TEXTURE AND MICROSTRUCTURE ANALYSIS WITH HIGH-ENERGY SYNCHROTRON RADIATION

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High-energy synchrotron radiation with wavelengths in the range of ~0.1 Å (i.e. photon energies of ~ 100 KeV) was used to study the texture (orientation distribution) and microstructure (distribution in real space) of polycrystalline materials. The experiments were carried out at the high-energy wiggler beamline BW5 at HASYLAB/DESY in Hamburg. The high parallelity of the synchrotron beam allows to reach highest angular resolution in the range of 0.01°. The high intensity allows to use very small beam cross-sections so that spatial resolution in the micrometer range can be reached. At the same time, high-energy synchrotron radiation has penetration depths in matter in the centimeter range comparable with those of neutrons. The combination of these properties makes them an exceptional tool for non-destructive texture and microstructure investigations in all kinds of polycrystalline materials.

In order to actually reach highest orientational and/or spatial resolution the conventional "step-scan" techniques had to be replaced by continuous "sweeping" (imaging) techniques using an area detector which is being continuously shifted during exposure. Detector shift can be coupled with sample rotation or translation. This way, three different kinds of two-dimensional sections through the combined (six-dimensional) orientation-location space can be obtained the combination of which allows to survey this whole space.

In many cases it is thus possible to resolve the orientations and positions of (all) individual crystallites, i.e. the orientation stereology of the material. One can also follow the lifespan of individual grains from nucleation through growth or their orientation changes during plastic deformation. As a particular example the orientation relationship of the \( \gamma \rightarrow \alpha \) transformation in iron meteorites was studied.