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Study of the DO_3 Superlatice Structure of The $Fe_{74.3}Si_{14.2}Cu_1Nb_3B_{7.5}$ Alloy

Geronimo Perez[1], Luiz Benyosef[2] and Guillermo Solorzano[3]

[1]National Institute of Metrology, Rio de Janeiro, Rio de Janeiro, Brazil, [2]National Observatory, Rio de Janeiro, Rio de Janeiro, Brazil, [3]Pontifical Catholic University of Rio de Janeiro, Rio de Janeiro, Rio de Janeiro, Brazil

$Fe_{74.3}Si_{14.2}Cu_1Nb_3B_{7.5}$ alloy ribbons were produced by the melt-spinning technique and annealed at 554 ^oC for 1 h to form the α-Fe(Si) nanocrystalline phase embedded in an intergranular amorphous B-Nb rich phase. The materials were subjected to structural, thermal and magnetic characterization. The formation of amorphous and nanocrystalline structures were verified by x-ray diffraction (XRD) and transmission electron microscopy (TEM) on the as spun and annealed samples respectively. The magnetic properties of the ribbons were analyzed by vibrating sample magnetometer (VSM). The lattice parameter of the BCC phase is calculated to be 0.284 - 0.285 nm from the X-ray diffractometry, that corresponding to (200) plane of the DO_3 superlatice structure. The transmission electron microscopy results show an evidence of the formation of the DO_3 superlatice structure. Previous works indicates that a approximate composition of the nanocrystalline phase is Fe_3Si [1] of a complex bcc structure [2] forming DO_3 superlatice structure [3]. TEM micrograph, of Fig. 1b, shows the amorphous structure of the as-spun sample and its corresponding selected area diffraction pattern, Fig. 1a, which shows diffuse rings of amorphous materials, typical of amorphous structures. TEM images on Fig. 1d confirm the formation of nanocrystaline phase in the annealed sample, showing grains in the order of 10 nm. Polygonal and faceted shapes were not observed; most of nanocrystals have a spheroidal shape, indicating the presence of the remaining intergranular amorphous phase that has avoided the impingement between the grains during the growth stage. Fig. 1c shows the electron diffraction pattern of the nanocrystalline sample, which shows typical sharp rings of nanocrystalline structure. The detailed observation of the selected area diffraction pattern (SAED) reveal the presence of the spots corresponding of 111 and 200 planes of the DO_3 superlattice cubic structure, and the presence of diffuse ring corresponding to the amorphous Fe-B phase, probably Iron (III) boride. The main peak (011) of orthorhombic structure of the FeB phase (crystallographic information file database code ICSD 30449) matchs with the diffuse ring corresponding of 0.25-0.26 nm interplanar distance. Fig. 2a show a SAED of the annealed sample and Fig. 2b present the intensity profile of the electron diffraction pattern. On the SAED of Fig. 2a is possible to observe an inner diffuse ring, inside of the most intense ring, corresponding to Fe-B amorphous phase (near 0.25 nm) and is possible to observe some spots corresponding to 111 and 200 planes of DO_3 structure near of the center of the electron diffraction pattern. The profile of Fig. 2b allows identifying clearly the diffraction spots.

