Y.; BANDEIRA, I. N.; RIBEIRO, M. F.

Brazilian Space Research Institute – INPE, São José dos Campos, SP, Brazil
[1] Master student the course of Science and Technology of Materials and Sensors - CMS.

filipe.estevao@gmail.com

Abstract. *The study of materials processed in centrifuges improves the understanding on acceleration influence and convection in materials processing. This work aims to study the influence of high gravity in PbSn eutectic alloy solidification using a small centrifuge designed and built in the Associate Laboratory of Sensors and Materials of the Brazilian Space Research Institute (LAS/INPE). The samples were analyzed by densitometry and scanning electron microscopy (SEM).*

Keywords: High Gravity; Centrifuge; Eutectic Alloy; Solidification.

1. Introduction

Experiments involving the solidification of metals and alloys are strongly influenced by gravity from the initial stages of nucleation and grain growth [Regel and Wilcox 1994]. All over the world, relatively large centrifuges are expensive and rarely available for crystal growth experiments. To overcome this difficulty, a small centrifuge was designed and built in the LAS/INPE, which provides an acceleration of up 5g [Chen 1997]. The aim of this work was to study the influence of high gravity in PbSn eutectic alloy solidification. The PbSn eutectic alloy is a low cost material that provides convenient physical properties such as low melting point, low vapor pressure, and does not react with the wall of the quartz ampoule, making it an ideal material for solidification studies of regular eutectic alloys.

2. Experimental

The solidification experiments were performed with the centrifuge of the LAS/INPE (Figure 1). The alloy was prepared from pure lead (99.9999 %) and tin (99.9999 %). A mass of 20g of the alloy was put into an 8 mm diameter and 150 mm length quartz ampoule. The ampoule is evacuate and sealed at 10^{-6} Torr. Two experiments were realized: with the furnace standing at 1g and with the furnace rotating at 3.5g, being 1 *g* the gravity acceleration on earth (9.8 m/s^2). In the second experiment, the furnace was adjusted with an angle of 16° and heated up to 200°C for about 2 hours. The motor was turned on at 70 rpm and, after 10 minutes, the furnace temperature was off and the motor kept running at constant speed during the solidification process of the sample. The same thermal parameters used with the rotating furnace were used for the solidification made with the standing furnace.

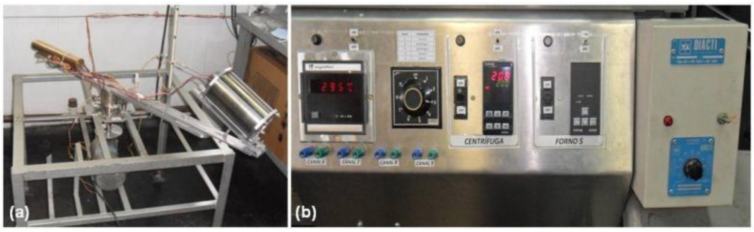

Figure 1. (a) centrifuge of LAS/INPE; (b) temperature and velocity controller.

3. Results and discussion

The graph (Figure 2a) shows that the density profile, at the beginning of samples, is well above the nominal values for both samples: about 50% of the solidified fraction (fs) for samples grown in 1g and between 10% and 30% of fs for samples grown in 3.5 g. This is due to accumulation of lead caused by natural convection and sedimentation.

It is noted from the micrographs (Figure 2b) that regions with different eutectic compositions are formed, due to the solute gradient caused by the gravity, resulting in diverse microstructures, and also the formation of dendrites at the beginning of both samples was observed.

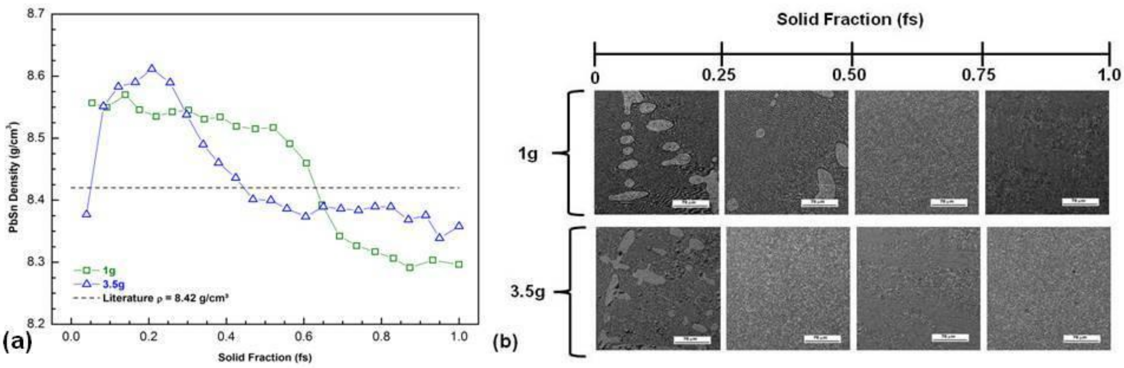

Figure 2. (a) Average density of PbSn eutectic alloys as function of the solidified fraction; (b) SEM images of the radial direction analysis the eutectic PbSn obtained by centrifuge.

4. Conclusion

PbSn eutectic alloys were solidified by centrifuge in high gravity. The samples solidified in 3.5g had density and solute distribution profiles more stable and a lower region with dendritic structure plus irregular eutectic structure (0 - 25% fs) as compared with the sample grown in 1g.

Acknowledgements: *The authors are grateful to the CNPq and CAPES for the financial support.*

Referências

Chen, Y. A. et al. (1997). A low cost centrifuge for materials processing in high gravity. In: Centrifugal materials processing. New York: Plenum Press.

Regel, L.L.; Wilcox, W.R. (1994). Materials processing in high gravity. New York: Plenum Press.