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Microstructural Characterization of the Polycrystalline Cu-13.7%Al-4%Ni Alloy

E. C. Pereira(1), A. N. Matlakhov(1), C. J. de Araújo(2) and L. A. Matlakova(1)

(1) Advanced Materials Laboratory. State University of the Northern Rio de Janeiro. Av. Alberto Lamego, 2000, Parque California, Campos dos Goytacazes, RJ, Brazil. CEP 2800-602; e-mail: <elainecp@uenf.br> <anatoli@uenf.br> <lioudmila@uenf.br>.

(2) Multidisciplinary Laboratory of Active Materials and Structures. Federal University of Campina Grande. Av. Aprígio Veloso, 882, Bodocongó, Campina Grande, PB, Brazil. CEP 58429-900; e-mail: carlos@dem.ufcg.edu.br

Abstract – The Cu-Al-Ni alloys, which show shape memory properties, have attracted great interest since present some advantages over the Ti-Ni, Cu-Zn and Cu-Zn-Al alloys in practical applications. It is very important to characterize the microstructure of these alloys to the appropriate use of functional properties. The polycrystalline Cu-13,7%Al-4%Ni alloy shows homogeneity of the chemical elements and chemical composition comparable to the nominal composition, provided by the manufacturer. Moreover, were observed microstructures typical of these alloys.

The Cu-Al-Ni alloys, which show the shape memory effect (SME), have attracted great interest since present some advantages over the Ti-Ni, Cu-Zn and Cu-Zn-Al alloys in practical applications. These advantages are in terms of thermal and electrical conductivities, lower cost and attractive thermoelastic properties. Monocrystals are known to have the best features of SME and ductility, compared to polycrystalline materials. Therefore, various manufacturing methods have been developed to improve ductility of polycrystalline alloys [1]. The main objective of this work is to characterize the microstructure of the polycrystalline Cu-13.7Al-4Ni alloy in the as received state. In this work a polycrystalline Cu-13.7%Al-4%Ni alloy, produced by plasma melting and injection molding, was investigated. Optical microscopy (OM), atomic force microscopy (AFM) and scanning electron microscopy (SEM) analyses were used to characterize the alloy. Inside the grains, Fig. 1(a), is the presence of martensitic variants with two different morphologies: fine needles and V-shape cross needles. According to the literature [1] martensitic β'_1 and γ'_1 phases present these microstructural features. The AFM analysis confirms the martensitic structure of the grains and the presence of dark spots deep, which probably corresponds to the structural defects, Fig. 1(b). The image of the structure shows a weak contrast in composition, indicating the possible uniformity of the phases present in the emission coefficients of backscattered electrons, Fig. 1(c). The microanalysis by spectroscopy of dispersion energy (SDE) in line, confirms the chemical homogeneity of the alloy, Fig 1(d). The mapping in X-rays characteristic of Cu, Al and Ni is shown in Fig. 2(a), which shows no segregation of the present elements. The chemical composition was determined by microanalysis performed in the points indicated in Fig. 1(c). The emission spectra of characteristic X-rays obtained in points 1 and 2 are identical and have the same intensities for the respective series of X-ray spectrum of Cu, Al and Ni, Fig. 2(b), confirming the chemical homogeneity of this alloy. The quantification of the chemical composition, determined as 81.93%Cu-13.99%Al-4.08%Ni (% weight), Fig.2(c) is comparable to the nominal alloy composition. According to the aluminum content it was concluded that the phases present in the alloy are based on the Cu_3Al intermetallic compound.

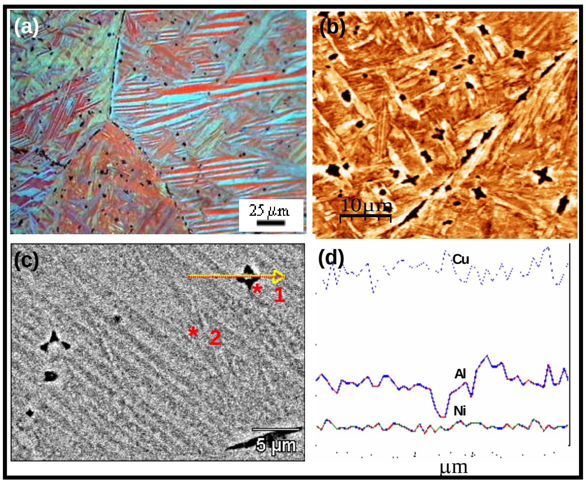
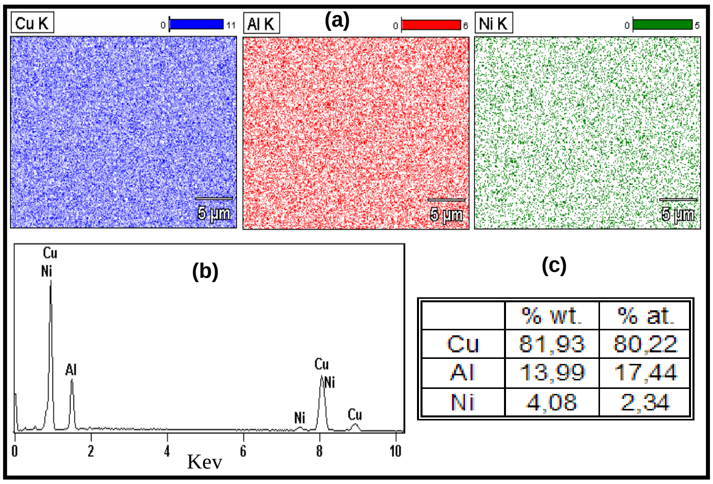


Figure 1: Morphologic aspect of the Cu-13.7Al-4Ni polycrystalline alloy obtained by **a)** OM, **b)** AFM, **c)** SEM, **d)** Microanalysis by SDE in line.



	% wt.	% at.
Cu	81,93	80,22
Al	13,99	17,44
Ni	4,08	2,34

Figure 2: a) Mapping in X-rays characteristic of Cu, Al and Ni. **b)** Chemical composition. **c)** Emission spectra of characteristic X-rays of the Cu-13.7Al-4Ni polycrystalline alloy.

[1] K. Otsuka and C.M. Wayman, Shape Memory Materials, (1999) University Press, USA. 284p.