# MS43-P5 Novel *transrotational* solid state order discovered by TEM in crystallizing amorphous films

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Novel microstructure with unexpected, dislocation independent, regular internal bending of the crystal lattice planes [1] are formed in thin films/layers as a result of amorphous – crystalline transitions. Such **perfect crystals/grains with regularly curved lattice** (built up by simultaneous translation and small regular rotation of the unit cell) **demonstrate a new "transrotational"** [2] **type of solid state order realized in thin films**. It is primarily dislocation independent and takes place round an axis lying in the film plane of the growing crystal, **Fig.1.** The maximal values correspond to essential lattice orientation gradients accumulated at the mesoscale (up to 300 degrees per µm). The main data have been obtained by diffraction transmission electron microscopy (TEM), primarily bend-contour method [3], including in situ studies, HREM. Thin films studied were prepared by laser, e-beam and thermal evaporation mostly with thickness or/and composition gradients across TEM grids (to learn these factors directly), solid state amorphization, pyrolysis.

Thin (10 - 100 nm) crystallized areas we examine vary from small crystals (0.1 - 100 µm), ribbons, whiskers or spherulites to large-scaled polycrystalline areas with a complex texture. They can be grown with the help of aging, heat treatment and local annealing by focused electron (or laser beam) in amorphous films of substances of different chemical nature including oxides, chalcogen/ides, some metals and alloys and are stable with years. Unlike other unusual regular nano aggregations of atoms widely recognized by the community in recent 30 years (quasi-crystals, fullerenes, nanotubes and other nano derivatives) these less known "transrotational" crystals/structures are less confined in dimensions and have much less curvature in atoms plane packing. Transrotational micro crystals have been eventually recognized/studied also by other authors in some vital thin film materials, i.e. PCMs (phase-change materials) for memory [4], silicides [5], SrTiO3 [6].

[1] I. E. Bolotov, V. Yu. Kolosov and A. V. Kozhyn, Phys. Stat. Sol. 72a (1982), p.645.

[2] V. Yu. Kolosov and A. R. Thölen, Acta Mat. 48, (2000), p.1829.

[3] I. E. Bolotov and V. Yu. Kolosov, Phys. Stat. Sol. 69a (1982), p.85.

[4] B. J. Kooi and J. T. M. De Hosson, J. App. Phys. 95 (2004), p.4714.

[5] E. Rimini et. al., J. App. Phys. 105 (2009), p.123502.

[6] V. Longo et. al., ECS SSS Techn. 2 (2013), N120.

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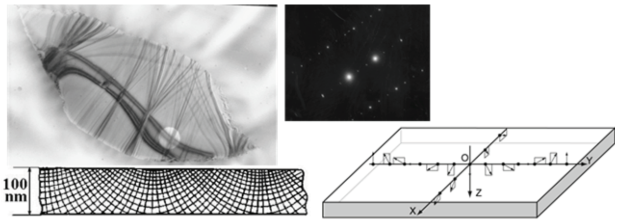


**Figure 1.** TEM of transrotational Se crystal (upper left) with one of the SAED patterns from the zone-axis pattern marked by 1 µm SA aperture. Schemes of internal lattice bending (lower left) shown in film cross section and regular rotation of the unit cell - 2-axes lattice bending (lower right).

**Keywords:** novel aperiodic crystals, electron diffraction, TEM, in situ, thin films, complex texture