To be presented at the 34th Annual Electron Microscopy Society of America Proceedings, Miami Beach, FL, August 8 - 13, 1976

LBL-4963

Conf-760803-3

# CLIMB AND GLIDE DISLOCATION SOURCES IN QUENCHED ALUMINUM ALLOYS

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March 1976

Prepared for the U. S. Energy Research and Development Administration under Contract W-7405-ENG-48

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LBL-4963

CLIMB AND GLIDE DISLOCATION SOURCES IN QUENCHED ALUMINUM ALLOYS LBL-4963

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Concentric dislocation loops are observed frequently in slowly quenched aluminum alloys (for a review see 1). In Al-Cu alloys containing Si as an impurity the loops are found to lie in {111} planes in configurations that have been inferred to arise from the operation of Frank-Read glide sources. On the other hand, in Al-Mg and Al-Si alloys detailed analysis has shown that the loops form by dislocation climb in the manner proposed by Bardeen and Herring. Recent work has shown that all multiple loop configurations in Al and its alloys have a common origin, and result from dislocation nucleation and/or vacancy condensation in the vicinity of inclusion particles(2). These processes occur to relieve the large compressive strains which are generated in the lattice around the misfitting particle. It is not clear, however, under what specific conditions the various processes, i.e. vacancy condensation, glide or climb loop generation, will operate. In the present paper it is shown that in Al-Si both climb and glide loops can be produced concurrently.

The alloy used in the experiment contained 0.67w/oSi and was quenched into silicone oil at 100°C after a solution treatment at 550°C. Samples for study in the Philips EM 301 were prepared by a chemical polishing technique to eliminate mishandling damage.

The samples contained high concentrations of multiple loops which analysis has shown arise from the operation of climb sources (2). In one instance, however, the detailed contrast analysis (See Fig. 1-4) revealed exceptional behavior. The loop Burgers vectors $\bar{b}$ were determined in the standard manner by setting up two-beam conditions for various diffraction vectors, $\bar{g}$. In Figs. 1-3 the electron beam direction, B, was [111], and the effect of varying $\bar{g}$ is shown. In Fig 4, B = [121] and g = [$\bar{1}1\bar{1}$]. The dislocation visibility in each condition is summarised in Table 1, while Table 2 shows the possible $|\bar{g}.\bar{b}|$ values for vacancy loops with [$\bar{1}1\bar{1}$] plane normals.

TABLE 1

| $\bar{g}$ | Loop 1 | Loop 2 | Loop 3 |
|---|---|---|---|
| $\bar{1}1\bar{1}$ | in | in | out |
| $\bar{2}02$ | in | in | in |
| $0\bar{2}2$ | in | in | out |
| $\bar{2}20$ | in (g.b = 2) | in (g.b = 2) | in |

TABLE 2

| Prismatic | | | | Glide | | |
|---|---|---|---|---|---|---|
| ½[$01\bar{1}$] | ½[$\bar{1}0\bar{1}$] | ½[$\bar{1}\bar{1}0$] | 1[010] | ½[$\bar{1}01$] | ½[$0\bar{1}1$] | ½[$\bar{1}10$] |
| 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 2 | 1 | 1 |
| 0 | 1 | 1 | 2 | 1 | 2 | 1 |
| 1 | 1 | 0 | 2 | 1 | 1 | 2 |



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A comparison shows that for both outer loops $\bar{b} = \pm\frac{1}{2}[\bar{1}01]$ i.e. they are glide loops, whereas for the inner loop $\bar{b} = \frac{1}{2}[0\bar{1}\bar{1}]$ and it is thus a perfect prismatic loop. By noting the apparent change in size of loops 1 and 2 when the sign of (g.b)s was changed (c.f. Fig. 1 and 3) the Burgers vector was uniquely identified as $\frac{1}{2}[1\bar{1}0]$.

From the results it is concluded that a single inclusion in Al-Si can generate both types of dislocation source to relieve stress. The particular mode which operates probably depends on the particle size and shape. Finally, it is noteworthy that many other glide dislocation segments with the same b were observed near the two outer loops. This suggests that small inclusions may be an important source of dislocations in metals.

I wish to thank the Naval Weapons Center for financial support and Professor G. Thomas for his encouragement and hospitality.

