

The structure formation of the F-type ZnMgHf icosahedral quasicrystal

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Quasicrystals represent an intriguing phase of a solid where at least one direction manifests aperiodic arrangement of atoms. Aperiodicity itself would not be much of a surprise as any amorphous state lacks periodicity either but in this case sharp diffraction peaks are observed suggesting long-range-positional order [1]. Among quasicrystals, ones with an icosahedral symmetry are least known in terms of the structure. The breakthrough came with the model of the i-CdYb, Tsai-type quasicrystal with a simple cubic unit cell in the six-dimensional space [2]. The observation that structure can be built out of aperiodically distributed clusters allowed to construct the model of quasicrystal. The next challenge is the structure of the F-type icosahedral ZnMgHf quasicrystal [3]. It forms Bergman-type clusters with two variations of clusters diversified by the hafnium position what makes analysis demanding. In the first cluster Hf is localized on the 5-fold vertices, whereas in the second one Hf is located in the 3-fold vertices. The study performed on this quasicrystal involved electron microscope imaging and diffraction only. This is the first time large quality single crystals were grown and investigated using X-rays. In this work we discuss the conditions of growing this quasicrystal and provide the cluster analysis based on the X-ray data. Comparison to the existing 1/1 approximant [4] is made. This system is particularly interesting as two different icosahedral quasicrystals are obtainable depending on the composition: Bergman F-type and Tsai P-Type. The explanation for such phase diversification can bring us toward the answer to the reason of the quasicrystalline structure stability.

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