GRAIN STATISTICS IN NEUTRON STRESS EXPERIMENT

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Every experimental scientist who has dealt with stress or/and texture measurements using neutron or x-ray radiation on coarse grained materials is familiar with the problem of “grain-size” or “grain statistics” caused by insufficient number of grains in the gauge volume. In a texture diffraction experiment, this leads to variations in the diffraction peak intensity and spots appearing pole figures. In diffraction stress measurements it can lead to large fluctuations in the apparent d-spacing values - even in stress free samples.

The impact of the grain statistics on the result of strain measurements is two-fold. Firstly, local stain variations are observed on the scale of grain size instead of the average value which is attributed to larger scale or sampling. Elastic anisotropy and particular orientations of individual grains, their local neighbourhoods and other micromechanical details all play role in this case.

Another aspect of grain statistics, which is less appreciated but can even be more important, is purely instrumental effects and it is directly related to the methodology of strain measurements. It arises from the fact that the experimentally measured strain on individual grains depends on the specific spatial arrangement of these grains within gauge volume. Particularly, the result of strain measurement on an individual grain is not the “true” strain but it depends on exact location of this grain within gauge volume. In that regard it is akin to another instrument related phenomenon, the “partial illumination” effect.

Theoretical and practical aspects of grain statistics effects are considered and treated numerically. Some experimental results are presented to illustrate our conclusions.