Anisotropy in the transport properties of the decagonal quasicrystals and approximants

Ana Smontara

Institute of Physics, Laboratory for the Physics of Transport Phenomena, Zagreb, Croatia
e-mail: ana@ifs.hr

Abstract

Crystallographic structures of decagonal quasicrystals (*d*-QCs) are described as a periodic stacking of atomic planes with quasiperiodic in-plane atomic order. The stacked-layer structures are observed also in the periodic decagonal approximant phases. In this talk, we consider the anisotropy in the physical properties in the *d*-QCs and their approximants on the basis of the measurements of the transport coefficients (electrical resistivity, thermopower, and Hall coefficient and thermal conductivity). By comparing the anisotropic transport coefficients along the stacking- and the in-plane directions of a series of decagonal approximants with different number of atomic layers within one periodicity unit; (the two-layer Y-Al-Co-Ni [1]; the four-layer o-$Al_{13}Co_4$ [2] , $Al_{13}Fe_4$ and $Al_{13}(Fe,Ni)_4$ [3]; the six-layer $Al_4(Cr,Fe)$[4] and T-$Al_3(Mn,Fe)$)[5] with that of a two-layer *d*-Al-Co-Ni decagonal quasicrystal[6-8], we show the universality that the stacking direction perpendicular to the atomic planes is always the most conducting one for both the electricity and heat, along the stacking direction, whereas the in-plane anisotropy is considerably smaller or negligible[5].

[1] A. Smontara *et al*., Phys. Rev. B **78** (2008) 104204.
[2] J. Dolinšek *et al*., Phys. Rev. B **79** (2009) 184201.
[3] P. Popčević *et al*., Phys. Rev. B **81** (2010) 184203
[4] J. Dolinšek *et al*., Phys. Rev. B **76** (2007) 174207.
[5] M. Heggen *et al*., Phys. Rev. B **81** (2010) 184204.
[6] A. Smontara *et al*., C-MAC Days, Dresden, 2010.
[7] P. Popčević *et al*., The Israel Journal of Chemistry **51** (2011) in press.
[8] B. Bobnar *et al*, Phys. Rev. B (2011) submitted.

Keywords: decagonal quasicrystals, quasicrystalline approximants, transport properties

Biographic sketch

Ana Smontara is a senior scientific adviser and the head of the Laboratory for the Study of Transport Phenomena at the Institute of Physics, Zagreb, Croatia. Her field of interest is condensed matter physics, mainly: charge and heat transport of low dimensional charge density wave systems, quasicrystals, complex metallic alloys and low-dimensional layered materials; influence of disorder, magnetic field and pressure on the electrical and heat transport and ground state properties. She is author/co-author of over a hundred scientific papers, two book chapters and review papers. She has given a considerable number of invited lectures at international conferences and schools and she was the Croatian coordinator in several international projects/collaborations.

The anisotropy of the physical properties is a reflection of the values taken by the elements of. , which are determined by the lattice symmetries. Bert et al. made a conjecture regarding these values to recover the anisotropic sound attenuation rates that they observed in decagonal quasicrystals [18]. In the second approach [19â€"21]â€"the one that we will employ in this paperâ€"the TLS is characterized by a 3 Ã— 3 symmetric tensor. and the coupling between.Â Like in hexagonal lattices, in the decagonal quasicrystals, we can have pure longitudinal and transversal waves propagating in all the three directions, , , and. . The coupling constants Transport properties (thermal conductivity, electrical resistivity and thermopower) of decagonal quasicrystal d-AlCoNi, and approximant phases Y-AlCoNi, o-Al13Co4, m-Al13Fe4, m-Al13(Fe,Ni)4 and T-AlMnFe have been reviewed. Among all presented alloys the stacking direction (periodic for decagonal quasicrystals) is the most conductive one for the charge and heat transport, and the in/out-of-plane anisotropy is much larger than the in-plane anisotropy. There is a strong relationship between periodicity length along stacking direction and anisotropy of transport properties in both quasicrystals an... structures, physical properties (transport, magnetic, dynamical, mechanical etc.), surfaces and over layers, applications and new frontiers, metamaterials (polymer, macro molecules, photonic/phononic crystals, oxide etc.), incommensurate/modulated structures, metallic glass, complex metallic alloys, clathrate compound, clusters etc.Â R. Widmer (Paul Scherrer Institute, Switzerland) presented on â€œFermi states and anisotropy of Brillouin zone scattering in the decagonal Al-Ni-CoÂ A.I. Goldman (Iowa State University, USA) presented the progress in the magnetism properties of quasicrystals and their related periodic approximants with the role of aperiodicity in shaping physical properties. â€¢ decagonal quasicrystals with local 10-fold symmetry [primitive lattice] â€¢ dodecagonal quasicrystals with local 12-fold symmetry [primitive lattice]. quasiperiodic in three dimensions - no periodic direction. â€¢ icosahedral quasicrystals with 5-fold [primitive, body-centered & face-centered lattices].Â The inferred differences between the properties of PC and QC are basically contained in the analysis of wave propagation of the two types of structures. Plane waves with any wave vector k except for k vectors which satisfy the diffraction condition, 2à¡³ â^™ à¢' Â± |à¡³|à«› = à«™ á^º2á^». 7. 8 The Properties and Applications of Quasicrystals. propagate easily in a periodic structure.