Preparation of icosahedral high-entropy alloy

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Quasicrystals are structurally complex phases with quasiperiodic long range order, first discovered by Schechtman in 1984 [1]. High-entropy alloys (HEA) are compositionally complex alloys composed of five or more principal elements in equimolar or near-equimolar ratios, first studied in 2004 [2,3]. Our aim is to develop a multi-component icosahedral quasicrystal, combining the structural and compositional complexity.

Our HEA design is based on the parent $Zn_{85}Sc_{15}$ icosahedral quasicrystal, or its rational approximants. The known suitable substitutions for "small" Zn atom include combinations of Al, Cu, Ga and Ag. Small amount of Mg potentially affects relative stability of the quasicrystal against its approximants. The already discovered compositions include $Cu_{46}Al_{38}Sc_{16}$, [4], $Zn_{80}Mg_5Sc_{15}$ [5], $Zn_{75}Ag_{10}Sc_{15}$ [6] or $Cu_{48}Ga_{34}Mg_3Sc_{15}$ [7,8]. The important aspect of the alloy stability is approximate *e/a~2* valence electron count, guiding us to a tentative composition around $Sc_{15}Zn_{25}Cu_{30}Ag_{10}Al_{10}Ga_{10}$. Possible addition of Mg would not affect the *e/a* ratio.

The alloy will be synthesised by temperature controlled induction melting in argon atmosphere, in the following stages:

1. preparation of the Zn-Cu pre-alloy;

2. preparation of the Ag-Ga pre-alloy;

3. preparation of the Sc-Al pre-alloy;

4. preparation of the final alloy from the pre-alloys.

To avoid evaporation of Zn in the first and final step, a molybdenum foil wrap will be used. The final alloy will be annealed in argon atmosphere for several hours and investigated by x-ray diffraction as well as scanning electron microscopy including both energy dispersive X-ray spectroscopy and electron backscatter diffraction.

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