Characterization of a {(Fe0.6Co0.4)0.75B0.2Si0.05}96Nb4 atomized glassy powder by Neutrons Diffraction and Differental Scanning Calorimetry

N. Ciftci[a]; U. Dahlborg[b]; M. Calvo-Dahlborg[b]; A-A.Bogno[c];H. Henein[c]

[a] Foundation Institute of Materials Science (IWT), Department of Production Engineering,
[b] University of Bremen, Germany
[c] Institut des Materiaux, UFR Sciences et Techniques, Universite de Rouen, Rouen, France

[c] Chemical and Materials Engineering, University of Alberta, Edmonton, Canada

Metallic glasses such as iron- and aluminum based amorphous alloys have a high potential as advanced engineering materials. To date, the formability of fully amorphous or partially amorphous materials are not clearly understood and thus offer great opportunities for industrial applications in order to replace commercial iron or aluminum alloys in near-net-shape processes.

The objective of the present work is to study the formability of fully- or partially amorphous microstructural features and evaluating its mechanical properties. Thus, an iron-based bulk amorphous alloy {(Fe0.6Co0.4)0.75B0.2Si0.05}96Nb4 was atomized using gas atomization (GA) and Impulse Atomization (IA).

To determine the amorphous fraction (percent crystallinity) and kinetic crystallization properties of the obtained powder samples, a fully amorphous reference powder was compared to atomized powder samples. Two different characterization methods were used these include Differential Scanning Calorimetry (DSC) and Neutrons Diffraction (ND). The diffraction patterns obtained from the neutron beam are shown in Figure 1, in which the different numbers and letters used in the legend correspond to the atomization gas and the average droplet size (see table 1).

	Nitrogen			Helium			
Legend	3N	8N	12N	3H	6H	9H	12H
Average droplet size (μm)	125	300	600	125	212	355	600

Table 1: Nomenclature of the characterized droplets by Neutron Diffraction

The ND technique proved to be yielding some valuable and unique information that could not be obtained using the DSC or even the X-ray diffraction (XRD) methods [1]. For instance, as can be seen on Figure 2, for a FeCo-BMG powder of average size 600 um atomized in He, ND data analysis indicates that it has about 5% amorphous fraction while the DSC characterization method yields an amorphous fraction of this sample of zero, that is 100% crystallinity.

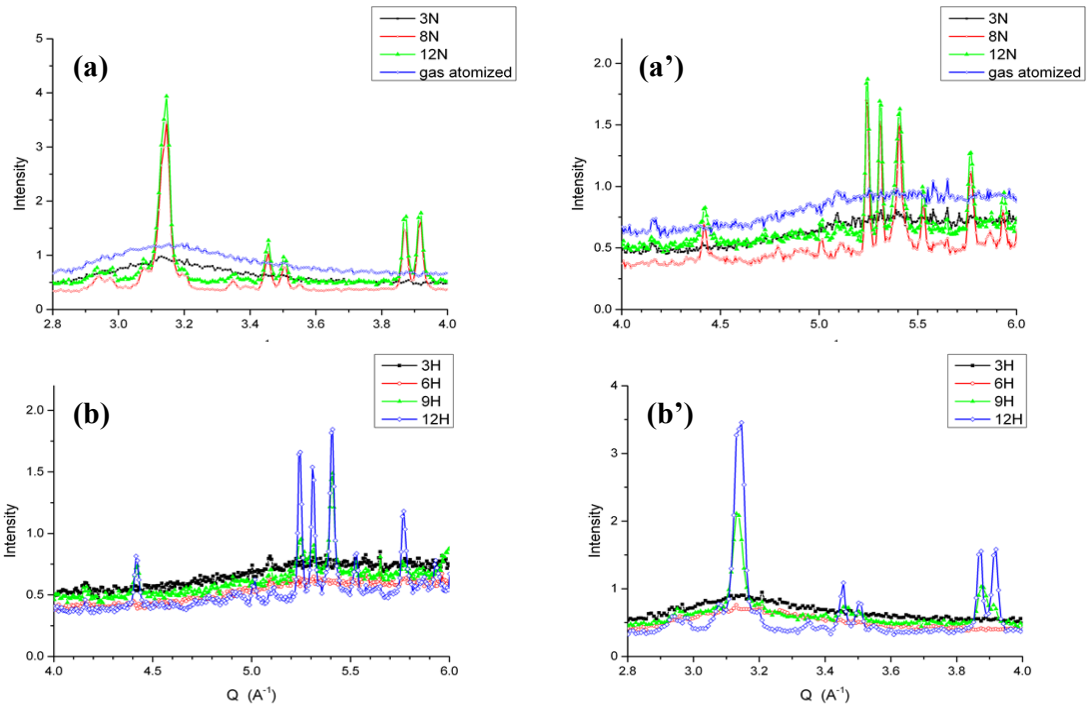

Figure 2: Diffraction patterns obtained from the neutron beam during experiments conducted using a C2 neutron powder diffractometer at the Canadian Neutron Beam Centre (CNBC) in Chalk River, ON. (a-a') Droplets atomized in Nitrogen, (b-b') droplets atomized in Helium. Patterns of a fully amorphous reference powder are plotted for comparison.

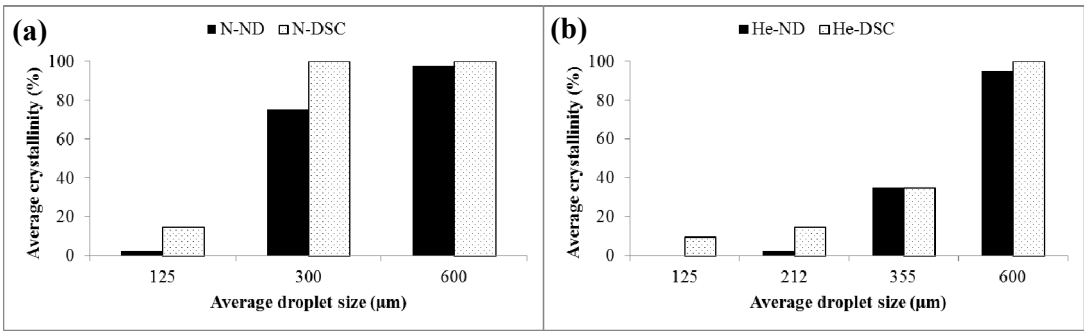

Figure 2: Comparison of percent crystallinity/amorphous between samples characterized by Neutrons Diffraction (ND) and by Differential Scanning Calorimetry (DSC).(a) Samples obtained by impulse Atomization under Nitrogen (N) (b) Samples obtained by impulse Atomization under Helium (He).

References

[1] Ciftci, N; Ellendt, N; von Bargen, R; Henein, H; Mädler, L; Uhlenwinkel, V; SDMA 2013 - 5th Int. Conf. on Spray Deposition and Melt Atomization – 23-25 Sept. 2013 - Bremen, Germany