In-situ crystallization of Fe68Cr8Mo4Nb4B16 amorphous alloy

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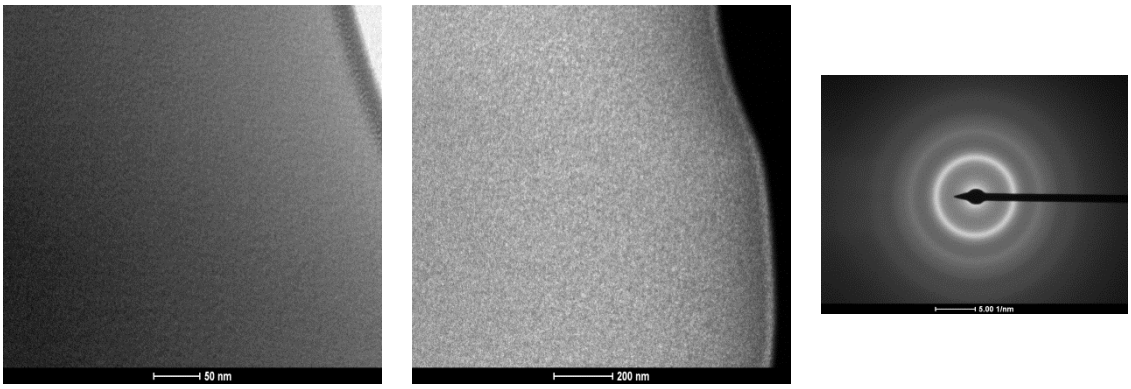
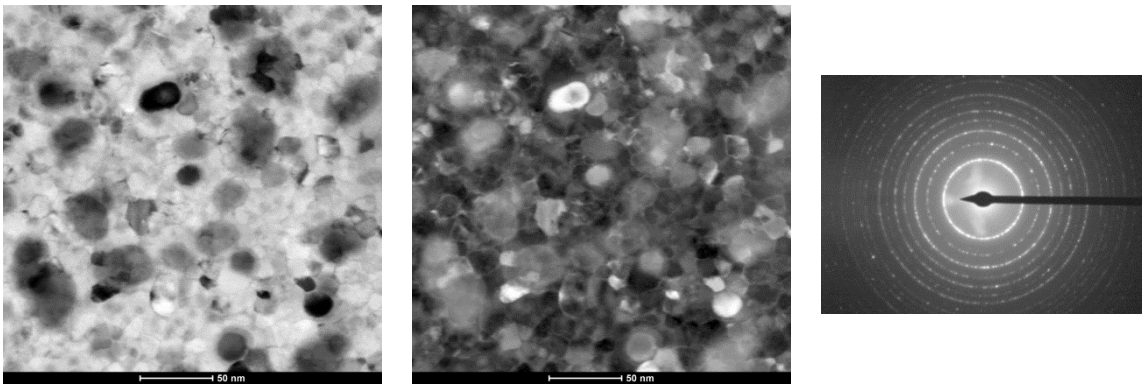
Recently it has been reported that Fe-based glassy alloys can be formed by B addition in the range of 16-18 at% in the multicomponent Fe-Cr-Mo-Nb-B system. This system, which can be classified as a pseudo high entropy type, is of great interest due to the possibility of better ductility in comparison with almost all other Fe-based glassy alloys, which have higher contents of metalloid elements. The multicomponent Fe-based alloys with low B contents may exhibit useful engineering properties even in partially and fully crystallized state. The presence of nanometric multicomponent borides in the structure can increase the Vickers hardness, wear resistance, corrosion resistance and the strength at elevated temperature. In the present work we report the TEM *in-situ* crystallization of the $Fe_{68}Cr_8Mo_4Nb_4B_{16}$ amorphous alloy. The master alloy was produced in an arc-melt apparatus, using a mixture of pure elements. This alloy was then rapid solidified in a melt-spinning apparatus resulting in 30 m-thick amorphous ribbons. TEM sample preparation was carried out by ion milling in a Gatan PIPS - Model 691. The in-situ crystallization was performed using a hot stage holder in a Philips CM120 microscope. The sample was heated up to 850 C at a heating rate of 100 C/min, left 10 min in temperature and then cooled down. The crystallized sample was then transferred to a FEI Tecnai G2F20 coupled with a Nanomegas ASTAR system for phase and orientation mapping. In this work we present the results associated only with the amorphous and fully-crystallized condition. Figure 1 shows a STEM bright and dark field images (Figures 1 (a) and (b)) and the electron diffraction pattern of the melt-spun ribbon (Figure 1 (c)) confirming the fully amorphous character of the $Fe_{68}Cr_8Mo_4Nb_4B_{16}$ alloy. STEM bright and dark field images of crystallized sample (Figures 2 (a) and (b)) shows that the structure is composed of crystals with grain size of about 30 nm. The electron diffraction pattern (Figure 2 (c)) confirms the polycrystalline structure. The results of automatic phase mapping using ASTAR (Figure 3 (a)) showed that the nanocrystalline phases present in the fully crystallized sample are ferrite (Fe-alpha), austenite (Fe-γ), orthorrombic-M_2B (Fddd space group) and the hexagonal- FeNbB (P6-2m space group).The orientation phase map diplayed in Figure 3 (b) confirms the nanometric grain size of the fully crytallized sample.



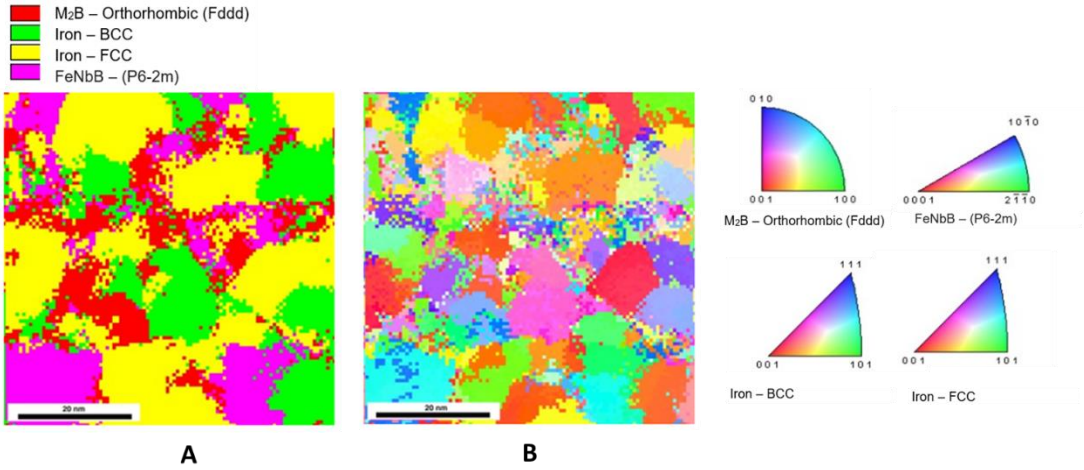
A B C

Figure 1: (a) STEM Bright field (b) STEM Dark field and (c) Electron Diffraction Pattern of the as-melt-spun ribbon.



A B C

Figure2: (a) STEM Bright field and (b) STEM Dark field and (c) Electron Diffraction Pattern of the fully crystallized melt-spun ribbon.



A B

Figure 3: (a) Phase orientation map and (b) Orientation map of the fully crystallized melt spun ribbon.