Abstract

A scanning LEED microscope facilitates the examination of surface crystal structures with an information depth of only few nanometers and lateral real space resolution of only few 10 nanometers.
Within the scope of this work a scanning LEED microscope consisting of a scanning electron microscope with a field emission cathode and a small moving LEED detector was put into operation and optimized to enable quick crystal examinations with very high spacial resolution. A digital mapping method of both the diffraction images and the intensity distribution images including diffraction contrast has been developed and integrated. The effects of the detector's mechanical mounting on the diffraction image mapping was also subject to close examination. Additionally, the supply electronics was improved which contributed to preventing disturbances and optimizing energy resolution.
The oblique-angled geometry of the assembly distorts the diffraction images in the LEED which renders an identification of reflexes difficult. Thus, a program has been developed for calculating the reflex positions using the kinematic diffraction theory. The theoretic diffraction images were confirmed by means of measurements on a Pt(100) surface.
This way, reflexes of unknown surfaces can be assigned to a crystal symmetry. It is demonstrated that this assignment allows the examination of polycrystalline surfaces, the determination of the crystallite's individual surface symmetries and even an identification of the orientation of oblique-angled surfaces. Such measurements can be performed with a scanning LEED microscope within a few minutes on areas of some 10 μm^2.
The LEED system provides a high resolution in the reciprocal space whereas the electron microscope, which acts as the electron source, has a high real space resolution. This permits a combined examination of singular reflexes as well as of the associated spatial structures. This way, two growth modes from Cu to Fe(100) have been found. A growth in rectangular crystallites with sizes of up to 4 μm^2 as well as in small elliptic islands with sizes smaller than 0,2 μm^2 could be identified. The bigger crystallites have a faceted surface. The various facets show identical diffraction images which is why no low indicated crystal surface could be assigned to them. The reflexes themselves showed a quadrangular cross section which indicates quadrangular structural domains, that could not be resolved in real space, with a statistic size distribution.
The advantages the scanning LEED microscope offers for the locally resolved crystal examination are discussed in comparison with similar techniques.