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An experimental study of the nanostructured i-$Al_{63}Cu_{23}Fe_{13}$ quasicrystal produced by arc-furnace and mechanical-alloying

Manolo Taquire[(1,2*)], Justiniano Quispe[(1)], Carlos V. Landauro[(1)], Alfredo Tolley[(2)], and Victor Peña[(1)]

(1) Faculty of Physical Sciences, National University of San Marcos, P.O.Box 14-0149, Lima 14, Peru
(2) Centro Atómico Bariloche (CNEA), S. C. de Bariloche 8400, Pcia. Río Negro, Argentina
* Corresponding author.

Abstract – In the present work we study conditions to obtain a nanostructured AlCuFe quasicrystal. The results indicate that nano-quasicrystals of grain-size of the order of 10 nm can be obtained after milling a bulk sample during five hours. The structural and micro-structural analysis of the sample has been studied employing X-ray diffraction and electron microscopy techniques.

Quasicrystals (QCs) open a new class of matter in the solid state between the amorphous and crystalline systems. The interest to understand the physical properties of these systems was rapidly growing. Special attention is taken to their potential industrial applications due to, for instance, the experimentally observed low coefficient of friction [1] and high hardness [2]. Among hundreds of alloys with quasicrystalline symmetry, the icosahedral AlCuFe phase is one of the best-studied QCs. Furthermore, in the last years nanostructured materials are intensively studied because they provide the possibility to improve the physical properties of the solid sample. Hence, the study of the nanostructured counterpart of this promising new material is of relevant importance. In this sense, ball milling has received special attention because it is a powerful method for material processing, and specially for reducing the grain size (to the nanometer scale) of the sample under study [3].

The main goal of the present work is to study the optimal conditions to obtain a nanostructured $Al_{64}Cu_{23}Fe_{13}$ quasicrystal. For this end, we employed two different routes: (1) arc furnace to produce the bulk sample and then ball milling to reduce the grain size, both in argon atmosphere, or (2) mechanical alloying to produce the solid sample and also to reduce the grain size. The structural and micro-structural characterization were made employing X-ray diffraction (XRD) and electron microscopy techniques (TEM/SEM), see fig. 1. The local arrangement around Fe atoms was studied by means of Mössbauer spectroscopy. The results indicate that the synthesized quasicrystal is of good structural quality showing the five-fold symmetry expected in these icosahedral samples. The grain-size of the nanostructured quasicrystal has been estimated to be of the order of 10 nm.

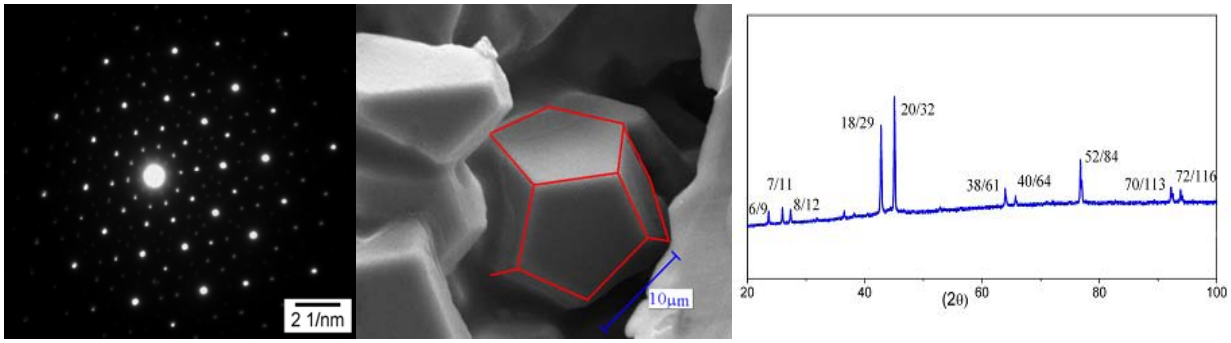

Figure 1. (Left)TEM and (center) SEM micrographs, showing the five-fold and dodecahedral symmetry. X-ray diffraction pattern (right) for the icosahedral quasicrystal which indicates the good structural quality of the sample.

References

[1] J. M. Dubois, Mater. Sci. Eng. A 294-296, 4 (2000); P. Brunet, L.-M. Zhang, D. J. Sordelet, M. Besser, J. M. Dubois, Mater. Sci. Eng. A 294-296, 74 (2000).
[2] B. Wolf, K. O. Bambauer, P. Paufler, Mater. Sci. Eng. A 298, 284 (2001).
[3] C. C. Koch, Ann. Rev. Mater. Sci. 19, 121 (1989); P. Barua, B. S. Murty, B. K. Mathur and V. Srinivas, J. Appl. Phys. 91, 5353 (2002).