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Quasicrystalline Phase Formation in the Mechanically Alloyed Al-Cu-Fe-Cr

S. N. de Medeiros[(1)*], E. E. Irikuchi[(2)], A. Paesano Jr.[(2)] and F. L. A. Machado[(3)]

(1) Departamento de Física Teórica e Experimental, Universidade Federal do Rio Grande do Norte, e-mail: snm@dfte.ufrn.br
(2) Departamento de Física, Universidade Estadual de Maringá, Maringá, Paraná, Brazil
(3) Departamento de Física, Universidade Federal de Pernambuco, Recife, Pernambuco, Brazil
* Corresponding author.

Abstract – In the present work, the formation of Al-Cu-Fe-Cr icosahedral and decagonal phases by means of mechanical alloying followed by thermal annealing was investigated by X-ray diffractometry and Mössbauer spectroscopy. The samples $Al_{70}Cu_{20}Fe_7Cr_3$ milled for 20 h and heat-treated at 350ºC for 16 h and 950ºC for 4 h presented an icosahedral and decagonal phases, respectively.

The quasicrystalline materials have long-range rotational order but lack of long-range translational order and are not truly periodic. Besides being theoretically interesting due to their complex atomic structure, the unique properties of quasicrystalline materials (low electrical and thermal conductivity, unusual optical properties, oxidation resistance, high hardness, etc.) also make them interesting for many applications. Quasicrystalline alloys are usually prepared by rapid or conventional solidification from the melt. However, in the last few years it has been reported that quasicrystalline alloys can also be prepared by mechanical alloying. In the present work, the formation of Al-Cu-Fe-Cr icosahedral and decagonal phases by means of mechanical alloying followed by thermal annealing, varying the starting relative concentration, the powder-to-ball weight ratio and milling time, was investigated by X-ray diffractometry and Mössbauer spectroscopy. In all X-ray spectra, a broadening of the reflection peaks was observed, revealing the strong particle size reduction of the milled products. The samples $Al_{70}Cu_{20}Fe_7Cr_3$ milled for 20 h and heat-treated at 350ºC for 16 h and 950ºC for 4 h presented an icosahedral and decagonal phases, respectively. The Mössbauer spectrum for these samples were fitted with one doublet and a quadrupole distribution assigned to the quasicrystalline phases. For the $Al_{70}Cu_{20}Fe_5Cr_5$ and $Al_{70}Cu_{20}Fe_3Cr_7$ samples, the results reveled the formation of the intermetalic Al_2Cu phase and the (Al, Fe, Cr) solid solution.

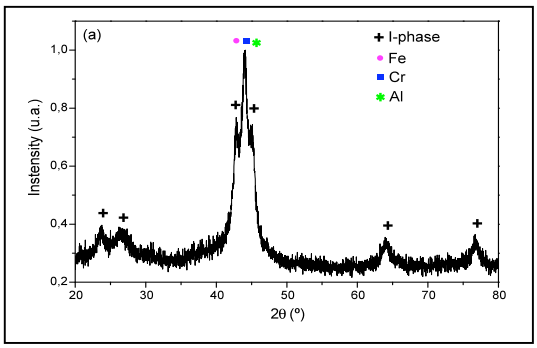

Figure 1: XRD pattern of $Al_{70}Cu_{20}Fe_7Cr_3$ alloy after 20 h of milling and heat-treated at 350º for 16 h.

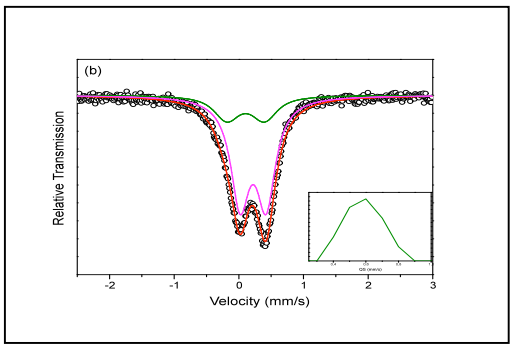

Figure 2: Mössbauer spectrum of $Al_{70}Cu_{20}Fe_7Cr_3$ alloy after 20 h of milling and heat-treated at 350º for 16 h.

References

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