doi:10.1017/S143192761800394X
Microsc. Microanal. 24 (Suppl 1), 2018

Facets on Spherical Particles in $Al_{65}Cu_{20}Fe_{15}$ Alloy

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Aluminum-Copper-Iron alloy of nominal composition $Al_{65}Cu_{20}Fe_{15}$ has drawn interest due to the well-documented formation of stable free-standing icosahedral quasicrystals. In past studies, spherical particles have been reported on this alloy [1]. The spheres were determined to have cubic structure [1]. Facets on these spheres have been reported but a detailed study has yet to be conducted. The purpose of this study is to offer an in-depth examination on these facets.

The alloy observed was prepared by arc melting pure aluminum, copper and iron. Once prepared, it was broken into smaller pieces to expose features of interest. The features were imaged using the TESCAN Vega-3 XMU Scanning Electron Microscope (SEM).

Figure 1(a) shows a sphere with typical facets. It has been reported that the spherical particles have cubic structure, possessing 2-, 3-, and 4-fold rotational symmetries. An examination of the facets based on such crystal structure consideration leads to the speculation that the facets can be classified to three groups, perpendicular to the <1 1 1>, <1 1 0>, and <1 0 0> crystalline directions, respectively. Figure 1(b) illustrates these facets' positioning with respect to the axes of rotational symmetry.

Other types of facets have also been observed on spherical particles. Figure 2(a) shows a facet whose set of rings is unevenly spaced. It is possible that the rings location on the sphere caused its unusual appearance. Displayed in Figure 2(b) is another atypical facet whose center is triangular. This seems to be an exhibit of 3-fold symmetry on the facet itself. The facet in question is presumably normal to the [1 1 1] axis. In Figure 2(c), two rings appear to be connected. This suggests that the rings will interact with one another rather than simply overlap. Figure 2(d) shows a facet whose rings appear to be twisted. Further study of these unusual facets may provide insight into their formations.

In summary, facets have been observed on spherical particles in $Al_{65}Cu_{20}Fe_{15}$ alloy. It has been observed that these facets lie perpendicular to the [1 1 1], [1 1 0], and [1 0 0]. Unusual facets found on these spheres may provide interesting insights into the nature of the spherical particles.

References:

[1] Balzuweit, K. et al, Philosophical Magazine B, **67(4)** (1993), p. 513.

