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### Title

STACKING FAULT IMAGES AT HIGH VOLTAGES

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Within a few hundred thousand volts either side of the disappearance voltage, a systematic twelve-beam computer program predicts different contrast for high-voltage bright-field images of a stacking fault in a foil oriented for strong second-order Bragg diffraction when the sign of the phase change at the fault is reversed. The fringes of the stacking fault are predicted to be of strong contrast when  $\bar{g} \cdot \bar{R} = -1/3$  and of weak contrast when  $\bar{g} \cdot \bar{R} = +1/3$ . Figure 1 shows the theoretical profiles for stacking faults in an aluminum crystal oriented for (222) diffraction at 500kV, just slightly above the disappearance voltage of 430kV for this reflection. This figure indicates that there should be significant and observable contrast differences between intrinsic and extrinsic stacking faults using the same diffracting conditions or from the same fault using reversed diffracting conditions.

Figure 2 shows the images obtained from an aluminum-1% silver alloy at 500kV by reverseing the diffracting conditions using beam deflection. The stacking fault contrast is considerably reduced in figure 2(b) compared to that in figure 2(a). Thus the effect of the sign of the phase change at the boundary predicted by the multiple beam theory is indeed exhibited in the micrographs. Figure 3 shows images taken at 650kV exhibiting similar behavior. The contrast differences were also noticed to some extent at 300kV although image qualities were poor due to specimen thickness.

Rules for determining the nature of a stacking fault have been

developed based upon the two-beam dynamical theory of electron diffraction in an absorbing crystal which are quite useful when they are applicable, that is, when strong two-beam conditions exist and when the stacking fault intersects the foil surfaces.<sup>1,2</sup> The same information can be obtained using systematic multiple-beam images obtained under the conditions described above. The phase shift at the boundary can be determined using a dark-field image of the first-order reflection taken when the second-order spot is on the reflecting sphere, the direction and indices of the second-order reflection can be obtained from the diffraction pattern.

The high voltage method further allows the determination of the nature of a stacking fault which does not intersect the foil surfaces, such as the loops shown in figure 2. The contrast difference between profiles for  $\bar{g}\cdot\bar{R} = -1/3$  and  $\bar{g}\cdot\bar{R} = +1/3$  are still noticeable at the foil center.

The examples of figs. 2, 3 show that the contrast behavior of images of second order reflections can be useful well above the disappearance voltage. However, the strongest contrast differences occur at this voltage. Stacking fault images of the Al-1% Ag specimen at 430kV showed marked differences in the B.F. images when  $g\cdot b$  reversed sign. Furthermore, at the disappearance voltage the weak contrast B.F. images showed relatively strong subsidiary fringes. The latter could be useful for obtaining absorption parameters in multiple beam systematic orientations.

