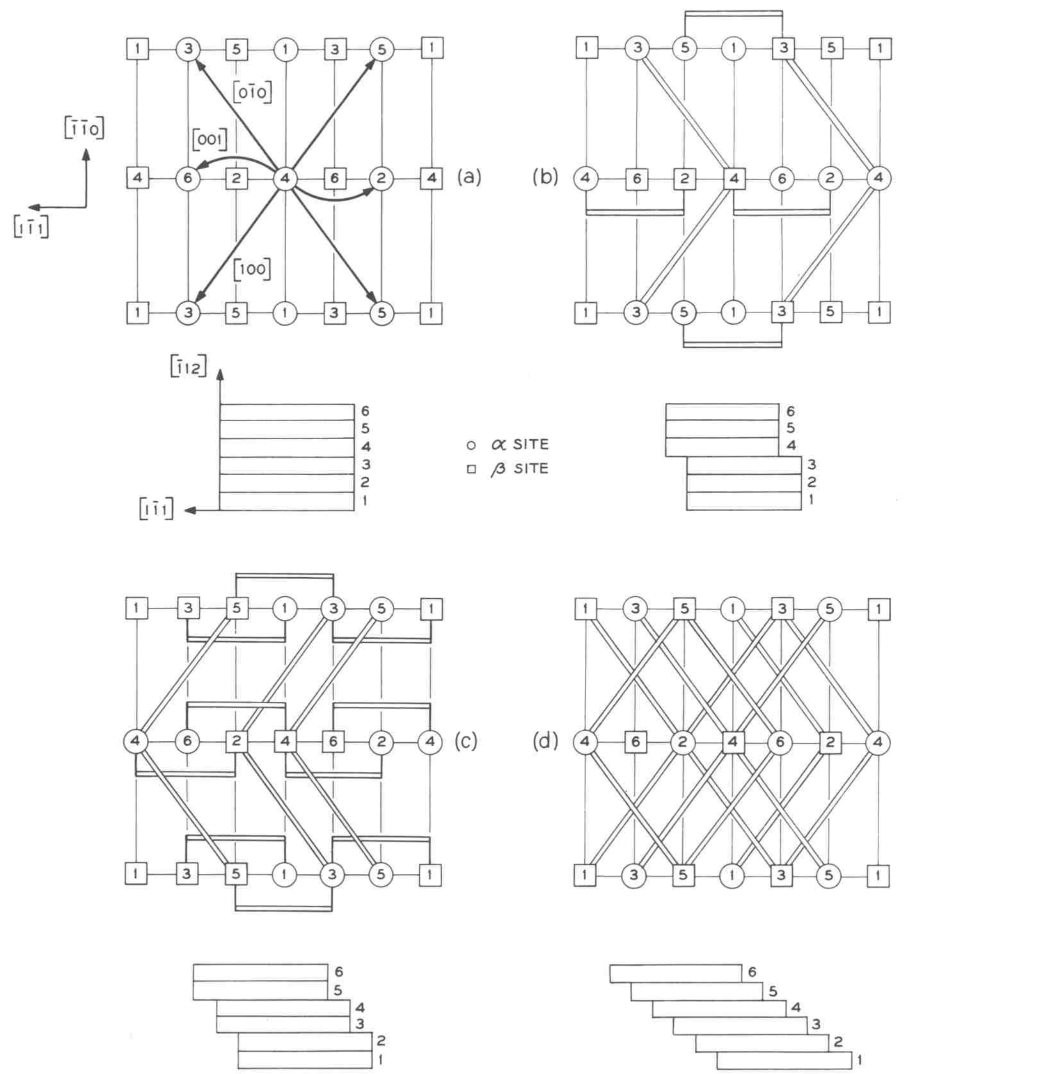

Fig. 6. Same as Fig. 5, except that emphasis is on *next-nearest-neighbor* pairs. (a) Undeformed state; all three ⟨100⟩ NNN directions contain AA and BB pairs only. (b) to (d) Alternative arrangements after $(\bar{1}12)$ $[1\bar{1}1]$ slip, showing AB pairs (double bars) induced in all three ⟨100⟩ directions.

