DISCUSSION

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In connection with the work of Gray and Szkopiak, *Dr. Foct* pointed out that Mössbauer experiments have shown that carbon atoms in martensite have a tendency to form agglomerates, while nitrogen atoms, because of the electronic structure of nitrogen, have a tendency to order. These observations agree with the fact that the carbon Snoek peak decreases when the sample is maintained near the peak temperature, while the nitrogen maximum remains constant. In answer, Prof. Szkopiak remarked that the tendency for interstitial atoms to cluster is greatest for carbon, less for nitrogen and least for oxygen ; this is also the order in which solid solubility decreases. This tendency is due not only to the size factor but there are also chemical and electronic reasons, as suggested by Dr. Foct.

Dr. Grandchamp enumerated some striking differences found in the annealing spectrum of the modulus defect and the internal friction of gold after low temperature irradiation or cold work, which depend on the mode of cold-work and deformation or excitation during measurements (see figure). *Dr. J. Lomer*, while recalling that their own measurements in gold agreed with Sosin's data, said she thought that one should not expect any difference between results obtained by transverse and longitudinal vibrations, unless in some way a different dislocation network is involved. Alternatively, since the pinning below 240 °K is thought to arise from the release of impurities from traps, a difference in the impurity content could increase the pinning and thus mask the depinning.

In relation to the model presented by Dr. Feltham, *Prof. Lücke* asked whether Dr. Feltham was not essentially translating the string model into a kink model, in which case it would be expected that the basic properties of the former model would be recovered, a decrement obtained which depended linearly on frequency. *Dr. Feltham* said that since in concentrated alloys the solute atoms present a discrete thermal barrier to dislocation displacement, it would seem more appropriate to use the Einstein equation to describe kink diffusion, rather than the Koehler-Granato-Lücke friction term, which is generally thought of, basically, as a « phonon » effect. The relation between the two ways of interpretation has not yet been studied. *Dr. Seeger* said he thought that Dr. Feltham's approach was basically correct : with the kink model it is easier to visualize the jerky motion of the dislocations that give some kind of additional strain ; the string model would probably give the same result if the fact that the dislocation line does not move uniformly because of inhomogeneities or the presence of foreign atoms were incorporated in the equations. Since it is known that kinks in alpha brass and copper are fairly wide, Dr. Seeger said he wondered whether the kinks in moving would not see some average interaction with solute atoms, and he asked whether the model would not be better applicable to dilute rather than to concentrated alloys. *Dr. Feltham* agreed with Dr. Seeger that the kink model gives a hysteretic contribution to the internal friction, leading to a nearly frequency independent decrement, and added that, in its present simple form, the model does not account explicitly for stress inhomogeneities in the crystal.

Prof. Lücke then sent us the following remark concerning the paper of Dr. P. Feltham :

Dr. Feltham points out that in metals an internal friction background is observed which in the range of 1 Hz to 10^5 Hz is to a certain extent independent of frequency. This background cannot be explained as dislocation damping, according to the vibrating string model, since this model predicts for this frequency range a logarithmic decrement proportional to the frequency. Therefore, Dr. Feltham tries to explain these frequency independent losses on the basis of the kink model and his final equation which is independent of frequency seems to justify this approach.

Prof. Lücke, however, believes that this equation, and therefore the whole approach, is incorrect. Dr. Feltham simply translates the string motion into a kink motion as originally carried out by Seeger and Schiller. Here, the stress-aided diffusion of kinks considered by Dr. Feltham corresponds exactly to the occurrence of the frictional term Bdx/dt in the string theory. As has been repeatedly shown, such a transformation does not change the general frequency dependance, i. e. here also a decrement proportional to the frequency should be expected in the low frequency range.

The reason for the discrepancy between this prediction and Dr. Feltham's calculation seems to lie in the following. In equation (6) Dr. Feltham assumes correctly that the loss follows a relaxation law

$$\Delta = \Omega \Delta_0 \frac{\omega/\omega_0}{1 + (\omega/\omega_0)^2}$$

however, he then assumes that the relaxation strength Δ_0 is inversely proportional to the frequency. He reaches this conclusion by considering the strain due to the dislocations after a stress has been applied for half a cycle. Prof. Lücke believes that this is incorrect. The relaxation strength is proportional to the dislocation strain obtained after an infinite loading time or, in other words, it is given by the equilibrium value of the kink arrangement and not by the arrangement which is reached after half the vibration time. The term $\frac{\omega/\omega_0}{1+(\omega/\omega_0)^2}$ already gives a dislocation amplitude which decreases with increasing frequency.

Finally Prof. Lücke would like to draw attention to the fact that the background damping observed is not necessarily caused by dislocations. This is shown, for example, by irradiation experiments in the kHz-range.

Dr. Feltham sent us the following reply to Prof. Lücke's comments :

Reference to my figure 1 shows that the displacement of the dislocation responsible for the modulus defect occurs without an increase in the length of the arc AB, a feature in which the model differs fundamentally from the « string ». The string analogy is therefore not adequate and, as shown, cannot explain the observations.

Within the limits of the approximations made, the anelastic strain attainable by kink diffusion, is partly hysteretic ; it is precisely in this that it differs from the classical string model. Concepts appertaining to the latter cannot therefore be translated schematically

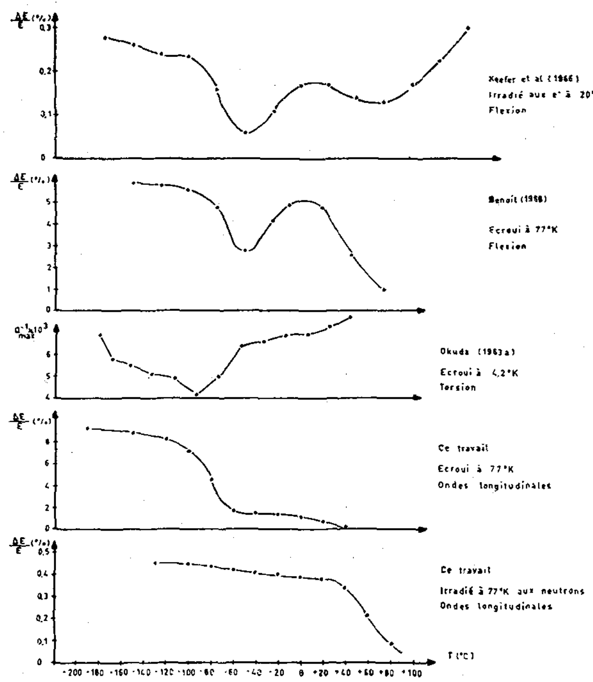

FIG. 1.

to the present case. The modulus defect, which would be measured, is due to the maximum displacement of the dislocations attainable by kink diffusion during a half-cycle. In deriving this, no reference has in fact yet been made to the « quasi » string behaviour of the system. This has been allowed for only subsequently in an admittedly approximate manner, by multiplying the modulus defect by the Debye term in equation (6).