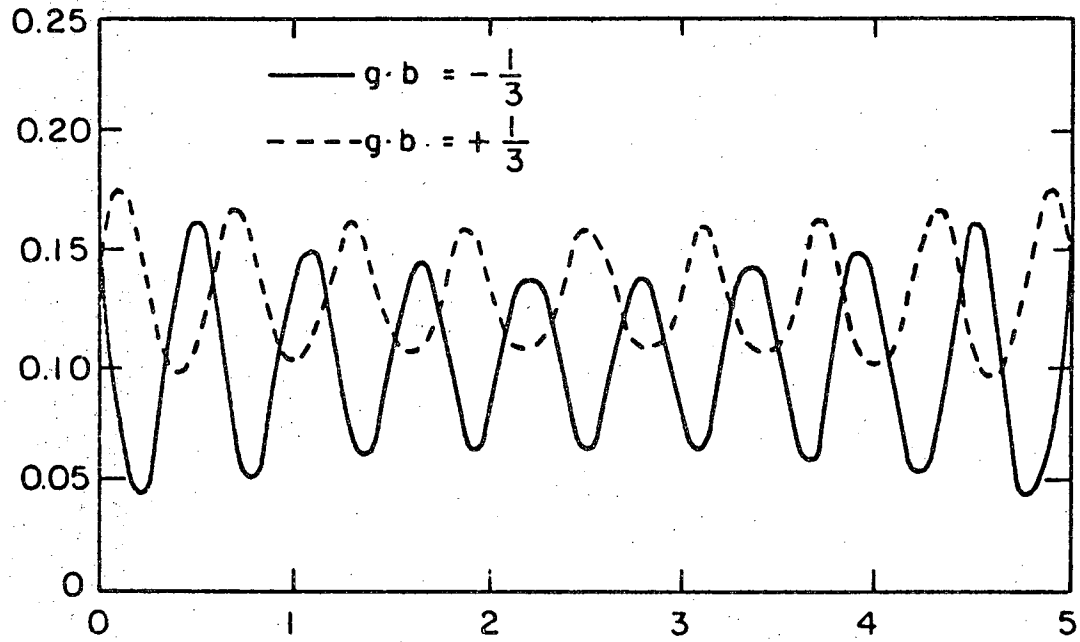
#### Acknowledgements

I wish to thank Professor G. Thomas for his support and encouragement.

