Structure analysis of ferecrystals by advanced methods of transmission electron microscopy: possibilities and limitations

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Ferecrystals (FCs) [1] are a special class of misfit layer compounds (MLCs) [2] described by the general formula [(MX)₁₊₁][TX₂]ₙ, where X = Se or Te, M = Sn, Bi, Pb, or a rare earth metal, and T = Ta, W, Nb, V, Mo and Ti. FCs are a state of matter between crystalline and amorphous having incommensurate intergrowth structures with in-plane crystallinity, abrupt interfaces, layer-to-layer misorientation, and turbostratic disorder. The Modulated Elemental Reactants (MER) method [3] enables the preparation of FCs for arbitrary n and m.

We will illustrate the possibilities and limitations of high-resolution transmission electron microscopy (HRTEM) and high-resolution scanning transmission electron microscopy (HRSTEM) for the analysis of the crystal structure and crystal imperfections of various FC-systems on the atomic scale. For the interpretation of the HRTEM images, computer simulations as a function of the microscope and specimen parameters are necessary [4]. An important task of the structure analysis of FCs is the measurement of the misorientation of the individual grains within the layers. It will be demonstrated how precession transmission electron diffraction (PED), nanobeam transmission electron diffraction (NBED) and scanning NBED (SNBED) can be applied for the automatic phase and orientation analysis of the crystallites in the layers [5-7].