Steady-state monotonic and cyclic deformation revisited, emphasizing the *quasi-stationary state of deformation*

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Abstract

So-called "steady-state" deformation is important technologically, for example in metal forming processes. In a fundamental sense, it forms the basis of the description and modelling of high-temperature creep and cyclic deformation in the so-called saturation stage. In these cases, it is frequently assumed that no further changes undergo in the deformation-induced microstructure. However, in careful experimental microstructure-based studies on deformation in steady-state high-temperature creep and, in particular, in cyclic saturation, non-negligible microstructural changes have been observed to persist after the macroscopic stress-strain response has become stationary. Thus, what is commonly referred to as steady-state deformation really is a state of *quasi-stationary deformation*.

Based on the analysis of selected experimental data, it will be shown that the microstructural changes are related primarily to a slight increase of the dislocation density, mainly in the form of geometrically necessary dislocations (GNDs) in the cell walls/subgrain boundaries which initially exhibit only minor misorientations but then transform gradually into much sharper subgrain boundaries with higher misorientations. As a consequence, the "arrangement factor alpha" in the Taylor flow-stress law is reduced a little. Thus, in the Taylor flow-stress law, the microstructural changes can be, to some extent, self-compensating, rendering the flow stress rather insensitive to subtle microstructural changes.