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HIGH RESOLUTION STUDIES IN MARTENSITE

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Detailed microstructural studies have been performed on the lath martensite in steels containing 0.1 and 0.3 wt.%-low alloy structural steels by lattice imaging. This method is providing considerable information on the fine substructural details of dislocated martensite.[1]

In many low and medium carbon dislocated lath martensites, very thin films (≈200Å) of retained austenite have been found to decorate the lath boundaries[2] (see inlet Fig. 1). At lower levels of C concentration, viz., 0.1 wt.%, since the dilatational component of the strain energy is small, no retained austenite is needed for accommodation of strains. Hence, occasionally, adjacent laths show varying degrees of shear strain. The analyses of these types of boundaries showed that shear angles of between 4 and 11° can be developed, Fig. 1. At high shear angles, dislocations form at the boundary (s in Fig. 1) to relieve the strain. In other regions, the strain is accommodated instead by long range strain fields (SF in Fig. 1).

Small angle boundaries have been observed between adjacent laths that contain an array of pure edge dislocations, Fig. 2. In this figure, the angle between the lattice on either side of the boundary is 10°. However, the angle predicted by the average distance h between the observed dislocations from the well-known formula, $\theta = h/b$ is about 12°. This discrepancy may be explained on the basis that C has segregated to these boundaries reducing the misfit between the two adjacent regions.

Martensite laths contain relatively uniform distributions of Moiré fringes which are arranged throughout the structure in the form of a fine network (Fig. 3a). An analysis of these fringes showed that they are of a pure rotation type with rotation angles within the range 11 to 15°. Two rotations can occur on top of each other. This is also evidenced by optical microdiffraction, which shows extra spots at different angles according to the rotation, Fig. 3b. Many of the fringes are associated with uniform distributions of dislocations. An explanation for this can be advanced that following the austenite to martensite transformation (during which very high stresses and strains are generated) local rotations occur throughout the laths as a form of residual stress relief. The presence of structural (misfit) dislocations at these rotated regions could provide further stress relief.

Examination of the tips of the laths indicate that the lattice planes at the leading edge are continuous into the adjacent laths, Fig. 4. There are, however, indications that numerous dislocations are present behind the leading edge at the interlath boundaries where the interface is still curved. This suggests that the laths grow in traverse direction by the creation of dislocations at the boundary well behind the edge and their movement to and disappearance at the tip.

ACKNOWLEDGEMENTS

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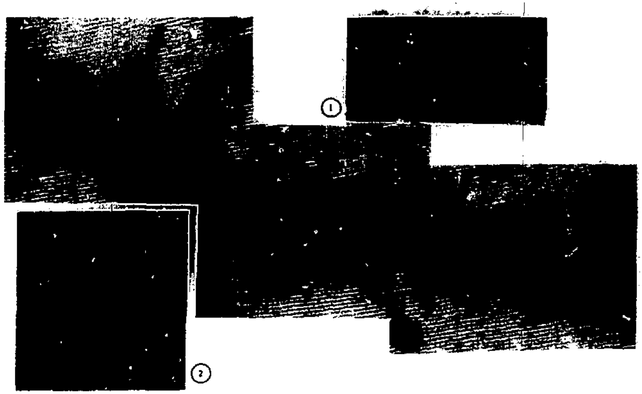

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Fig. 1 - Accommodations of transformation strains by dislocations (d) and strain fields near and at the boundary. Inlet (1) Location of the boundary, Inlet (2) Low Mag DF micrograph showing the characteristic appearance of continuous films or retained γ at the lath boundaries (0.1 wt.% C steel).

Fig. 2 - Low angle boundary between two laths showing the dislocation arrangement.

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Fig. 3a - Structural Moiré fringes within a lath.

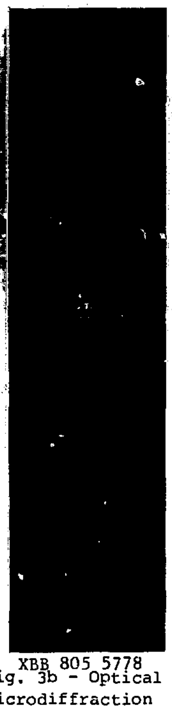

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Fig. 3b - Optical microdiffraction pattern.

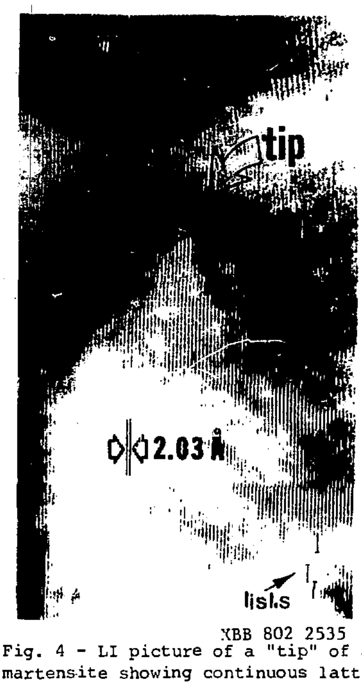

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Fig. 4 - LI picture of a "tip" of a martensite showing continuous lattice fringes.

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