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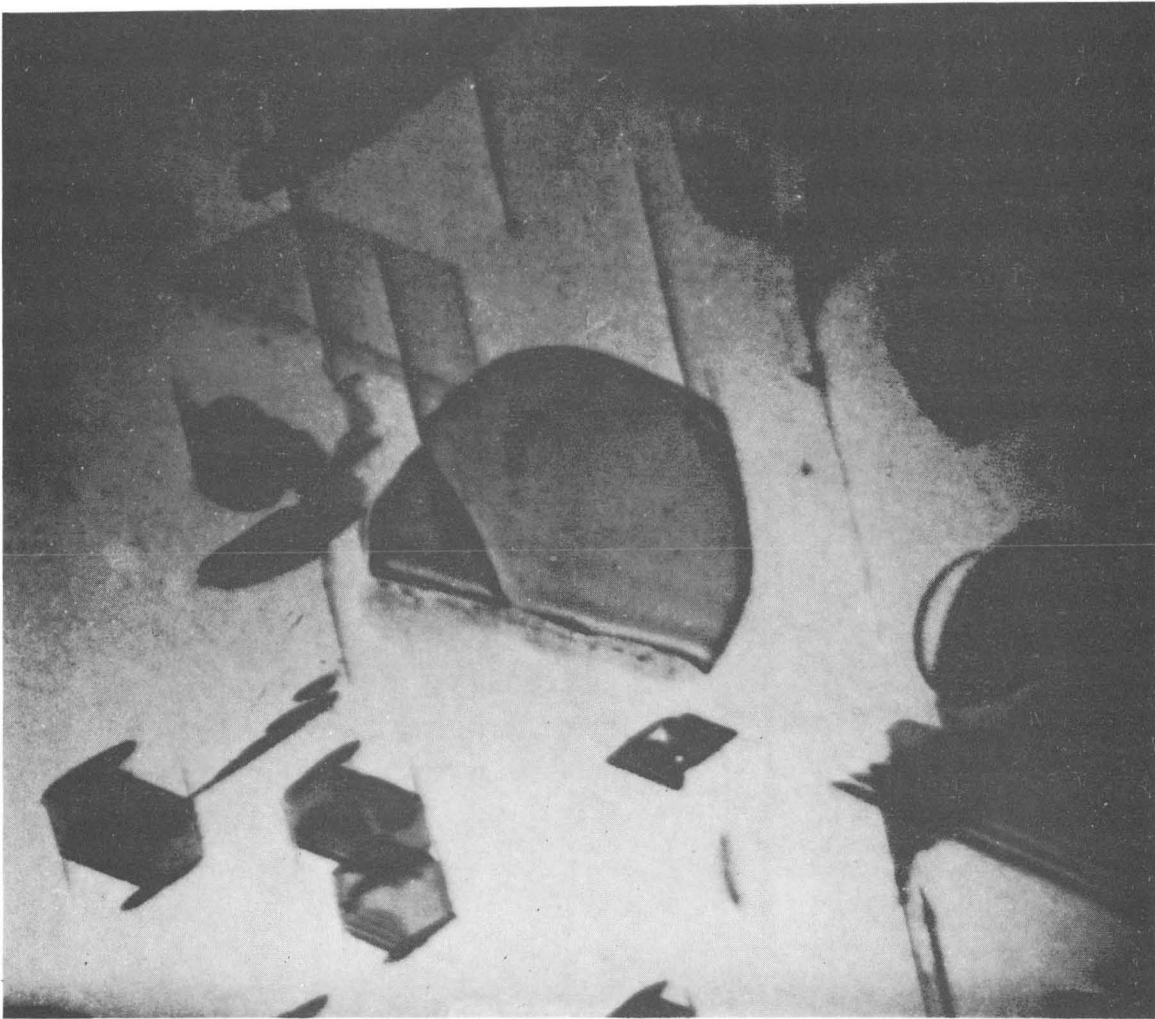
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P. B. Hirsch, et al., Electron Microscopy of Thin Films, Butterworths, 1965.  
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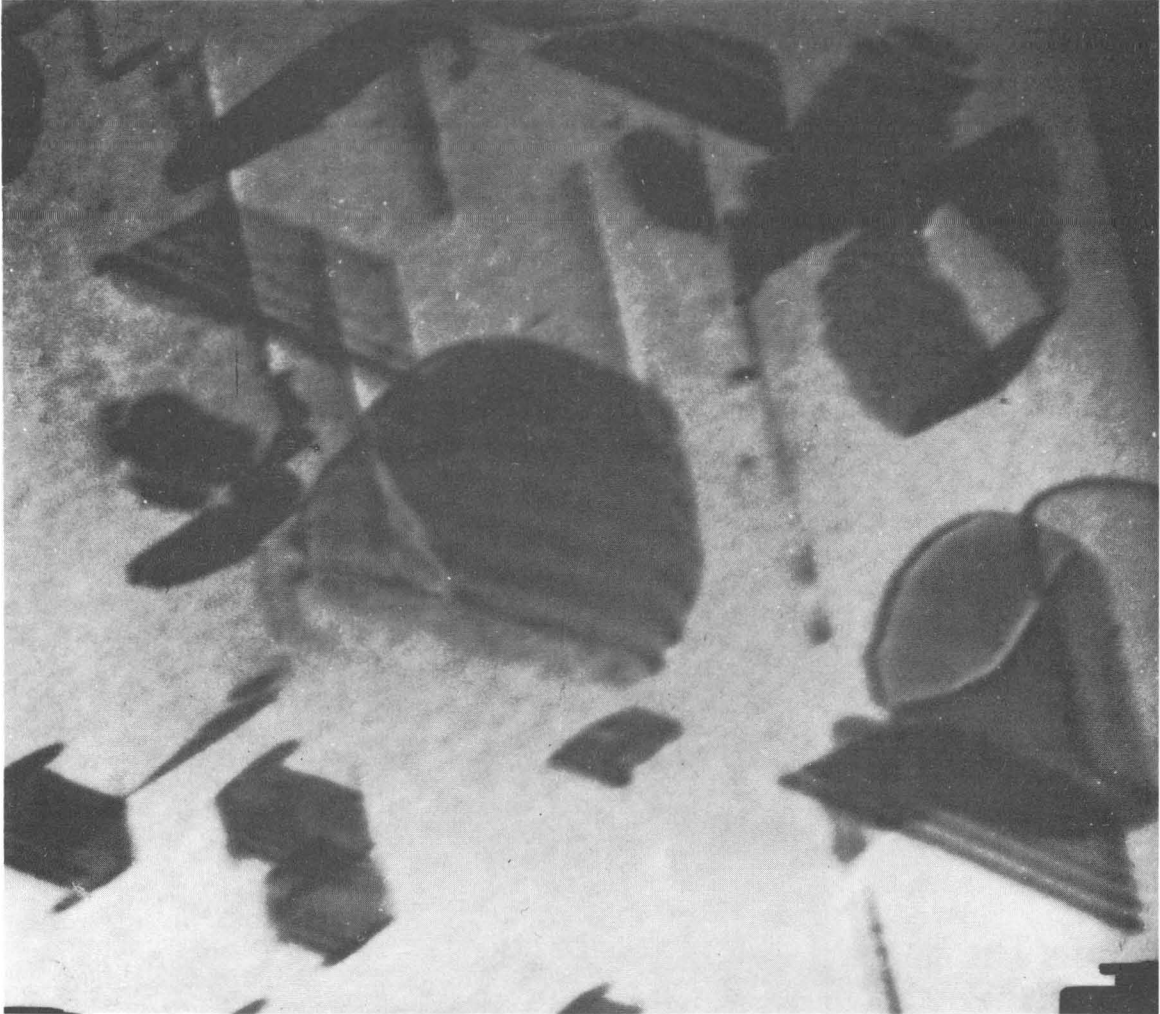
Fig. 1



