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Processing of Ni- and Ti-based bulk metallic glasses by injection and suction casting

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Abstract – Ni-based and new Ti-based bulk metallic glasses (BMGs), i.e. $Ni_{59,5}Nb_{33,6}Sn_{6,9}$, $Ni_{60}Nb_{36}Sn_3B_1$ and $Ti_{55}Ni_{10}Cu_{35}$, were processed by injection and suction casting into copper molds to investigate the effect of the processing route on the maximum amorphous diameter/thickness. The suction casting technique, despite of providing higher increase in alloy oxygen content than the injection casting technique, presented the best results for maximizing amorphous diameter/thickness, which can ascribed to the higher cooling rate for this technique compared with injection casting technique resulted from optimization of the metal/mold contact.

During the last decades amorphous metals have attracted much attention because of their scientific importance and remarkable physical, chemical and mechanical properties. Recently it was reported the production of bulk metallic glasses (BMGs) by simple casting techniques using cooper molds [1,2]. Processing BMGs is not an easy task because it involves several important processing requirements such as precise control of alloy composition and imposition of high cooling rate. In the present work, processing of BMGs was carried out by two copper mold casting techniques, i.e. injection and suction casting, to investigate the effect of the processing route on the maximum amorphous diameter/thickness.

Ni- and Ti-based alloys were analyzed, i.e. $Ni_{59,5}Nb_{33,6}Sn_{6,9}$ [3], $Ni_{60}Nb_{36}Sn_3B_1$ [3], and a new Ti-based alloy, $Ti_{55}Ni_{10}Cu_{35}$, designed with basis on the lambda criterion [4]. The alloy ingot was prepared by arc melting high-purity constituent elements in a Ti-gettered high-purity argon atmosphere. Wedge and rod shaped samples, with diameters (rods) up to 6 mm or thickness (wedges) up to 10 mm, were produced by copper mold injection and suction casting. Samples were characterized by X-ray diffraction (XRD), differential scanning calorimetry (DSC), optical microscopy (OM) and scanning electron microscopy (SEM). The oxygen content of Ti-based samples after processing was analyzed.

Fig. 1 shows SEM images of $Ti_{55}Ni_{10}Cu_{35}$ alloy processed by injection and suction casting techniques. As an example, Fig. 2 shows DRX pattern and OM micrograph of suction-casted $Ni_{60}Nb_{36}Sn_3B_1$ alloy with a thickness of 3 mm. For the three alloys analyzed, the maximum amorphous diameter/thickness was higher by the suction casting than by the injection casting. However, the oxygen analyses of Ti-based samples (not shown here) revealed that the injection technique provided the lower increase in alloy oxygen content compared with the suction-casted Ti alloy.

The suction casting technique, despite of providing higher oxygen content than the injection casting technique, presented the best results for maximizing amorphous diameter/thickness, which can ascribed to the higher cooling rate for the suction processing due to the optimization of the metal/mold contact.

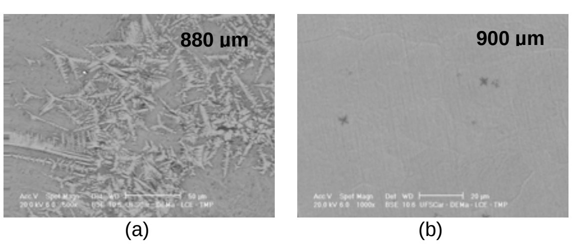

Figure 1: SEM micrographs of $Ti_{55}Ni_{10}Cu_{35}$ alloy processed by the injection (a) and suction (B) casting techniques. Samples thicknesses are indicated on the images.

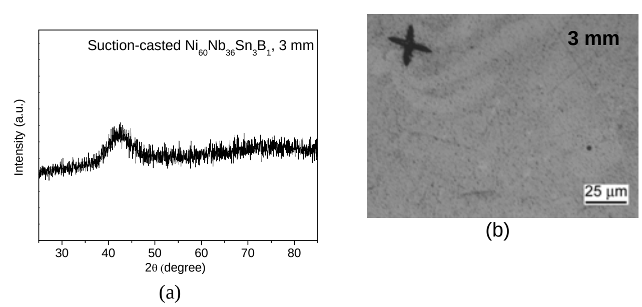

Figure 2: DRX pattern (a) and OM micrograph of suction-casted $Ni_{60}Nb_{36}Sn_3B_1$ with a thickness of 3 mm.

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