microscope (TEM) fitted with a spherical aberration corrector on the probe forming lens to minimize the effect of lens aberrations on the Fourier image. As expected, these images bring different spatial frequencies into focus for different probe cross-over positions above the specimen. Under certain conditions, this enables specific families of atomic planes to be imaged individually. We discuss how this phenomenon can be used to image crystal defects in coherent CBED patterns. Furthermore, we show how, by using an appropriately configured detector in scanning transmission electron microscopy, this approach can be used to generate atomic resolution images with preferential contrast from selected atomic planes and defects. The applications of this scanning image mode will be further discussed at this congress.

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"Transrotation" revealed by electron diffraction: perfect crystal in curved space

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Earlier the bend-contour technique for direct lattice orientation analysis [1] by means of diffraction transmission electron microscopy had been developed. Using it we had discovered unusual micro crystals growing in thin (20-100 nm) amorphous films with strong (dislocation independent) internal bending of the crystal lattice planes [2]. Initially we observed the new phenomenon for Se (primarily *in situ*) and Te. Later on it has been revealed for many other substances and materials [3], [4], [5] of different chemical bonding and various preparation conditions (Se-C, Se-Te, Sb_2 Se_3, Sb_2S_3, Ge-Sb_2Se_3, Ge-Te, Tl-Se, Cu-Te, α-Fe_2O_3, Cr_2O_3, Co-Pd, Re, W, carbides, amorphous metals, ferroelectrics, phase change materials for memory devices).

The main feature of novel micro-, nanostructure is the permanent regular bending/curving of the lattice planes (about axes primarily lying in the film plane) for the micro-, nanocrystals growing in amorphous film. Different geometries are revealed, Fig.1. Thus one can detect in a perfect crystal ("single crystal") usual translation complicated by relatively small rotation of the unit cell. Anyway more or less significant rotations, up to 300 degrees per 1 micrometer of the crystal length can be attained. Therefore the new term "transrotation" [5] was introduced for such novel crystals/structures. The geometry and gradient of lattice orientations depend upon crystallography of the substance, crystal growth rate (e.g., upon heating), film thickness (the thinner is the film, the stronger is the transrotation) and composition (for binary films with composition gradients).

Earlier hypothetical mechanism of unusual phenomenon based on surface nucleation has been improved and supported by atomistic model of transrotational microcrystals. The last is based on mathematic instruments of conformal transformations. Generally transrotational crystals/structures revealed by TEM can be considered as a new state intermediate between glassy and crystalline ones (similarly to the structure of liquid crystals intermediate between crystalline and liquid). Alternatively transrotation can be regarded as an example of new kind of extended defect in condensed matter. In this sense transrotations (in thin crystals) supplement dislocations (in crystals) and disclinations (in liquid crystals). For the simplest case of cylindrical lattice bending small transrotational "single" crystal has organization of the atoms similar to the hypothetical 2.5D endless plane semicircular multi-walled nanotube.

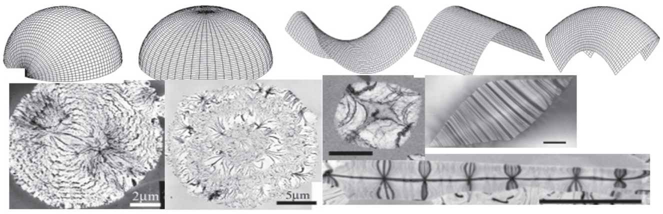

Fig.1 Schemes of lattice transrotation geometry with crystal TEM images below: Se, Fe_2O_3, Ta_2O_5, C+Se+C, Cu-Te. Bar = 1 μm (if not specified).

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Transmission electron microscopy studies on $Bi_{1/2}Na_{1/2}TiO_3$-$Bi_{1/2}K_{1/2}TiO_3$-$K_{0.5}Na_{0.5}NbO_3$ ceramics.

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For the last decades, lead-zirconate-titanate (PZT)-based materials have been the material of choice for high-performance actuator, sensor and transducer applications. Due to detrimental effect of lead on the environment, it has to be replaced by lead-free non-hazardous materials in the near future. Among the various lead-free systems, the $Bi_{1/2}Na_{1/2}TiO_3$-$Bi_{1/2}K_{1/2}TiO_3$-$K_{0.5}Na_{0.5}NbO_3$ system seems to be a promising candidate for actuator applications.

For this study, lead-free (1-y)($Bi_{1/2}Na_{1/2}TiO_3$-x$Bi_{1/2}K_{1/2}TiO_3$)-y$K_{0.5}Na_{0.5}NbO_3$ specimen with x=0.2 or x=0.4 and y=0, 0.02 or 0.05 were prepared by the conventional solid state reaction method [1]. For transmission electron microscopy (TEM) investigations, samples were polished, dimpled and ion thinned.

Selected area electron diffraction (SAED) revealed the presence of superlattice reflections of the type ½{ooe} and ½{ooo} for specific compositions, where o and e denotes odd and even Miller indices, respectively. For higher $Bi_{1/2}K_{1/2}TiO_3$ content, the appearance of domains was observed. The corresponding SAED patterns showed reflection splitting. This was further confirmed by X-ray diffraction (XRD) measurements that showed peak splitting of (200) pseudo cubic reflections, implying the presence of a tetragonal distorted phase. In contrast, $K_{0.5}Na_{0.5}NbO_3$ addition destabilised the ferroelectric order indicated by the absence of domains and a decrease of peak splitting in XRD. A clear correlation between the aforementioned microscopic features and macroscopic measurements such as polarisation and strain could be drawn.

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