



Course: Fundamental Properties of Solids

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A review on article “Properties- and applications of quasicrystals and complex metallic alloys”

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Abstract Summary:

Quasicrystal are such structure that is ordered but but not periodic. It is formed by t he combination of different elements of different elements in different quantity. This article is totally about the discovery, properties, applications and composition of quasicrystals.

About the author:

Jean-Marie Dubois is the author of this article. He was born at 1950. He is director of research at CNR, France. He has authored 330 scientific articles, IU patents and 7 books. He has established structure model for metallic glasses and quasicrystals. He is also interesting in study of other properties of these materials.



Introduction:

Thirty years ago, the scientist “Danny Shechtman” discovered quasicrystal in melt-spun ribbons of an Al-Mn alloy. Last year he got Nobel prize in chemistry.

After the discovery of Al-Mn quasicrystall by Scechtman, Tsai also make a lot of contribution during his PhD work. He found that the essential part of quasicrystal can be Fe-Cu, Pd-Mn, and Ni-Co.

According to Tsai, by combining aluminum with different other elements, we get different quasicrystal as Al-Tm. where “Tm” is transition metal like Fe, Cu, Pd, Mn, Co and Ni etc

Due to some properties, quasicrystal has wide useful applications. Theses properties can be listed as:

- ü Transport Properties
- ü Mechanical Properties
- ü Chemical Properties

Structure Complexity:

The structure of quasicrystal is very complex. The complexity of crystal compound is difficult to access. The complex index of a unit cell can be given as;

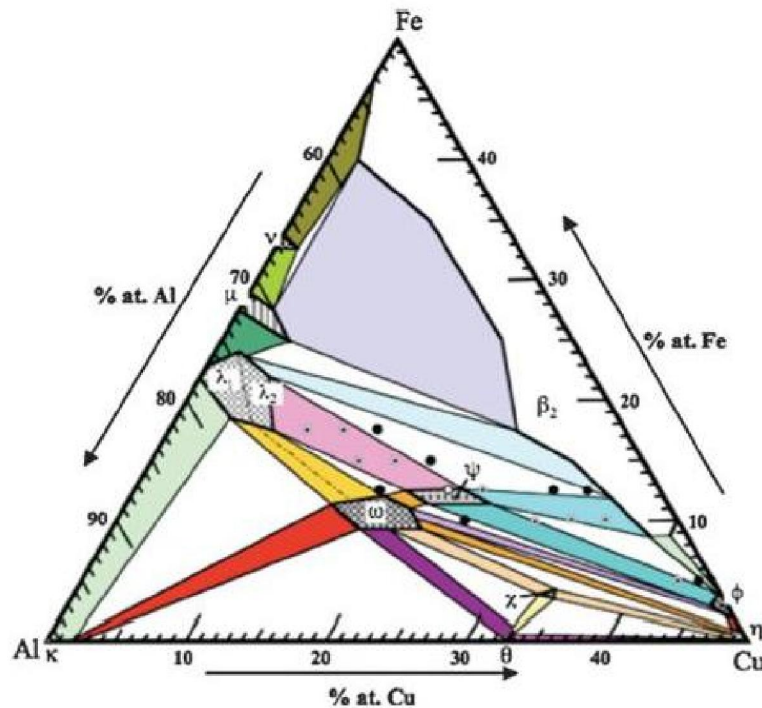
$$\beta_c = \ln (N_{uc})$$

Where N_{uc} is number of atoms in unit cell of crystal. The complexity index can be extended to encompass as well complexity of periodic stacks of periodic layers. For the decagonal phase (or for the pentagonal approximant), it reads:

$$\beta_c (\text{deca}) = \ln(m_z) + 2/3 \beta_c (\text{ico})$$

Aluminum-based complex inter-metallic and quasicrystals:

Tsai discovered that Al-Cu-Fe quasicrystal. This phase diagram shows that if we change the composition of Al, Cu or Fe, we will get different compounds.



Overview on Electron Transport Properties of Complex Metallic alloys:

After discovery of quasicrystal, it was realized that they obey the same stability values as other alloys follow. But there was little difference. The difference was study according to some values and these values known as Hume-Rothery, which shows a weak difference in the constituents' size and an appropriate electron to atom (e^- / Atom) ratio.

Some other differences are;

- ∅ Particle density states.
- ∅ Self organized critical transport properties in Al-based CMAs*.
- ∅ Number of electrons.

- Ø Electron versatility.
- Ø Heat diffusivity.

Preparation of Quasicrystal:

Bulk CMA specimen can be prepared including in very large quantities by standard metallurgical processing. Steps can be summarize as;

1. Fusion of the constituents
2. Homogenization of liquid
3. Solidification

Solidification of liquid takes place instead through a paratactic reaction, which requires transport of atom through a solid phase. It is a slow process usually a thermal treatment is thermal treatment is applied post solidification to achieve this stable state.

Suppose we are forming the quasicrystal of Al-Cu-Fe-Cr (weight – 1.16 Kg). first of all we have to powder from a crushed pre-alloyed ingot. Powdering of the ingot at start may be continently achieved by a mechanical alloying step. Furthermore allows addition of new elements. This technique was used to prepare mixtures of an Al-Cu-Fe icosahedra compound with Sn or Bi additions.

Applications of Quasicrystal:

- è Heat insulation
- è Reduction of friction.
- è As solid light absorber.
- è At the edges of blades.
- è For reducing adhesion.
- è Infrared light absorption.
- è In production of frying-pans.
- è Information storage using heat pulses.
- è In the preparation of metal-matrix composites.
- è For protection against corrosion and adhesion.
- è In the preparation of polymer-matrix composites.
- è In thermal and plasma spray of atomized powder.
- è In preparation of non-fritting surface that do not stick to each other under mechanical contact or viberational environment.