Since ΔN_{BB} occurs in [111], $[\bar{1}11]$ and $[11\bar{1}]$, we have from eqn. (1)

$$\cos^2\varphi = (\cos^2\varphi_{[111]} + \cos^2\varphi_{[\bar{1}11]} + \cos^2\varphi_{[11\bar{1}]}) = -\tfrac{2}{3}(\alpha_1\alpha_2 - \alpha_2\alpha_3 + \alpha_3\alpha_1)\,, \tag{15}$$

which means that the $[1\bar{1}1]$ slip direction is the effective direction of unlike pairs, which is a hard direction of magnetization for FeCo. In the general case, where the slip direction of slip system i has the direction cosines d_{1i}, d_{2i}, d_{3i},

$$\cos^2\varphi_i = -2(d_{1i}d_{2i}\alpha_1\alpha_2 + d_{2i}d_{3i}\alpha_2\alpha_3 + d_{3i}d_{1i}\alpha_3\alpha_1) \equiv -2f_i(\alpha_1, \alpha_2, \alpha_3)\,. \tag{16}$$

The insertion of eqns. (14) and (16) into eqn. (1) then leads to

$$E = -\tfrac{1}{2}Nlp_0p's^2\sum_i |S_i| f_i(\alpha_1, \alpha_2, \alpha_3)\,. \tag{17}$$

(*b*) *Short-range order case*

For the short-range order case, the two nearest-neighbor bonds associated with each ⟨111⟩ direction (in a unit cell) contain a total of $(1-\sigma)/2$ BB pairs in the undeformed state (see Appendix). After slip, $\sigma = 0$ for the 3⟨111⟩ directions other than the slip direction. Hence the gain in BB pairs in each of these directions is $\sigma/2$, or $\sigma/2a^2\sqrt{6}$ per

TABLE III: VALUES OF ε AND d (REFERRED TO CUBIC AXES) FOR THE TWELVE $\{112\}\langle 111\rangle$ SLIP SYSTEMS

No. of slip system	*Slip plane*	*Slip direction*	$2\varepsilon_{xx}$	$2\varepsilon_{yy}$	$2\varepsilon_{zz}$	$4\varepsilon_{yz}$	$4\varepsilon_{zx}$	$4\varepsilon_{xy}$	$3d_1d_2$	$3d_2d_3$	$3d_3d_1$
1	$(11\bar{2})$	111	S_1	S_1	$-2S_1$	$-S_1$	$-S_1$	$2S_1$	1	1	1
2	$(1\bar{2}1)$	111	S_2	$-2S_2$	S_2	$-S_2$	$2S_2$	$-S_2$	1	1	1
3	$(\bar{2}11)$	111	$-2S_3$	S_3	S_3	$2S_3$	$-S_3$	$-S_3$	1	1	1
4	(112)	$11\bar{1}$	S_4	S_4	$-2S_4$	S_4	S_4	$2S_4$	1	-1	-1
5	$(\bar{1}21)$	$11\bar{1}$	$-S_5$	$2S_5$	$-S_5$	$-S_5$	$2S_5$	S_5	1	-1	-1
6	$(2\bar{1}1)$	$11\bar{1}$	$2S_6$	$-S_6$	$-S_6$	$2S_6$	$-S_6$	S_6	1	-1	-1
7	$(1\bar{1}2)$	$\bar{1}11$	$-S_7$	$-S_7$	$2S_7$	S_7	$-S_7$	$2S_7$	-1	1	-1
8	(211)	$\bar{1}11$	$-2S_8$	S_8	S_8	$2S_8$	S_8	S_8	-1	1	-1
9	$(12\bar{1})$	$\bar{1}11$	$-S_9$	$2S_9$	$-S_9$	S_9	$2S_9$	$-S_9$	-1	1	-1
10	$(21\bar{1})$	$1\bar{1}1$	$2S_{10}$	$-S_{10}$	$-S_{10}$	$2S_{10}$	S_{10}	$-S_{10}$	-1	-1	1
11	(121)	$1\bar{1}1$	S_{11}	$-2S_{11}$	S_{11}	S_{11}	$2S_{11}$	S_{11}	-1	-1	1
12	$(\bar{1}12)$	$1\bar{1}1$	$-S_{12}$	$-S_{12}$	$2S_{12}$	$-S_{12}$	S_{12}	$2S_{12}$	-1	-1	1