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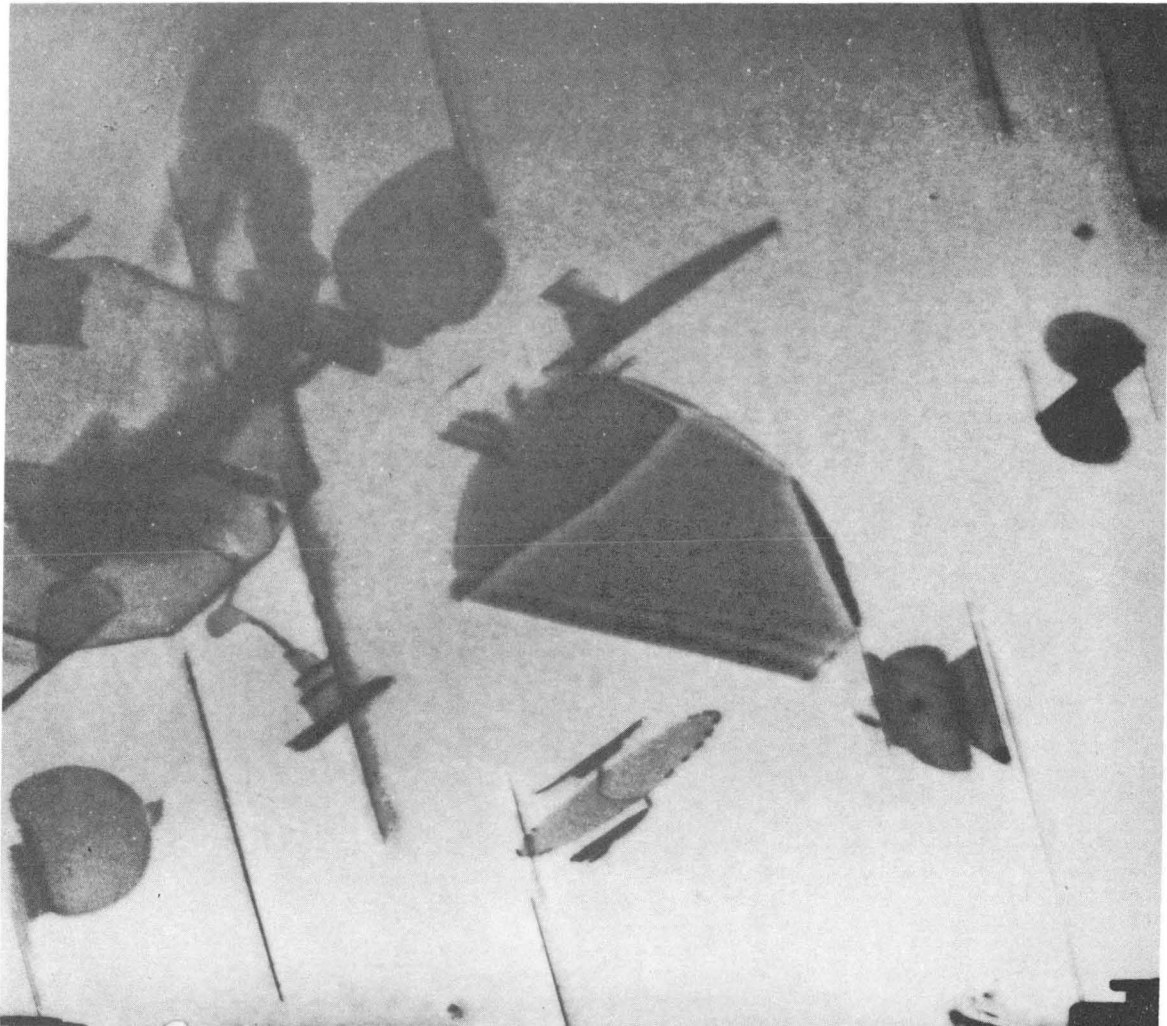
Fig. 2(a)





