Growth and coarsening of $Al_{71}Pd_{19}Mn_{10}$ quasicrystals: New insights from synchrotron X-ray tomography

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The dynamics of growth and relaxation of icosahedral single quasicrystals in a liquid phase have been investigated using in situ synchrotron-based X-ray tomography. Our 4D studies (i.e., space- and time-resolved) provide direct evidence that indicates the growth process of an $Al_{71}Pd_{19}Mn_{10}$ quasicrystal is governed predominantly by bulk transport rather than attachment kinetics [1]. This dynamic phenomenon is characterized by anisotropic interfacial velocities due to gravity-driven convection. During the growth process, the i-QC adopts a pentagonal dodecahedron shape, further validating the theoretical findings of Ho. et. al. [2]. The growth shape subsequently transforms into the truncated dodecahedral shape near equilibrium as shown in Figure 1. This morphological transformation is likely governed by the detachment of loosely-bound clusters at the vertices of the pentagonal dodecahedron, giving way to the formation of triangular facets. Coarsening is observed in the later stages of evolution, wherein the average length-scale of the quasicrystals increases in time. At the resolution of the X-ray tomography experiment, we also observe that liquid pores develop in the QC very close to nucleation and are progressively shrinking as the QC coarsens. These findings provide new insights in the growth and equilibration dynamics of icosahedral quasicrystals.

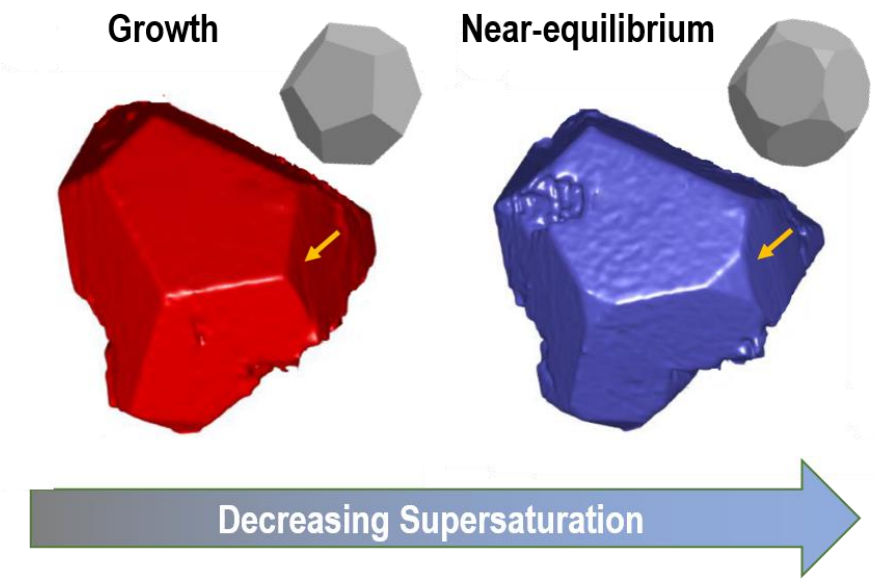

Figure 1. The growth and near-equilibrium shape of an icosahedral $Al_{71}Pd_{19}Mn_{10}$ quasicrystal.

1. N. Senabulya, X. Xiao, I. Han, A. J. Shahani, Scripta Materialia, 146 (2018) 218-221.

2. T. L. Ho, J. A. Jaszczak, Y. H. Li and W.F.Saam., Phys. Rev. Lett 59 (1987) 1116–1119.

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