1. Smallman, R.E. and Westmacott, K.H., Mat. Sci. and Engin., 9, 249 (1972).
2. Westmacott, K.H., Phys. Stat. Sol. (1976) in press.

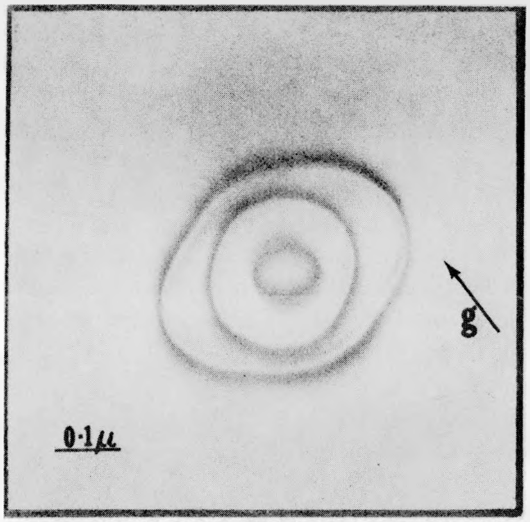


Fig. 1. B = [111] $\bar{g} = [\bar{2}20]$

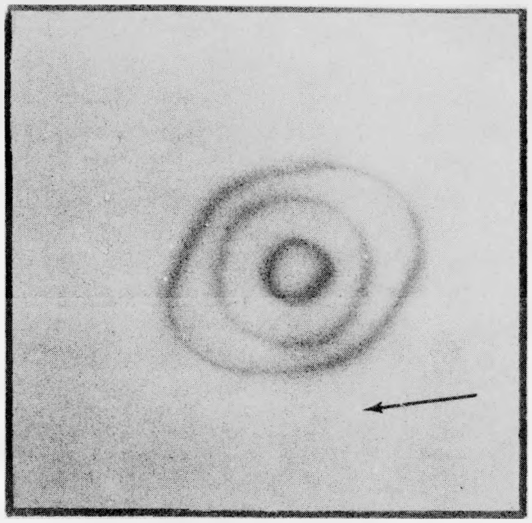

Fig. 2. B = [111] $\bar{g} = [\bar{2}02]$

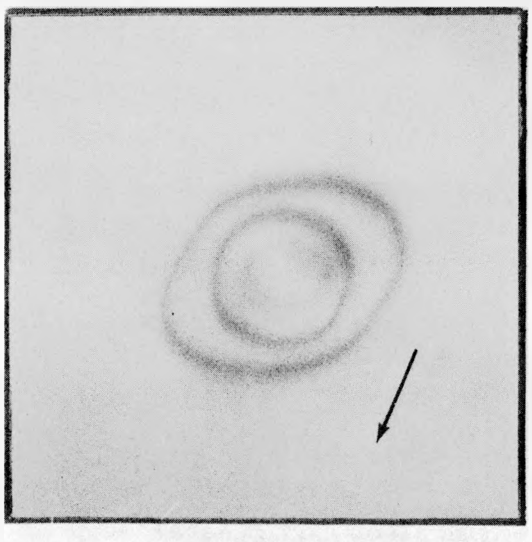

Fig. 3. B = [111] $\bar{g} = [0\bar{2}2]$

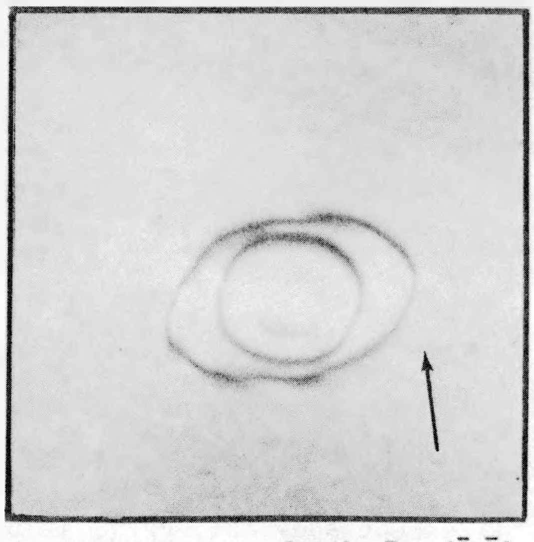

Fig. 4. B = [121] $\bar{g} = [\bar{1}1\bar{1}]$

XBB 764-3142

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