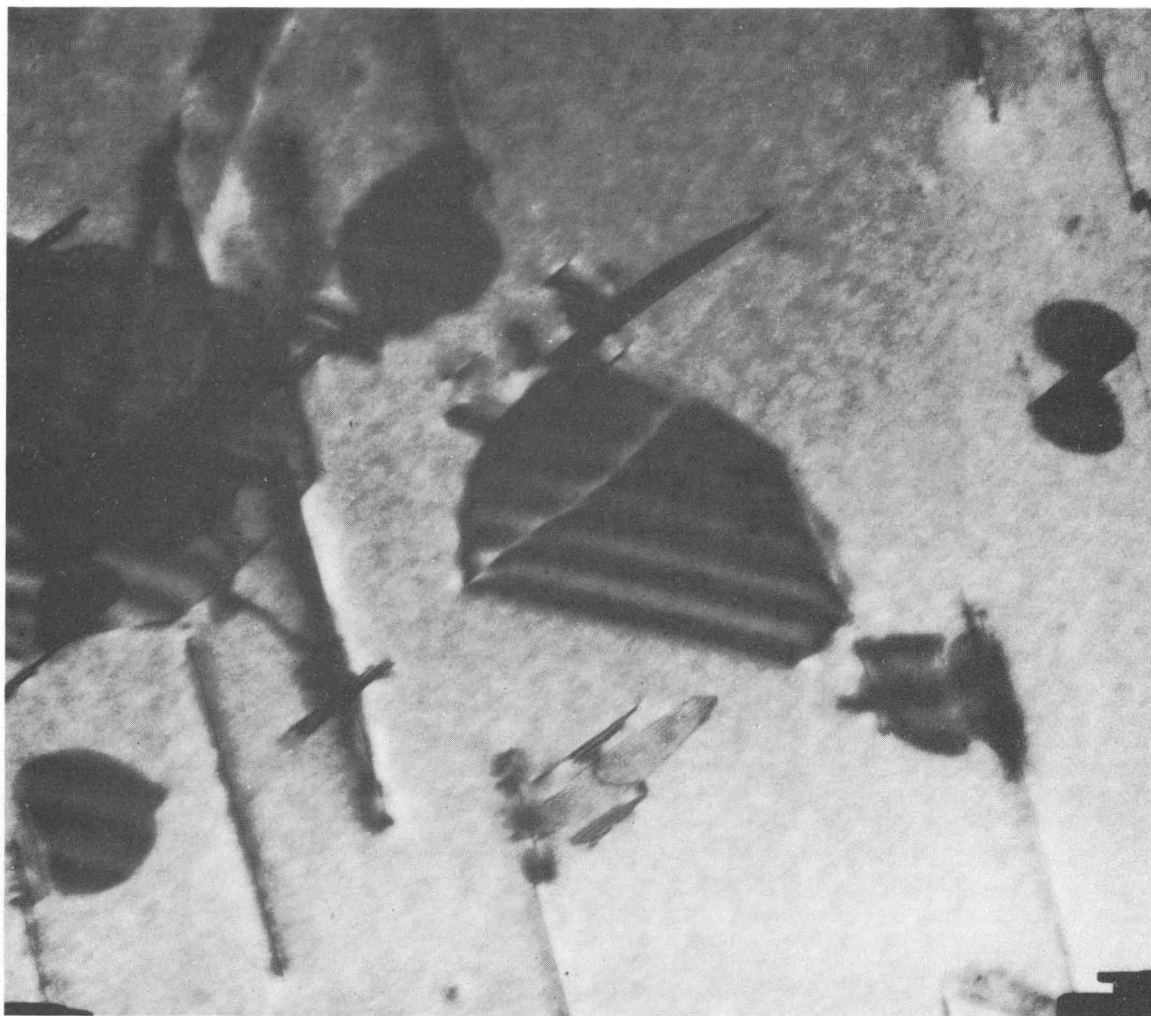
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Fig. 2(b)



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Fig. 3(a)



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Fig. 3(b)

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