7.6: Dislocation Intersections to Form Jogs and Kinks

Introduction

Commonly, dislocations are generated and move on more than one slip system simultaneously. These dislocations must therefore intersect each other, leading to the formation of jogs. Jogs refer to, confusingly, both a jog and a kink. A jog is a short section with length and direction equal to $b$ of the other dislocation and lies out of the slip plane. A kink is a short break in the dislocation line which lies in the slip plane. The formation of jogs has two important consequences:

1. Jogs increase the lengths of the dislocation lines. Hence the intersection of dislocations involve the expenditure of additional energy.
2. Jogged dislocations will move less readily through the crystal, so they play an important role in work hardening.

Formation of a jog

Below is a video showing how a jog is formed when two edge dislocations intersect.

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Formation of a kink

Kinks are formed when the jogs resulted from a dislocation intersection lie in the slip plane instead of normal to it. This can occur when two orthogonal edge dislocations with parallel Burgers vectors intersect each other. As kinks lie in the same plane, they do not inhibit movement of dislocation (i.e., they are glissile). Kinks may also assist dislocation motion, as atoms or vacancies diffusing to them can enable the dislocation to move at stresses below the critical resolved shear stress. In addition, they are often unstable since during glide they can line up and annihilate the offset.

![Figure 6: Intersection of two edge dislocations with parallel Burgers vectors. (Left) Before intersection; (Right) after intersection. (Source of image: G.E. Dieter, Mechanical Metallurgy (1988), p. 171)](image)

Contribution to work hardening

From the viewpoint of plastic deformation, the most important type of dislocation intersection is the intersection of two screw dislocations (Figure 7). The intersection of two screw dislocations produces jogs of edge orientation in both screw dislocations (line vectors of the jogs are perpendicular to the Burgers vectors of the screw dislocations).

![Figure 7: Intersection of two screw dislocations. (Left) Before intersection; (Right) after intersection. (Source of image: G.E. Dieter, Mechanical Metallurgy (1988), p. 172).](image)
Figure 8: Movement of an edge-oriented jog on screw dislocation. The jog is constrained to move along the dislocation in plane AA'BB'. (Source of image: G.E. Dieter, Mechanical Metallurgy (1988), p. 172)

Since an edge dislocation can glide freely only in the plane containing its line and Burgers vector (Plane AA'BB'), the only way the jog can move by slip (conservative motion) is along the axis of the screw dislocation. If the screw dislocation is to slip to a new position, such as MNN'O, it can only do so by taking its jog with it by a non-conservative process such as climb.

Because dislocation climb is a thermally activated process, the movement of the jogged screw dislocation will be temperature-dependent. At temperatures where climb cannot occur, the motion of screw dislocations will be impeded by jogs (i.e. the jogs are sessile) and so the crystal becomes work hardened.