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IDENTIFICATION OF SOME CRYSTALLOGRAPHIC FEATURES OF MARTENSITE IN STEELS BY MICRODIFFRACTION

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Considerable attention should be paid to the interpretation of electron diffraction, such as the understanding of the extra reflections and other effects in an SAD pattern obtained from lath martensite by making allowances for spatial resolution limitations in the SAD patterns. These difficulties can be overcome by utilizing the convergent beam electron diffraction (CBED) method[1] which permits the use of different probe sizes to obtain crystallographic information from very small regions. In the present study some crystallographic features of lath martensite in low and medium C steels have been identified and some others verified by using CBED.

Fig. 1(b) shows a <111> cubic SAD pattern containing reflections wihch suggest a slight misorientation. In the past this was attributed[2] to small angle boundaries between the adjacent laths in a packet. However, the present detailed analysis shows that what is indeed happening is that the information contained in the patterns actually comes from two different packets - one in longitudinal configuration (laths 1), and the other in edge-on configuration (laths 2). It has been ascertained that laths marked 1 have a $\{111\}_A$ habit and laths 2, the $\{11\bar{1}\}_A$ habit. Thus, these two packets are separated by a 70.54° (angle between (111) and $(11\bar{1})$ planes) rotation around a vector normal to the plane of the foil, i.e., $<110>_A$ (or $<111>_M$). In a superimposed SAD pattern, the $\{110\}_M$ rel-vectors corresponding to the different packets are then expected to be separated by a 10.54° rotation, (Fig. 1(b)).

Strains created during the austenite to martensite transformation in steels are accommodated by many means such as shearing (slip or twinning) in martensite, rotation of adjacent laths, and deformation of retained austenite at the lath boundaries. Martensite packets also contribute to this stress relieving process by assuming different austenite variants, as discussed above. Fig. 2(a) is a unique example where at least six packets have oriented themselves with respect to each other in such a small region. As shown in the figure, even a single lath can represent a packet (e.g., lath (1)). This is confirmed by the CBED patterns which show either a single $<111>_M$ pattern (1,4,5), or superimposed patterns (2,3,6,7,8), rotated by ∿70° (or 110°) according to the site on which the probe was placed.

It has been shown by the earlier investigations[3] that the orientation relationships (OR) between retained γ and α' is not unique. In fact, in the steels investigated, most frequently both Kurdjumov -Sachs (K-S) and Nishiyama-Wassermann (N-W) OR are observed simultaneously in local regions containing martensite crystals and retained austenite. CBED patterns in Fig. 3 taken from the region indicated show single orientations belonging to $<100>_M$, $<111>_M$, or $<110>_A$. Here $[100]_M$ and $[110]_A$ indicate an N-W OR, while $[111]_M$ and $[110]_A$ indicate a K-S OR by noting that the reflections from $(0\bar{1}\bar{1})_{M1}$, $(1\bar{1}0)_{M2}$, and $(111)_A$ are superimposed in SAD pattern (4).

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1. J.W. Steeds, CBED, Introduction to A.E.M., p.387, by J.J. Hren, J.I. Goldstein, and D.C. Joy, eds., Plenum Press, N.Y., 1979.
2. J.M. Chilton et al., JISI, 1970, Vol. 208, p.184.
3. B.V.N. Rao, Met. Trans., 10A, 1979, p. 645.

