

Electron diffraction study of disorder in $\text{Al}_{.63}\text{Cu}_{.24}\text{Co}_{.13}$ decagonal quasiperiodic crystal

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Here, we present our recent electron diffraction study on type, range, and degree of structural order and disorder in decagonal $\text{Al}_{.63}\text{Cu}_{.24}\text{Co}_{.13}$ quasiperiodic crystal¹.

Traditional definition of crystal was based on a concept of regular unit cell and its infinite repetition on three-dimensional (3D) lattice². However, crystal structure can be perfectly ordered (on long range) with no translational 3D lattice periodicity, so that one can consider two general categories of crystals³: periodic (PC) and quasiperiodic (QC). QC order is prominently revealed in reciprocal space, so that contemporary definition of crystal refers to: “an essentially discrete diffraction diagram”.

Decagonal crystals are layered structures characterized by periodic inter-layer stacking with intra-layer quasiperiodic order. Diffraction patterns of such crystal have to be assigned by 4+1 indexes, Fig.1.

Disorder in PC is revealed in diffraction patterns by additional intensity at fractional positions between basic spots. For QC, the positions are irrational as in Fig.1, with the 10-fold symmetry and no 2D lattice, Fig.1-c. The inter-layer periodicity is revealed by lines of spots indicating double and quadruple layer stacking (lattice parameter 0.41 nm and 0.82 nm), in Fig.1-a&b, Diffuse intensity in Fig.1-d discloses intra-layer disorder within the double layer stacking unit with first-neighbour correlation $q^* \approx 4 \text{ nm}^{-1}$.

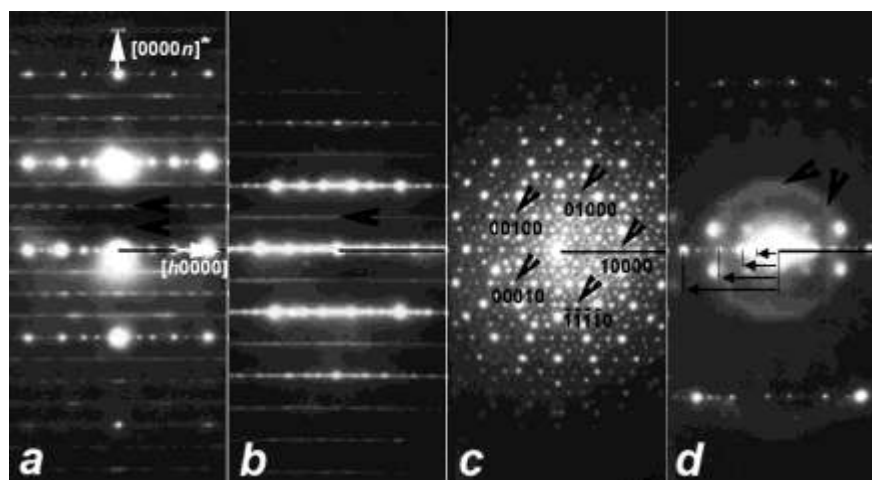


Figure 1. ED Patterns of decagonal $\text{Al}_{.63}\text{Cu}_{.24}\text{Co}_{.13}$ QC along: (a) periodic stacking zone; (b) oblique zone; (c) 10-fold zone; (d) tilted zone (tilting axis – along [10000] direction). Sharp discrete spots in (c) reveal aperiodic long range order. Diffuse halo in (d) indicates in-plane correlation, while arrows in (d) indicate quasiperiodic $(1, \tau)$ linear sequences. Diffuse streaks marked by arrow-heads in (a)(b) indicate stacking disorder within 2- and 4-layer unit slabs.

References:

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- ² C. Giacovazzo et al., in *Fundamentals of Crystallography*, (2002), IUCr, Oxford UP,
- ³ *Int. Tables for Crystallography, vol. C*, ed. A.J.C. Wilson, (1995) pp 797-844