Anisotropy in the transport properties of the decagonal quasicrystals and approximants

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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.

Electronic and Transport Properties (chair: J Dolinsek) Fermi states and anisotropy of Brillouin zone scattering in the decagonal Alâ€“Niâ€“Co quasicrystal (invited) Unified cluster-based description of valence Bands in AlIr, $RuAl_2$, $RuGa_3$, and Alâ€“TM quasicrystalline approximants Valence fluctuations in heavy fermion system on the Penrose lattice: real-space dynamical mean-field approach Search for semiconducting quasicrystal and.Â approximants Magnetic order in RCd_6 single crystals â€“ the. approximants to the spin-glass i-R-Cd quasicrystals. Hiroto. Neutron-scattering study on the quasicrystal approximants Au-Si-R (R = rare-earths). Coffee. Session VIII: Jagannathan Tamura Gullo Fang Break. Electronic Structure in Approximants of Stable Quasicrystals p.417. Band Structure of Aperiodic Sytems p.427. Electronic Density of States for Penrose Tilings and Vicsek Fractal p.435. Transport Properties of the Decagonal Single Quasicrystals p.445. Electronic Transport of 2-D Penrose Lattice with Random Phason Strain p.457. Formation of Al-Pd-Re Icosahedral Quasicrystals and their Electrical Properties p.465. Third Sound of Superfluid 4He Films in the Penrose Lattice p.473. Problems in Crystallography of Quasicrystals and Imperfectly Ordered Crystals p.481. HomeMaterials Science ForumMateria...Â Anisotropy, Decagonal Quascrystal, Fermi Surfaces, Transport Property. Export: RIS, BibTeX. Transport properties (thermal conductivity, electrical resistivity and thermopower) of decagonal quasicrystal d-AlCoNi, and approximant phases Y-AlCoNi, o-$Al_{13}Co_4$, m-$Al_{13}Fe_4$, m-$Al_{13}(Fe,Ni)_4$ 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... The finding of the stable decagonal quasicrystal is important in the clarification of the formation mechanism and fundamental properties of the quasicrystals with an icosahedral or a decagonal structure. View. Show abstract.Â Our results can explain the appearance of large transport anisotropies in the quasicrystalline and approximant phases. The effect of disorder on the anisotropies has been investigated. View. Structural Vacancies of Al-based Quasicrystals and Anomalous Transport Property: Positron Annihilation Studies.Â Decagonal quasicrystals (QCs) are extremely tempting structures to study due to the unique combination of the periodic and QP orders in the same crystal. The lattice of such materials can be obtained by appropriate projection of the periodic lattice in five-dimensional space to the three-dimensional (3D) space1. The real and the reciprocal space (k-space) lattice vectors of decagonal QCs thus can be denoted by five vectors2 (Fig. 1a), spanning a reciprocal lattice in aperiodic plane and a set of discrete maxima with 2p/c spacing in the periodic (00001) direction, where ce4A is a lattice parame