

about 15 to 30 initial grains. The actual initial orientation distribution of this limited number of grains would certainly have a great influence on the outcome of the experimental results. In fact, there are initial orientations in copper single crystals (such as  $\{110\}\langle 112\rangle$ ) which are retained in rolling to yield a brass type texture in the rolled copper product. Because of these considerations, we purposely limited our investigation to the penultimate grain size of 0.5 mm.

The "dislocation interaction" hypothesis is a crystallographic analysis of texture orientations based on octahedral slip as the principle deformation mode, supplemented by specific dislocation interactions introduced in order to give a more detailed understanding to the development of various particular orientations in the final texture. In the hypothesis, it a prerequisite that the active slip systems which participate in the formation of a  $\{358\}\langle 523\rangle$  texture orientation must share the same slip directions to produce a slip rotation. This condition is known to be prohibited in metals of low stacking fault energy. The imposed condition in dislocation interaction demands that two partial dislocations show a repulsion at long range but are attractive at short range in metals of low SFE. In order to fulfill both requirements, the  $\{358\}\langle 523\rangle$  type texture orientation is suggested to exist in metals with a separation

distance between the two partial dislocations of about five times the lattice parameter. Thus, although the short-range interaction is favored in low SFE metals, the prerequisite of slip rotation in the development of the  $\{358\}\langle 523\rangle$  orientations is not fulfilled and the mechanism for the development of  $\{110\}\langle 112\rangle$  orientations is therefore the only one available. On the other hand, in a relatively high SFE metals, both prerequisites can be satisfied and the copper texture is developed as stated in the text. In the text we have presented an abridged version of the hypothesis which might have caused some confusion in the understanding of our explanation.

1. Y. C. Liu and G. A. Alers: *Met. Trans.*, 1973, vol. 4, p. 1491.
2. H. J. Bunge and J. Tobisch: *Z. Metallk.*, 1968, vol. 59, p. 471.
3. G. Bouysset and P. Coulomb: *Mem. Sci. Rev. Met.*, 1968, vol. 65, p. 887.
4. G. Wassermann: *Z. Metallk.*, 1963, vol. 54, p. 61.
5. I. L. Dillamore and R. E. Smallman: *Metal Sci. J.*, 1972, vol. 6, p. 184.
6. T. Leffers and A. Grum-Jensen: *Trans. TMS-AIME*, 1968, vol. 242, p. 314.
7. T. Leffers: *Z. Metallk.*, 1969, vol. 60, p. 785.
8. T. Leffers: *Z. Metallk.*, 1970, vol. 61, p. 306.
9. T. Leffers and P. Kayworth: Proceedings of the Third European Symposium on Deformation and Recrystallization Textures of Metals and their Industrial Applications, 1973 (to be published).
10. Y. C. Liu: *Trans. TMS-AIME*, 1964, vol. 230, p. 656.
11. J. P. Hirth: *J. Appl. Phys.*, 1961, vol. 32, p. 700.

## About Optimization of the Elastic Deformation Range by Prestraining of a Unidirectional Composite Material (Discussion of Reference 1)\*

M. Kh. SHORSHOROV, L. M. USTINOV,  
AND Yu. G. KUZNETSOV

R. W. Heckel and others<sup>1</sup> analyzed the influence of prestraining of a fibrous composite material on residual stresses of matrix  $\sigma_m^R$  and fiber  $\sigma_f^R$ . They showed that the residual stresses which are stated in the matrix and the fibers after prestraining and the critical volume fraction  $V_f^c$  did not depend on primary residual stress in the matrix  $\sigma_m^{R0}$  and the fiber  $\sigma_f^{R0}$ .

However, the authors made a mistake in the scheme of a composite material with  $V_f > V_f^c$  (see Fig. 3(b) in paper 1). The residual deformation in a composite after relieving the stress  $\sigma_c$  must correspond to OC (Fig. 1). In article 1 it corresponds to OC', because the authors did not take into account beginning of a compression plastic deformation in a matrix. Therefore, the resid-

ual stress in a fiber after relieving the composite must be  $\sigma_f^R$ , but not  $\sigma_f^{R1}$  (Fig. 1).

This mistake does not affect the analysis of the results in paper 1. However, it may lead to wrong conclusions while analysis of the second and following loading-unloading cycles (for example, low-cycle fatigue). According to the scheme of paper 1, plastic deformation of matrix during the second loading begins in composite at the stress (point  $n'$ ) which is smaller than the first unloading stress of the composite (point  $a$ ). In reality, a matrix plastic deformation during the second loading must begin at composite stress which is equal to the first unloading stress of the composite.

The second note. The authors neglected primary residual stresses  $\sigma_m^{R0}$  and  $\sigma_f^{R0}$  during calculation of the optimal prestraining value  $e_s$  (Eq. [5] and [8] in work 1) of a fiber composite aluminum alloy 2024/tungsten wire. Yet, these stresses calculated by the special method<sup>2</sup> have rather significant values. Dependence of the calculated values  $\sigma_m^{R0}$  on  $V_f$  is shown in Fig. 2. Therefore, we believe that authors of work 1 did a mistake when they neglected the primary residual stresses  $\sigma_m^{R0}$  and  $\sigma_f^{R0}$  during calculation of  $e_s$ . One can receive more exact correlation between calculated and experimental values of composite yield point after prestraining if  $\sigma_m^{R0}$  and  $\sigma_f^{R0}$  are taken into account.

\*R. W. HECKEL, R. J. ZAEHRING, and H. P. CHESKIS: *Met. Trans.* 1972, vol. 3, pp. 2507-13.

M. Kh. SHORSHOROV is Prof., Dr. Techn. Sc., A. A. Baikov Institute of Metallurgy, USSR Academy of Sciences, Leninskij prospekt, 49, USSR. L. M. USTINOV and Yu. G. KUZNETSOV, Junior Fellow of Science, are associated with A. A. Baikov Institute of Metallurgy, USSR Academy of Sciences, Prospekt Lenina, 49, USSR.

Discussion submitted April 18, 1974.

1. R. W. Heckel, R. J. Zaehring, and H. P. Cheskis: *Met. Trans.*, 1972, vol. 3, p. 2507.

2. M. Kh. Shorshorov, L. M. Ustinov, Yu. G. Kuznetsov, V. I. Jamnova, and L. V. Vinogradov: *Physics and Chemistry of Materials Treatment*, 1974, in print.