21-Crystallography at Non-Ambient Temperatures and/or Pressures; Phase Transitions

In this short lecture, we will perform a review of the experimental and theoretical works related to these phase transformations.

MS-21.03.08

ATHERMAL TRANSFORMATION KINETICS AND THERMAL HYSTERESIS AT WEAKLY FIRST ORDER PHASE TRANSITIONS. By W.W. Schmahl, Fachbereich Materialwissenschaft, Technische Hochschule Darmstadt, Germany.

Although thermal hysteresis is a common feature of first order phase transitions, there is only rudimentary knowledge about its origin and characteristics. The non-suspendable α↔β-cristobalite phase transition near 520 K is associated with a 'thermal' hysteresis of ± 15 K and α↔β-phase coexistence in the hysteresis loop. Measurements by x-ray diffraction (0.03 K/min) or DSC (5K/min) give practically the same result (see figure). The transformation proceeds instantly as a function of temperature; thermal activation is not a relevant factor. These 'athermal' features are similar to martensitic transformations in metals and alloys and to field-reversal hysteresis in ferroics. The bulk Landau-free energy isotherms suggest that local strain-fields control nucleation and initiate both phase coexistence and 'thermal' hysteresis.

MS-21.03.08

MS-21.03.06

MICROSTRUCTURAL DEVELOPMENT RELATED TO PHONON ANOMALIES LEADING TO DISPLACITIVE TRANSFORMATIONS IN METALLIC PHASES. By L.E. Tannery, A.J. Schwartz, D. Schryves, Lawrence Livermore National Laboratory, Livermore, CA, U.S.A.

The phonons of crystalline phases (pure metal and alloyed) that undergo first-order displacive transformations on cooling exhibit anomalously low energies along those branches related to the atomic displacements of the ensuing structural changes. Present at elevated temperature equilibrium, these effects become more pronounced as T → T_c (or M_f), the bulk transformation temperature, though the "softening" is never complete at T_c. The coupling between the soft phonons and local parent lattice distortions (defects) sets the stage for heterogeneous nucleation. (Phys. Rev. B 44, 9301 (1991); Ultramicroscopy, 37, 241 (1990)). HREM and neutron scattering observations of Ni-Al, Ti-Ni, Fe, Ti-Pd-Fc, Ti-Pd-Ct, Ti-Mo and Zr-Nb transformations illustrate the foregoing and will be discussed in terms of nonclassical heterogeneous nucleation theory.

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MS-21.03.07

DOMAIN WALLS IN CRYSTALS WITH INCOMMENSURATE PHASES. By Y. Isahashi, Synthetic Crystal Research Laboratory, School of Engineering, Nagoya University, Nagoya 464-01, Japan.

The domain wall is a transient region where two domains with different values of the order parameter meet. Fundamental features of domain walls, like the spatial variation of the order parameters in the wall, the wall energies and the activation energies, are discussed on the basis of the Landau-type thermodynamic potentials applicable to crystals, which have the incommensurate phases. The domain walls to be considered will be those between two commensurate domains, two incommensurate domains, and a commensurate domain and an incommensurate domain. It will be clarified how the factors stabilizing the incommensurate phase should affect characteristics of the domain walls. In particular, the contribution from the Lifshitz invariant to the wall structure and on will be discussed.

MS-21.03.08

PHASE TRANSITIONS IN QUASICRYSTALS By F. Dénoyer*, P. Launois and M. Lambert, Laboratoire de Physique des Solides, Associé au C.N.R.S., Building 510, Université Paris-Sud, 91405 Orsay Cédex, France.

The Al-Cu-Fe equilibrium diagram has been the subject of many experimental investigations. It has been shown that a phase transformation between a high temperatureicosahedral quasicrystalline phase and a low temperature rhombohedral microcrystalline phase occurs in the vicinity of the composition 63.5-24-12.5. The material also exhibits an "intermediate" modulated quasicrystalline state.


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