Evolution of deformation-induced microstructures

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Deformation of metals leads to special microstructures composed of dislocation-rich boundaries separating nearly dislocation-free regions. A significant part of these boundaries are called geometrically necessary boundaries (GNBs). These GNBs form a characteristic layered pattern with a characteristic spacing. Experimentally the evolution of these special microstructures follows a general pattern. It is observed that the average spacing between boundaries decreases monotonically with increasing strain for tension, compression, torsion and rolling. It has also been found for many different metals that the probability distributions of GNB spacings collapse into a single function when scaled by their average spacings. We have extended the previous experimental observations by generating bit maps of boundary tracings in a given area. These maps allow for a statistical measurement of all boundary spacings in that area, thereby obtaining a more precise definition for the tails of the scaling distribution. The technique led to the refinement of the scaling properties for the GNBs. This information is also used to give insight into the boundary creation process during deformation. This insight will form the basis for formulating the evolution of the spacing probability distributions.

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