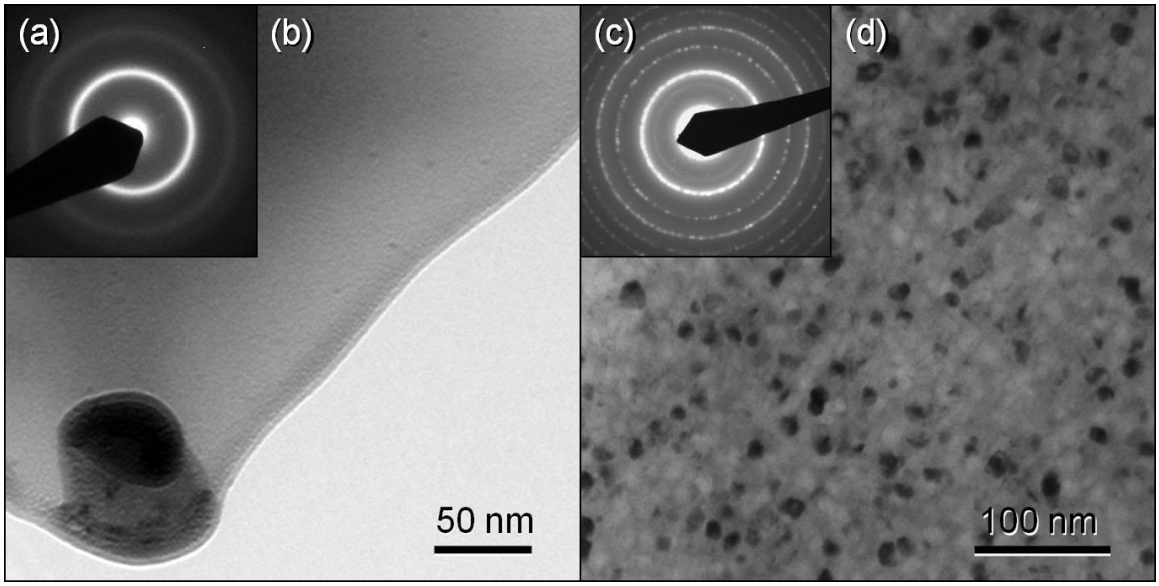

Figure 1. (a) inserted corresponding selected area electron diffraction pattern of the as-spun sample, (b) TEM micrograph of amorphous structure of the as-spun sample, (c) selected area electron diffraction pattern of the annealed sample, (c) TEM micrograph of annealed sample.

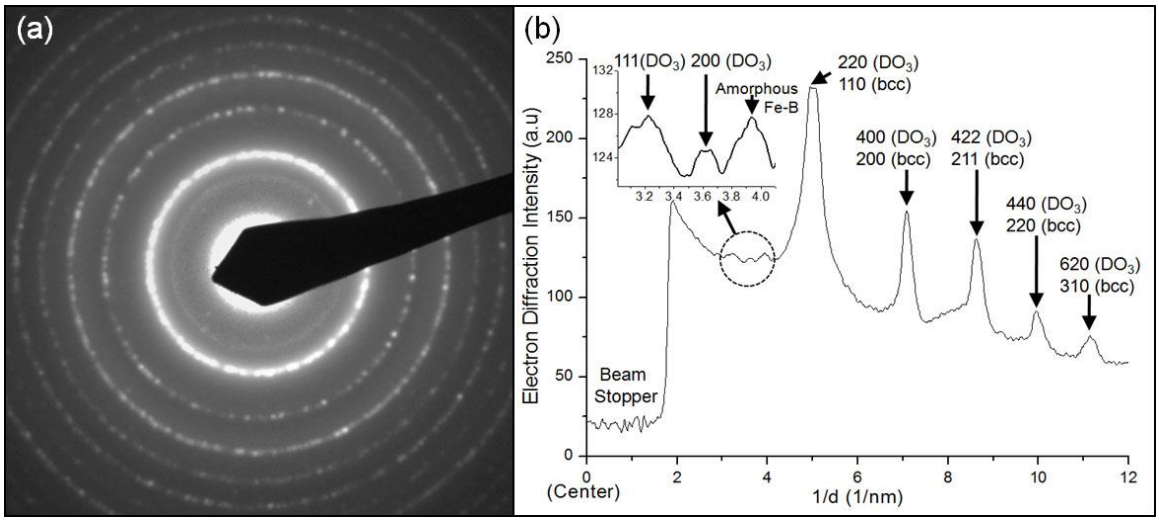

Figure 2. (a) Electron diffraction pattern of the annealed sample and (b) its respective intensity profile.

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