Texture, 1972, Vol. 1, pp. 141–142.

ON THE ROLLING TEXTURE REVERSAL IN FCC METALS

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(*Received February* 2, 1972, *in final form March* 25, 1972)

As all factors governing the process of the development of texture are strongly dependent on stacking fault energy, a marked influence of SFE on the wire texture and rolling texture characteristics should be expected. This relationship has been established for wires by English and Chin.[1] Using their own experimental data, as well as those from literature, they plotted the amount of $\langle 100 \rangle$ wire texture component against γ/Gb, γ being SFE, G the shear modulus, and b the Burgers vector, as shown in Figure 1. The most important conclusion drawn by the authors from this relationship is that the general trend toward larger proportions of $\langle 100 \rangle$ with reduced SFE is reversed for the lowest values of γ/Gb. At the same time they come to the conclusion that: "this reversal is not found in rolling textures, which vary monotonically from "brass" to "copper" type with increasing SFE . . . However, the same factors governing wire texture differences are presumably operative in rolling as well".[1]

Recently Bunge and Tobisch[2] in their investigations on rolling textures in α-brasses with variable zinc contents revealed texture transition in terms of a relationship between $\{110\}\langle 001 \rangle$ texture component and the stacking fault energy parameter, and obtained a curve with a maximum at about the same γ/Gb value as in English and Chin's experiments. They conclude that the results confirm Wassermann's[3] theory of mechanical twinning which is responsible for the texture transition.

In a previous paper Truszkowski and Król[4] have proposed the coefficient T_c as a measure of the variance of the density of $\{111\}$ poles from the mean value, which in this case is equal to one, according to

$$T_c = \sum_{i=1}^{n} P_i(1-I_i)^2 \qquad (1)$$

where P_i is the fraction of the equal area $\{111\}$ pole figure with the pole density equal to I_i. For random orientation, $T_c = 0$.

Experiments carried out on cold rolling of several fcc metals with a random orientation have revealed the linear change of T_c with the degree of percentage cold deformation z. In the case of aluminium with a sharp cube texture as the starting material, a method has been elaborated to calculate the straight line function $T_c = f(z)$ for the case of random orientation in the annealed state. A counterpart of a close-to-random orientation at $z = 0$ is a very low value of T_c. The straight line relationship made possible the calculation of its slope m_t, which represents the sensitivity of the metal or alloy to the formation of preferred orientation during cold rolling. It was established that m_t has a constant value over a wide range of rolling reduction (from 0 up to above 90 per cent), therefore it constitutes an essential characteristic from the point of view of the ability of a fcc metal to form privileged orientation. Consequently, it can be expected that its dependence on stacking fault energy should reveal the rolling texture reversal. The respective m_t values for copper, nickel, aluminium,[4] silver[5] and 80–20 brass[6] are listed in Table I.

The function $m_t = f(\gamma/Gb)$ determined from the experimental data is shown in Figure 2. Here the γ values for pure metals were adopted from the recent critical survey of Gallagher[7] and for 80–20 brass from Alers and Liu.[8] A steep increase of m_t values is seen within the range up to about $\gamma/Gb = 5 \cdot 10^{-3}$ followed by its subsequent decrease. A more precise determination of abscissa corresponding to the maximum is, however, impossible because of difficulties in selecting the most credible values of SFE from the literature, and too small a number of experimental points over the considered range. This would demand investigations on metals or alloys for which γ/Gb would cover the range $5\text{–}10 \cdot 10^{-3}$.

The lack of evidence of the rolling texture reversal in many authors' earlier investigations should be ascribed to the fact that a quantitative criterion of privileged orientation in sheets was not taken into consideration.

TABLE I

m_t values of fcc metals examined

Metal or alloy	γ, ergs/cm^2	γ/Gb.10^3	m_t
Aluminium	200	29.0	0.80
Nickel	250	13.0	0.91
Copper	55	5.1	2.00
Silver	23	2.9	1.20
80–20 Brass	5	0.5	0.81

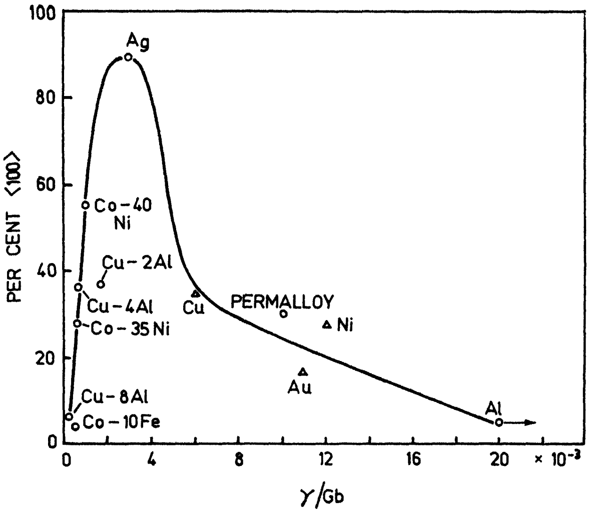

FIGURE 1 Wire textures of various fcc metals and alloys as a function of the parameter γ/Gb, according to English and Chin[1].

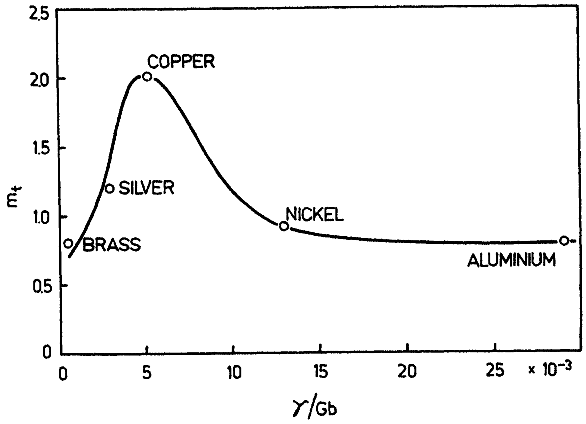

FIGURE 2 m_t vs γ/Gb plot for cold rolled fcc metals and alloys.

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