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# Spray forming of glassy alloy $Fe_{65}B_{30}Nb_4Ti_1$

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**Abstract** - A lower percentage of amorphous phase was expected during spray forming of alloy Fe66B30Nb4 with the addition of 1%Ti and the reduction of Fe, since it was expected the formation of (Ti-B)N due to the utilization of $N_2$ as the atomization gas, which could induce crystallization. Melt spun ribbons were used to the characterization of the thermal properties, amorphous and main crystalline phases of the alloy. The spray formed samples were analyzed with optical and scanning electronic microscopy, x-ray diffraction, and hardness tests.

The first results show low formation of vitreous phase and no nitrogen intermetalic was found in the bulky part of the spray formed deposit. The hardness values lies in range 792 to 919 HV 30.

By melt spinning under argon atmosphere the alloy Fe65B30Nb4Ti1 can form amorphous phase. This alloy presents high hardness and might have good wear response. Spray forming (SF) is a mass production process and can be classified as a two-stage manufacturing process, where the solidification begins during the flight of the particles, which can be considered a rapid solidification step, and finishes during the building of the perform, where the remained liquid droplets solidify under considerable slower rates. During gas atomization a wide range of particles size are produced and as a result of different cooling rates, the microstructure in these particles can vary quite well. The solidification is basically influenced by both the cooling rate of the droplets and the presence of satellites inducing heterogeneous nucleation in larger fully molten droplets. Rapidly solidified microstructures have been observed in atomized alloys as a result of the high cooling rates achieved by the droplets. Hence, SF have been successfully applied in processing both commercial and advanced alloys aiming: extension of the solid solubility, fine dispersion of second phase particles, low porosity, low segregation level, and finally metastable or even amorphous phase. This paper describes some results obtained by spray forming the glassy iron-based alloy Fe65B30Nb4 with the addition of Ti. The alloy was atomized by using nitrogen as atomizing gas aiming to induce the formations of extra (Ti,B)N hard particles to increase its hardness.

The alloy presented low formation of glassy phases for the processing parameters employed. Even the melt spun ribbons presented four kinds of intermetallics in the thicker portions, as detected by X-ray diffraction, showing that the glass forming ability of the alloy decreased by the addition of Ti. However, in the thinner portions SEM showed a complete amorphous structure. DSC gave the peak of crystallization of the amorphous phase at 550°C, fig 1. Spray formed deposits showed low amorphisation; see XRD-pattern in figure 2. The major phases were $Fe_2B$ and alpha iron. Precipitates not detected by XRD were analyzed by EDS. Despite the presence of (Ti,B)N hard particles was not verified, the hardness of the spray formed deposits ranged from 792 to 919 HV 30, showing the great ability of this composition to produce high levels of hardness.

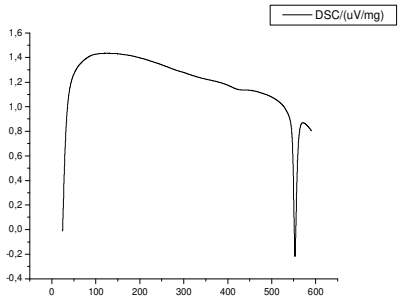


**Figure 1**: DSC of the melt spun ribbon showing crystallization

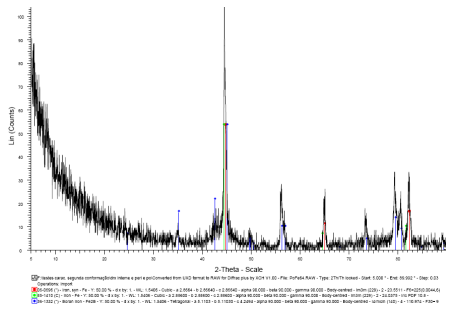


**Figure 2:** Diffraction scan of the thin section (1mm) of the spray formed deposit.