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STRAIN FIELD AROUND A BOUNDARY OF
A SLIGHTLY DEFORMED BICRYSTAL

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Interaction of dislocation with grain boundaries can be most easily studied in bicrystals, where the boundaries are well defined. A bicrystal of Fe-6at%Si alloy [1] containing a $(1\bar{1}2)$ symmetrical boundary (described by a rotation about $[110]$ axis by an angle of 70.5°) was deformed by compression along $[1\bar{1}\bar{1}]$ direction until few slip bands of the system $[111]/(2\bar{1}\bar{1})$ developed in one of the grains and stopped at the boundary. Both $\pm(110)$ surfaces of the sample normal to the boundary were investigated using several X-ray topographic methods giving complementary informations, namely: Lang reflection topography (parallel non monochromatized beam), modified Schulz method (divergent non monochromatized beam), double crystal (DC) topography (parallel monochromatic beam) and topography with monochromatic divergent beam (TMD) [2]. Strong distortions were observed around intersections of the slip bands with the boundary in both deformed and non deformed grains. On both sides of the boundary mutually corresponding steps caused by orientation contrast are visible. Their shape and magnitude depend on the observed surface and on the reflection used. Local lattice rotations were measured using DC and TMD methods.

The observed distortions can be described by a simple model: the front of the slip band at the boundary is simulated by a superdislocation situated at the intersection of the slip band and the boundary, with Burgers vector equal to several hundreds of unit Burgers vectors $a[111]/2$. Distortions important for the formation of topographic image were calculated

$$\Delta\varphi = \frac{1}{|\vec{g}|} \left(\pm \frac{\partial}{\partial z} - \operatorname{tg} \varphi \frac{\partial}{\partial x} \right) (\vec{u} \cdot \vec{g}) = F(x, y, z)$$

The coordinates x and z are parallel to the diffraction vector $\vec{g}$ and $\vec{k}_0 + \vec{k}_g$, respectively ($\vec{k}_0$ and $\vec{k}_g$ are wave vectors of the primary and diffracted beam, resp.). The coordinates x, y, z are fixed with the surface (z is the surface normal). The displacement $\vec{u}(x, y, z)$ due to the superdislocation including the surface relaxation of stresses was calculated after Yoffe [3]. The superdislocation is declined by 17° from the surface normal. At the surface the distortion has the form

$$\Delta\varphi(z=0) = \frac{b}{4\pi r} \frac{1}{r} f(\varphi)$$

$$r = \sqrt{x^2 + y^2} \quad \varphi = \operatorname{arctg} \frac{y}{x}$$

As an example the angular part $f(\varphi)$ of the calculated distortion is shown in the figure ($2\bar{1}\bar{1}$ asymmetrical reflection, $(1\bar{1}0)$ surface, $\text{CuK}\alpha_1$ radiation; full line: surface relaxation included, dashed line: infinite dislocation only). Good agreement with the distortions measured by DC was observed. By comparing the theoretical and experimental results the Burgers vectors of the superdislocation can be found.

References :

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