

in the f.c.c. case. Hence the steps in the calculations are identical in both cases. Since these steps have been followed in detail in ref. 4, only the results of the present analysis are presented. They are summarized in Table II.

(d) Comparison with observed results

Fahlenbrach and co-workers⁶⁻⁸ have investigated the magnetic anisotropy in rolled Hyperm Co 50 (49% Fe-49% Co-2% V) and Koerzit T (35% Fe-53% Co-8% V-4% Cr). They found that in the heavily rolled condition, the direction of easiest magnetization is the rolling plane normal, the next easy direction is the transverse direction, and the hardest direction is in the rolling direction. Accordingly we calculated from Table II the anisotropy energies in these three directions, for crystals of (001)[$\bar{1}10$], (115)[$\bar{1}10$], (112)[$\bar{1}10$] and (111)[$\bar{1}10$] orientations which comprise the rolled texture (plus (110)[$\bar{1}10$] for completeness). The results are given in Figs. 3 and 4, with the energy in the rolling direction set at zero arbitrarily.

It may be noted in Fig. 3 that in the nearest-neighbor (NN) case, the rolling plane normal is

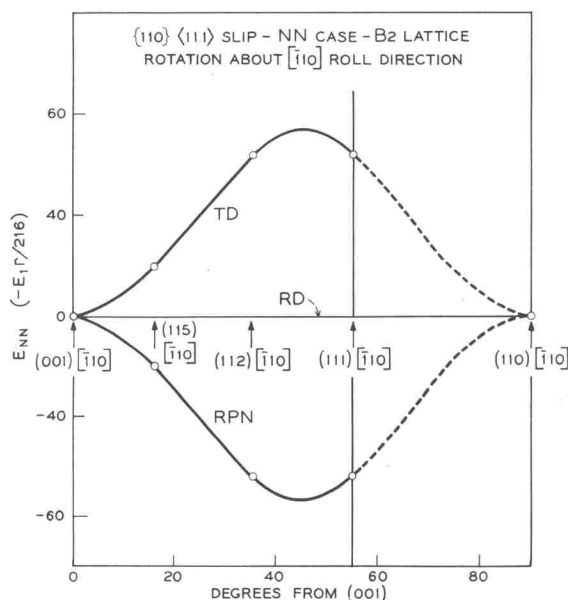


Fig. 3. Calculated slip-induced magnetic anisotropy energy in the three symmetry directions of a rolled strip, as a function of orientation from (001)[$\bar{1}10$] to (110)[$\bar{1}10$]. Curve from (111)[$\bar{1}10$] to (110)[$\bar{1}10$] not applicable for rolled FeCo (see Fig. 2). Calculations based on nearest-neighbor interactions, for the case of {110}<111> slip (see Table II). Energy in RD arbitrarily set at zero. Note $E_1 < 0$ for FeCo.

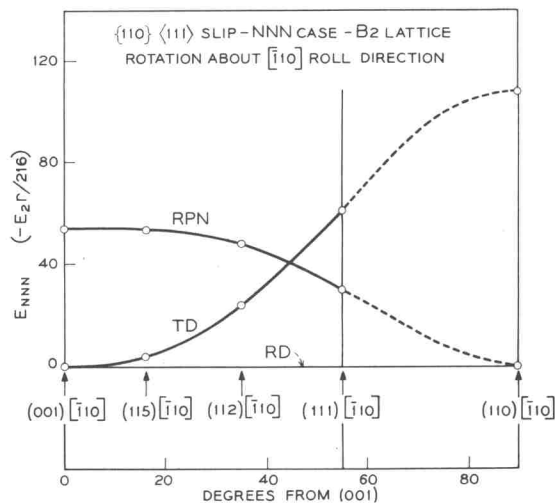


Fig. 4. Same as Fig. 3 except that calculations are based on next-nearest-neighbor interactions.

indeed the lowest energy direction as observed by Fahlenbrach *et al.* However, the transverse direction is the hardest, contrary to the observed results. In the (weaker) NNN anisotropy, Fig. 4, the transverse direction is again predicted to be harder than the rolling direction, assuming $l_2 < 0$. Hence it may be concluded that {110}<111> slip alone is insufficient to explain the observed anisotropy. It turns out that substantial {112}<111> slip is also required. The latter analysis will now be presented.

3. ANALYSIS OF {112}<111> SLIP

The case of {112}<111> slip is somewhat more complicated than those of {111}<110> and {110}<111> slip, since the b.c.c. structure repeats itself after every sixth {112} layer. Consequently, the distribution of atom pairs resulting from {112}<111> slip generally depends on the arrangement of the slipped planes. Several of these arrangements are shown in Figs. 5 and 6. To a reasonable approximation, one may conclude from examining these arrangements that the effects of {112}<111> slip are (1) to convert the three <111> nearest-neighbor directions, other than the slip direction, to an increase of BB (like atom) pairs; and (2) to convert all three <100> next-nearest-neighbor directions to a decrease of BB pairs. The latter effect means that the magnetic anisotropy from NNN interactions may be neglected, and that we may concentrate on the nearest-neighbor case only.