TABLE IV: SUMMARY OF RESULTS BASED ON $\{112\}\langle 111\rangle$ SLIP

Rolling plane	*Rolling direction*	*Active slip systems*	$\lvert S_i\rvert$	E_{NN}	*Easy* axis*
(001)	$[\bar{1}10]$	7,12	$r/2$	$\left(\frac{E_1 r}{6}\right)\alpha_1\alpha_2$	TD
(115)	$[\bar{1}10]$	4,7,8,11,12	$\lvert S_4\rvert = 2r/27$ $\lvert S_8\rvert = \lvert S_{11}\rvert = 6r/27$ $\lvert S_7\rvert = \lvert S_{12}\rvert = 21r/54$	$\left(\frac{E_1 r}{162}\right)(31\alpha_1\alpha_2+2\alpha_2\alpha_3+2\alpha_3\alpha_1)$	TD
(112)	$[\bar{1}10]$	4,7,8,11,12	$r/3$	$\left(\frac{E_1 r}{18}\right)(3\alpha_1\alpha_2+\alpha_2\alpha_3+\alpha_3\alpha_1)$	RPN
(111)	$[\bar{1}10]$	4,7,8,11,12	$\lvert S_4\rvert = 2r/3$ $\lvert S_8\rvert = \lvert S_{11}\rvert = 2r/9$ $\lvert S_7\rvert = \lvert S_{12}\rvert = 7r/18$	$\left(\frac{E_1 r}{54}\right)(5\alpha_1\alpha_2+6\alpha_2\alpha_3+6\alpha_3\alpha_1)$	RPN
(110)	$[\bar{1}10]$	1,4,7,12	$r/2$	0	—

* Relative among the three symmetry directions of rolled strip.
TD-transverse direction, RPN-rolling plane normal.

unit $\{112\}$ area. To this quantity we multiply by a factor $(p'|S|/d = p'|S|\sqrt{6}/a)$ as before, leading to the expression

$$\Delta N_{BB} = p'|S|\left(\frac{\sqrt{6}}{a}\right)\left(\frac{\sigma}{2a^2\sqrt{6}}\right) = \tfrac{1}{4}Np'\sigma|S| . \qquad (18)$$

Insertion of eqns. (16) and (18) into eqn. (1) then leads to

$$E = -\tfrac{1}{2}Nlp'\sigma\sum_i |S_i|\, f_i(\alpha_1,\alpha_2,\alpha_3) \qquad (19)$$

for the SRO case.

Finally, by combining the LRO and SRO expressions of eqns. (17) and (19), we obtain

$$E = -\tfrac{1}{2}E_1\sum_i |S_i|\, f_i(\alpha_1,\alpha_2,\alpha_3)\,, \qquad (20)$$

where $E_1 = Nlp'(p_0 s^2+\sigma)$ as before. Equation (20) is the expression for the slip-induced anisotropy energy developed by $\{112\}\langle 111\rangle$ slip and based on NN interactions.

(c) *Applications to rolling*

As in the treatment of $\{110\}\langle 111\rangle$ slip in Part 2 above, eqn. (20) has been applied to rolling of $(001)[\bar{1}10]$, $(115)[\bar{1}10]$, $(112)[\bar{1}10]$, $(111)[\bar{1}10]$ and $(110)[\bar{1}10]$ orientations. For the convenience of calculations, the appropriate parameters (similar to