STUDY OF THE REDISTRIBUTION OF SOLUTE IN EUTECTIC LEAD-TIN ALLOYS SOLIDIFIED UNDER HIGH ACCELERATION

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1. Introduction

The study of materials processed in centrifuges improves the understanding on influence of acceleration and convection in materials processing. Large centrifuges are expensive and rarely available for crystal growth and solidification experiments. To overcome this difficulty, a small centrifuge with an electric tubular furnace was designed and built at LAS/INPE, which provides an acceleration ranging from 1 to 10 times the earth gravity [1,2]. The scope of this work is to study the influence of the high gravity in the redistribution of solute due to effects of the buoyancy-driven convection and sedimentation. The samples were analyzed by densitometry and energy dispersive spectrometry (EDS). The PbSn eutectic alloy is a material that provides convenient physical properties such as low melting point (183°C), low vapor pressure, and does not react with the surface of the quartz ampoule, making it an ideal material for solidification studies of regular eutectic alloys [3].

2. Experimental

The solidification experiments were carried out in a furnace attached to the centrifuge (Figure 1). A mass of 20g of the $Pb_{38.1}Sn_{61.9}$ (wt%) eutectic alloy was prepared from 99.9999% purity elements and sealed under vacuum (5.10^{-6} Torr) in an 8 mm diameter and 100 mm length quartz ampoule (Figure 2). Solidification experiments were perfomed with both the furnace standing at 1g and rotating at 6g with the same thermal parameters, where g is the gravity acceleration on earth (9.81 m/s^2). In the second experiment, after heating the furnace up to a temperature of 200°C for 1 hour, the temperature controller was disconnected and the motor turned on at 92 rpm and kept running at constant speed during the whole solidification process.

Fig. 1. *Centrifuge (with furnace at the right side) of LAS/INPE***.**

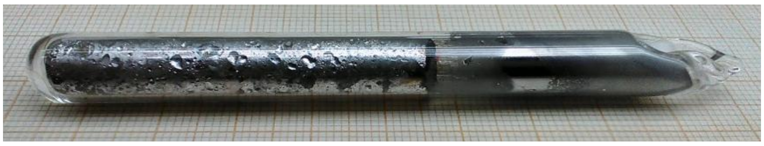

Fig. 2. *PbSn eutectic alloy sealed in a quartz ampoule.*

3. Results and Discussions

Figure 3(a) shows the average lead composition profile along axial direction measured by density measurements. It is observed that at the beginning of the both samples (at the tip of the quartz ampoule) there is a solute (Pb) accumulation caused by both convection and sedimentation due to density differences between Pb ($11.34g/cm^3$) and Sn ($7.31g/cm^3$). On the other hand, the samples analyzed by EDS, Figure 3(b), shows a smaller difference between both profiles because that in this case only the surface composition of each sliced

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sample was took into account. It was expected that higher gravity levels would cause a larger composition gradient along sample axial direction.

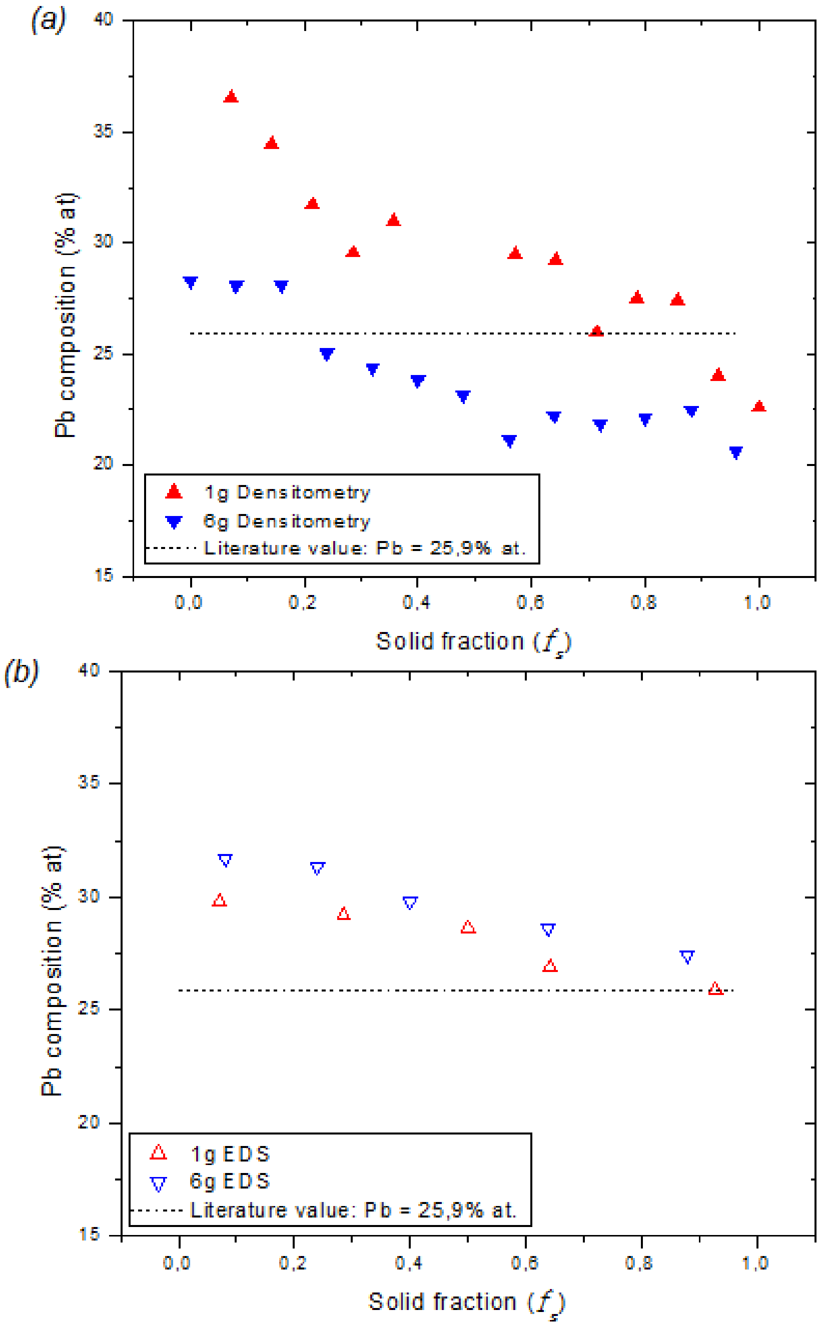

Fig. 3. *Lead composition profile for 1g and 6g PbSn eutectic alloy analyzed by densitometry (a); energy dispersive spectrometry (EDS) (b).*

4. Conclusion

PbSn eutectic alloys were solidified by centrifuge under high acceleration, and the average composition profile obtained at 6g level presents a smaller axial density gradient than that obtained under 1g earth gravity. The centrifuge can be used to control the solute redistribution by the effects of the buoyancy-driven convection and sedimentation.

5. References

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