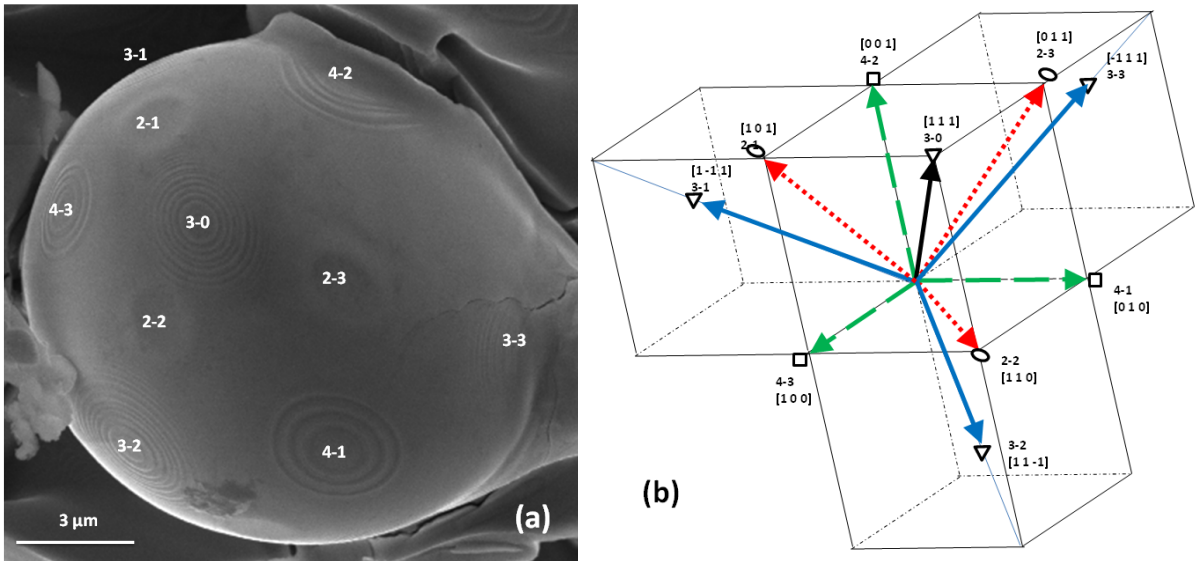

Figure 1. (a) SEM image of sphere with facets corresponding to [1 1 1], [1 1 0] and [1 0 0] directions. (b) Schematic diagram of corresponding rotational axes.

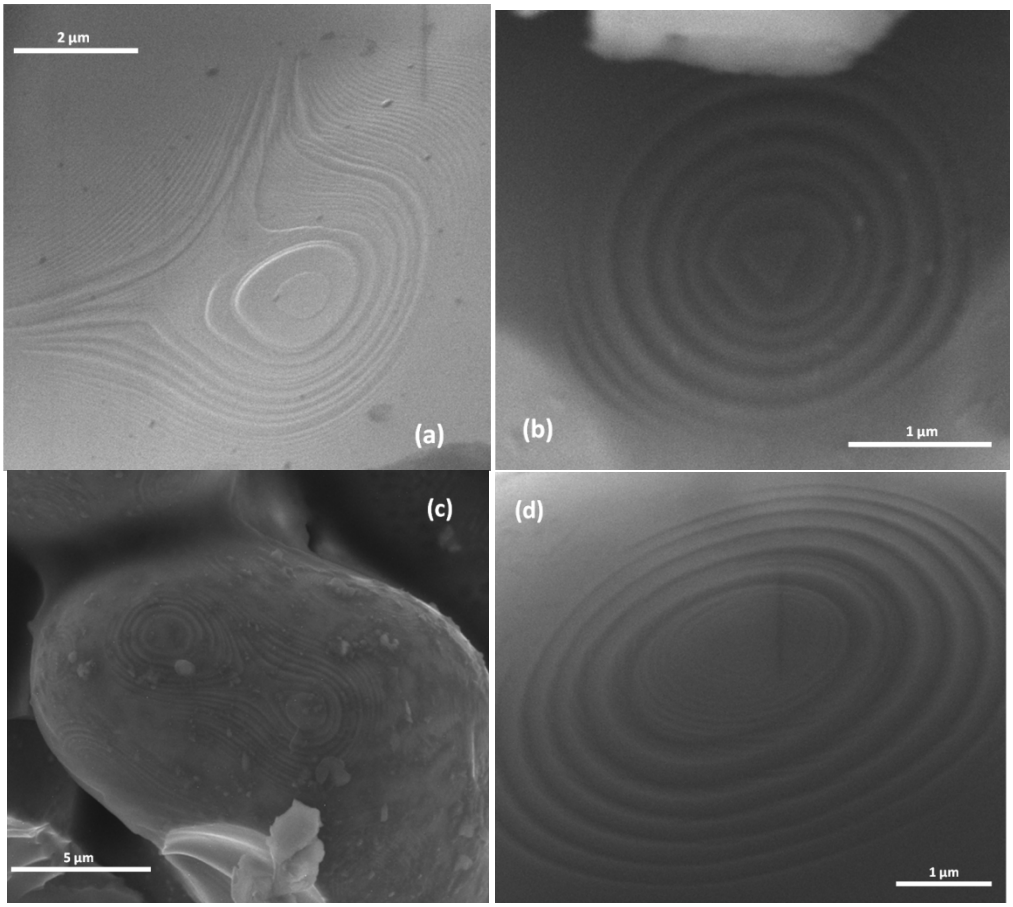

Figure 2. SEM images of (a) unevenly spaced rings, (b) facet with triangular center, (c) two ring sets conjoining, and (d) ring set with twisting appearance.

https://doi.org/10.1017/S143192761800394X Published online by Cambridge University Press