Object Parameter Retrieval using Inverse Electron Diffraction including Potential Differences

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Object data can be directly retrieved from the electron microscope exit wave function without using trial-and-error iterative matching [1]. The retrieval of local data, e.g. thickness, orientation, potential, as a basis of a general object reconstruction, can be gained by linearizing the scattering problem and constructing regularized and generalized inverse matrices. Starting e.g. from a hologram, where all reflections **g** are separately reconstructed, the moduli (A) and phases (P) of the exit plane wave Φ^{exp} are determined for each **g** (cf. Fig. 1, Fouriertransform of the hologram and selected **g**). Theoretical waves Φ^{th} are then calculated using the dynamical scattering matrix M for an a priori model characterized by the number of beams and the scattering potential. With a suitable experimentally predetermined trial average beam orientation $\mathbf{K}_{Oxy}$ and a sample thickness t_o as a free parameter, a perturbation approximation yields both Φ^{th} and M as linear functions of parameters to be retrieved. The analytic form of the equations enable the inverse solution $[t,\mathbf{K}_{xy}, ...]=M_{inv}\cdot(\Phi^{exp}-\Phi^{th})$, thus yielding directly for each image pixel (i,j) the local thickness t(i,j) and the local beam orientation $\mathbf{K}_{xy}(i,j)$. Generalizing of M_{inv} avoids the ill-posedness, the problem, however, is now ill-conditioned. As pointed out in different previous analyses (cf. e.g. [2]) a regularization of the retrieval procedure requires the control of the confidence and stability region. As shown in the retrieved t and $\mathbf{K}_{xy}$ of Fig.1, the modeling errors because of the potential difference are the remaining fault.

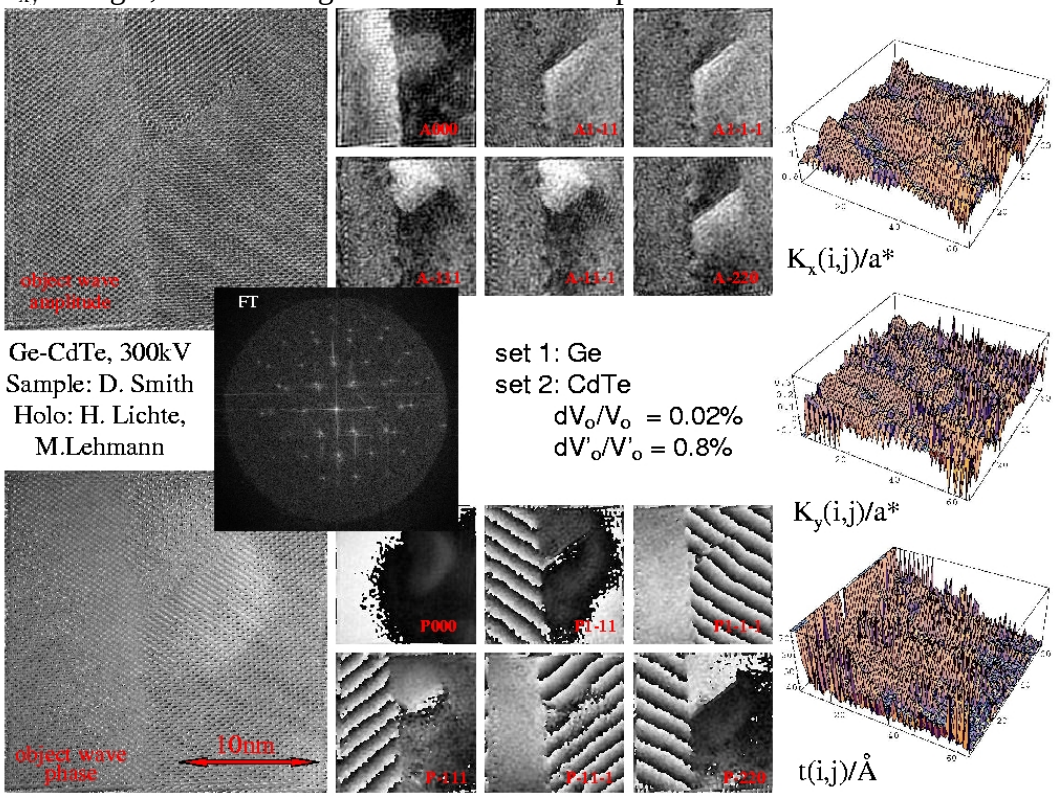

Fig.1: Retrieval of local thickness t and orientation **K**xy for an Ge-CdTe interface including different potential parameters

References:[1]. K. Scheerschmidt, Lecture Notes in Physics **486** (1997) 71and Journal of Microsc. 190 (1998) 238-248. [2] K. Scheerschmidt, Microsc. Microanal. **9**, Suppl.6 (2003) 56 and WAVES 2003, Proc. 6th Int. Conf, Math. Num. Aspects Wave Prop., Eds.: G.C. Cohen and P. Joly, Springer Vlg., 2003, 607.