As for the NN case, we again express the mag-

netic anisotropy energy by eqn. (1):

$$E = l \sum_i \Delta N_{\text{BB}i} \cos^2 \varphi_i. \quad (1)$$

(a) Long-range order case

To calculate $\Delta N_{\text{BB}i}$ in the long-range order case, we note that in a unit cell, the area of any one set of $\{112\}$ planes is $a^2\sqrt{6}$. In this cell there are eight nearest-neighbor bonds, two each in the four $\langle 111 \rangle$ directions. In the fully-ordered, undeformed state, these are AB bonds, i.e., joining an A atom at an α site with a B atom at a β site. We assume, to a reasonable approximation, that after $(\bar{1}12)[1\bar{1}1]$ slip, all odd number of slip steps will convert the

two AB bonds to an AA bond plus a BB bond, in all $\langle 111 \rangle$ directions except the $[1\bar{1}1]$ slip direction. Hence along $[111]$, $[\bar{1}11]$ or $[1\bar{1}\bar{1}]$, we gain one BB pair. In case of partial LRO, the gain is s^2 (see Appendix). Hence $\Delta N_{\text{BB}} = s^2/a^2\sqrt{6}$ per unit $(\bar{1}12)$ area.

As in the previous treatment for $\{110\}\langle 111 \rangle$ slip, the complete expression for ΔN_{BB} includes the factor $(1/2)(p_0 p' |S|/d)$, where $d = a/\sqrt{6}$ is the $\{112\}$ slip plane spacing. Hence, per unit volume,

$$\begin{aligned} \Delta N_{\text{BB}} &= \frac{1}{2} p_0 p' \left(\frac{\sqrt{6}}{a} \right) \left(\frac{s^2}{a^2 \sqrt{6}} \right) |S| \\ &= \frac{1}{4} N p_0 p' s^2 |S|. \end{aligned} \quad (14)$$

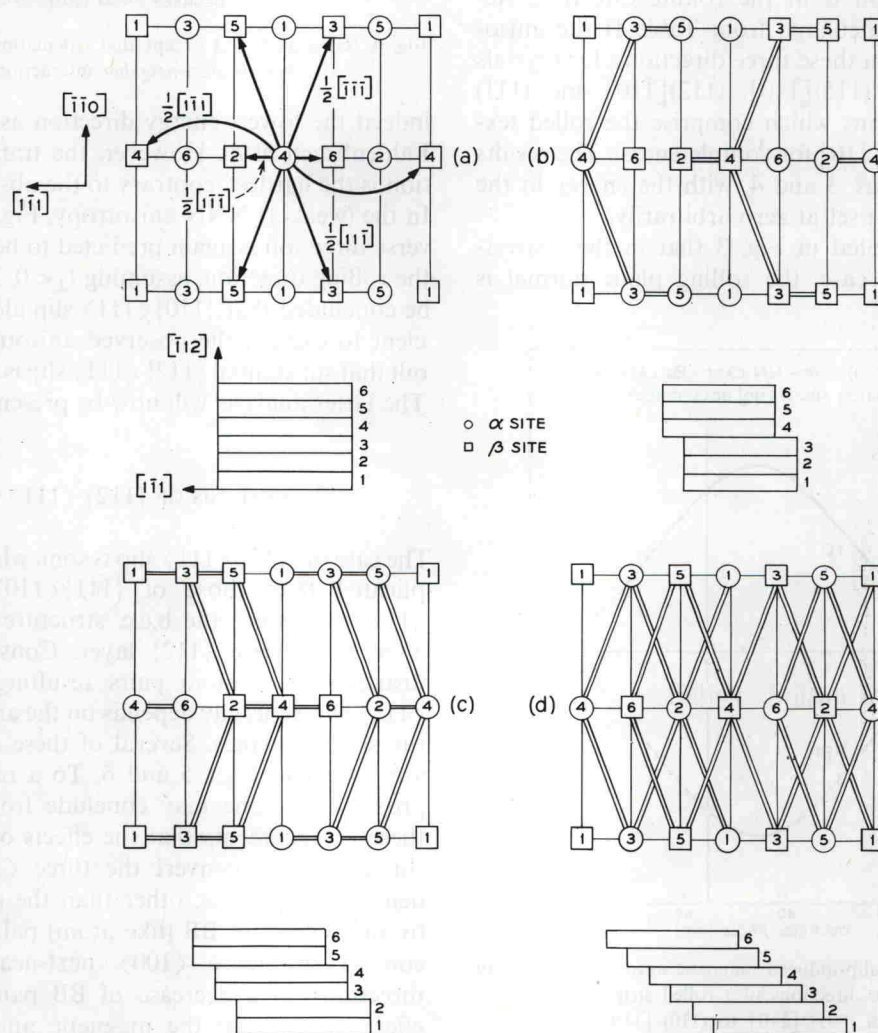


Fig. 5. Atomic arrangement in six consecutive $(\bar{1}12)$ layers of a B_2 superlattice, showing effect of $(\bar{1}12)[1\bar{1}1]$ slip on the distribution of nearest-neighbor atom pairs. (a) Undeformed state; all four $\langle 111 \rangle$ NN directions contain AB pairs only. (b) to (d) Alternative arrangements after $(\bar{1}12)[111]$ slip, showing AA and BB pairs (double bars) induced in all $\langle 111 \rangle$ directions except the $[1\bar{1}1]$ slip direction.