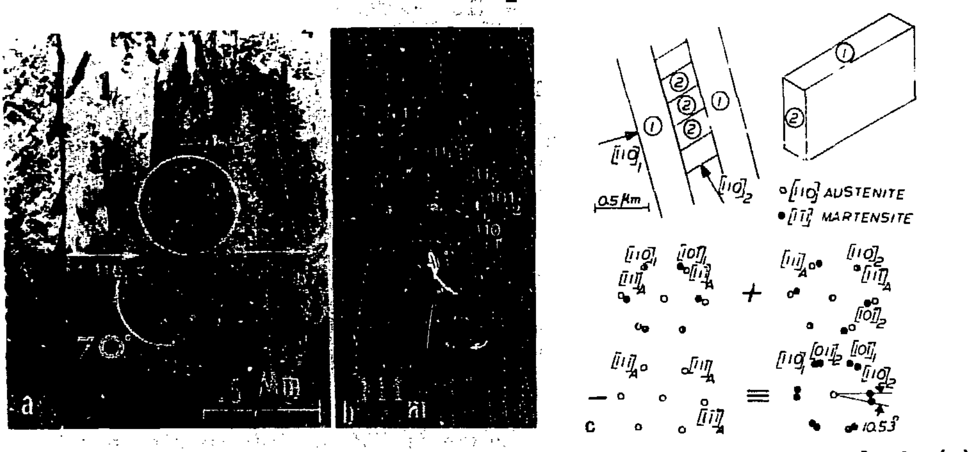

Fig. 1 - BF (a), SAD (b) from the region encircled, and schematic analysis (c) of SAD pattern (b). Note measured separation. (0.3 wt.%C steel).

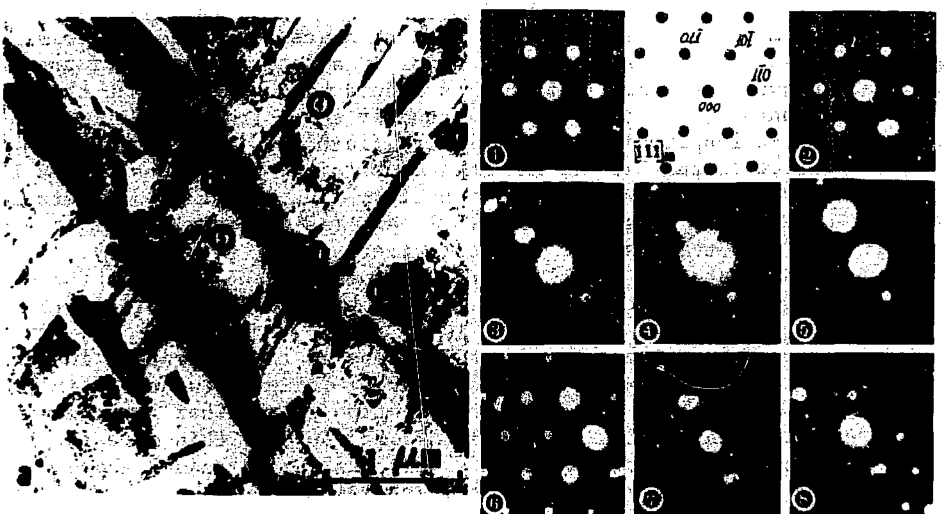

Fig. 2 - BF (a) and CBED patterns from the regions indicated. (0.1 wt.% steel). Note the zig-zag excursions due to the shearing of individual laths with respect to each other.

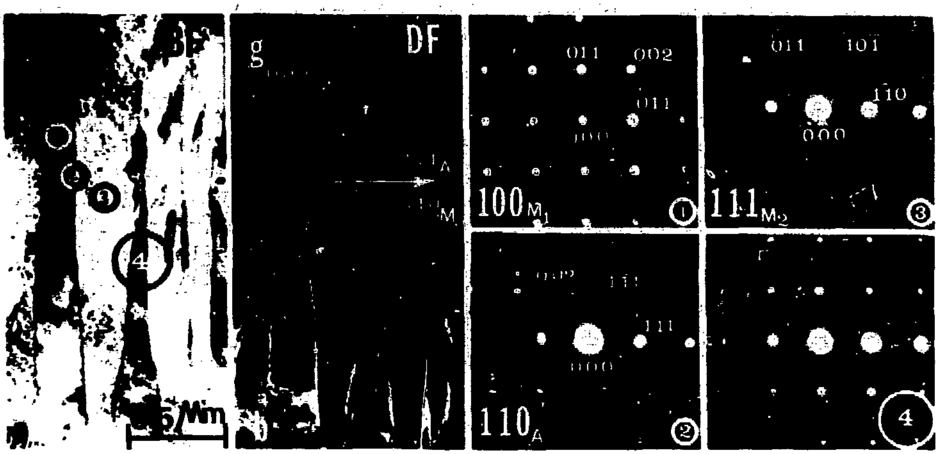

Fig. 3 - BF (a), DF (from $g_{00\bar{2}_A}$) and CBED patterns from the adjacent regions in BF. (4) is a composite SAD pattern.