11th International Conference
on Advanced Materials

ICAM 2009

Rio de Janeiro Brazil
September 20 - 25

$Ti_{34}Cu_{36}Ni_{8}Zr_{22}$ and $(TiZr)_{80}Co_{12}Fe_{8}$ Bulk Amorphous Alloys: Processing and Characterization

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Abstract – This work aimed to obtain bulk amorphous of $Ti_{34}Cu_{36}Ni_{8}Zr_{22}$ and $(TiZr)_{80}Co_{12}Fe_{8}$ alloys. For in such a way, the alloys were arc melted and then rapidly solidified in copper molds in wedge and spread cylindrical formats by suction and centrifugal casting process. The samples were characterized by scanning electron microscope and microanalyses (SEM/EDS), x-ray difraction (XRD) and differential scanning calorimetry (DSC). After analysis of the results, can be identified the presence of glass transition temperature (T_g) and characteristic difractogram of amorphous structure in both the compositions.

A titanium alloy with high glass forming ability, as $Ti_{50}Ni_{25}Cu_{25}$ and its derivation $Ti_{50}Ni_{20}Cu_{23}Sn_{7}$, developed by Zhang and Inoue [1] in 1998, presented the first successful case to find an alloy with good glass forming ability, which can be cast totally amorphous in 5-6 mm thickness ribbons. The Ti-based former glassy alloys represent a challenge for scientists worldwide.

Using known selection criterions for high glass forming ability alloys (criterion lambda and mean electronegativety), it was proposed the study of $Ti_{34}Cu_{36}Ni_{8}Zr_{22}$ e $(TiZr)_{80}Co_{12}Fe_{8}$ alloys, which presented high glass forming ability in preliminaries results obtained by melt-spinning ribbons as showed in table 1, where T_g is the glass transition temperature, T_x is the crystallization onset temperature, ΔT_x is the difference between the T_g and T_x and T_m is melting temperature [2].

The elements used in this work were previously pickled, weighted and then arc-melted under argon atmosphere, using a water-cooled electrolytic copper crucible, and two Ti getters. The alloys were submitted from four to five melting steps in order to obtain homogeneous alloys. The produced ingots were divided in pieces of 8g each, then submitted to suction and centrifugal casting process, and later, poured in electrolytic copper mold, aiming a quick fulfilling and high heat extraction rate. In both process, three purge with argon were realized and, finally, casted under argon atmosphere.

The samples, were characterized by scanning electron microscope/energy dispersive spectroscopy (SEM/EDS), X-ray diffraction (XRD) under Cukα radiation, scanning angle 2θ from 20° to 90° and 0,02° angular step, and differential scanning calorimetry (DSC) with heating and cooling rate equal to 40K/min under pure argon continuous flow atmosphere.

It was observed XRD typical difratograms of amorphous structure with a certain amount of nanocrystals, for both alloys (figure 1). DSC analyses showed a crystallization peak between 723 and 823K for $(TiZr)_{80}Co_{12}Fe_{8}$ alloy and 648 and 773K for $Ti_{34}Cu_{36}Ni_{8}Zr_{22}$ alloy. The bulks results agree with ribbons results.

Table 1. Thermal characteristics obtained in preliminaries results, Tg, Tx, ΔTx and T_m.

Alloy	T_g (K)	T_x (K)	ΔT_x (K)	T_m (K)
$Ti_{34}Cu_{36}Ni_{8}Zr_{22}$	616	683	67	1090
$(TiZr)_{80}Co_{12}Fe_{8}$	750	775	25	1143

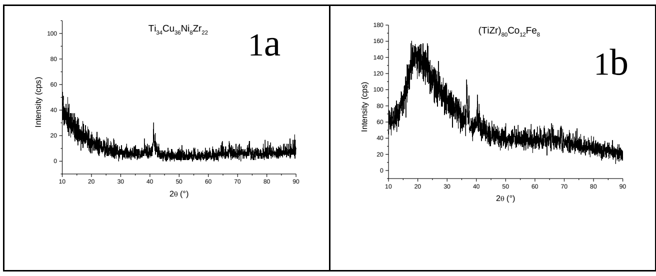

Figure 1 – X-ray difractograms **(a)** $Ti_{34}Cu_{36}Ni_{8}Zr_{22}$ and **(b)** $(TiZr)_{80}Co_{12}Fe_{8}$

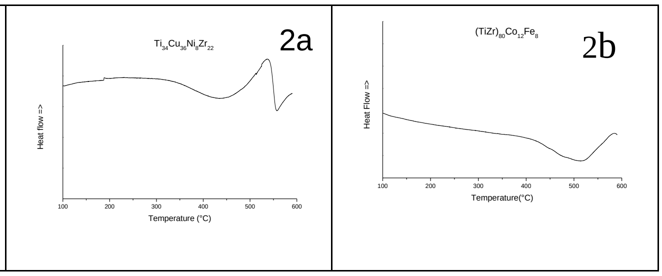

Figure 2 – DSC analyses **(a)** $Ti_{34}Cu_{36}Ni_{8}Zr_{22}$ and **(b)** $(TiZr)_{80}Co_{12}Fe_{8}$

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