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Structural Characterization of High Entropy Alloy (FeCoCrNiCu) Synthesized by Mechanical Alloying

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High entropy alloys (HEAs) which usually contain five or more elements with equal or near equal atomic ratios, were proposed recently at the start of this century [1,2]. It opens up the possibility of creating new metallic alloys with good mechanical properties, especially at elevated temperatures. In these alloys, the entropy term may dominate over enthalpy, preventing the occurrence of chemical ordering [3,4]. Mechanical alloying (MA) process is described by the repeated welding and fracturing of powder particles entrapped between milling media, the extent of which depends on the mechanical attributes of powder constituents. MA offers the advantage of extended solid solubility even in immiscible systems. It can be attributed to the enhanced diffusion rates due to nanosize of powder components before alloying. Therefore, besides increased configurational entropy, MA lends enhanced stability to solid solution phases in HEAs [5].

In this work, the FeCoCrNiCu-HEA was synthesized during 100 h by mechanical alloying. The pure elements were alloyed in a planetary mill, at 300 rpm with a ball / powder ratio of 10: 1 and a ball / ball ratio of 1: 1. The alloyed powders were sintered in a high temperature tube furnace at 1100°C for 2 h. The microstructural characterization of HEA bulk was carried out by X-ray diffraction to identify the phases formed after sintering. Also, the bulk was analyzed by scaning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) to determine the morphology and chemical composition of the phases formed.

Figure 1 shows the diffraction pattern of HEA after sintering, in which the presence of two phases are appreciated. These phases are FCC and FCC with Cu precipitations, the formation of precipitations are attributed to the strong repulsive interaction of Cu with the other elements, and that Cu has the highest positive enthalpy of mixing with Fe, Cr, Co and Ni [6].

Figure 2a shows Backscattered electron image (BSE), in which the two phases formed can be observed, Fo is the dark phase and Fc is the light phase, also the presence of porosity. Figure 2b shows the EDS chemical mapping of HEA, where it is observed that the elements of the alloy are uniformly distributed except for Cu that precipitates in certain areas. These precipitations coincide with the diffraction pratrons obtained in figure 1.

In conclusion, the microstructure of FeCoCrNiCu HEA sintered at 1100 ° C for 2 h, is composed of two phases, these phases are FCC, one of them with Cu precipitate.

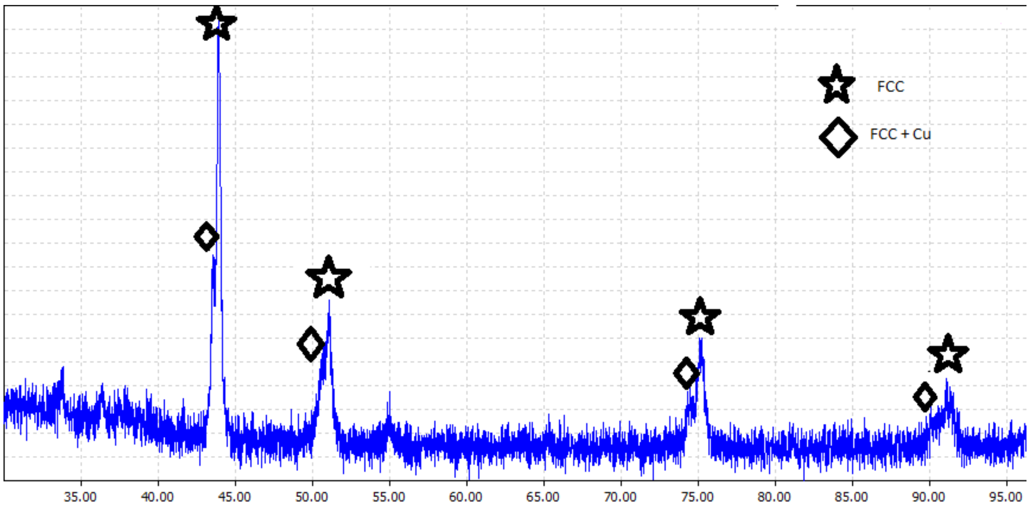

Figure 1. Diffraction pattern of FeCoCrNiCu HEA.

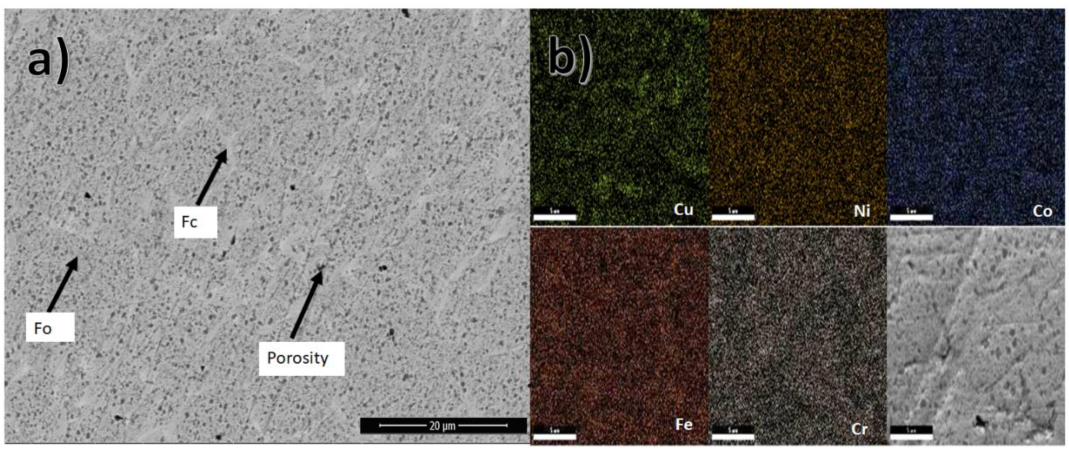

Figure 2. SEM images of FeCoCrNiCu HEA, a) BSE image and b) EDS chemical mapping.

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