On the Mechanical Relaxation of the $\langle100\rangle$-Split Interstitial in Cold-Worked Copper ($^*$).

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Summary. — A damping peak in cold-worked copper near 250 K which had been considered as a proof for the mechanical relaxation of the $\langle100\rangle$-split interstitial could not be reproduced by all authors. To clarify this discrepancy additional damping and modulus measurements have been performed in the 1 Hz range. In these measurements high-purity copper samples of different suppliers have been used and the heating rate has been varied. The results are discussed with regard to the interpretation of this damping peak by split interstitial relaxation.

As a proof for the existence of the $\langle100\rangle$-split interstitial in stage III of cold-worked copper sometimes a damping peak has been considered ($^*$). This peak, called $P_\alpha$ here, appears at about 250 K for 1 Hz and has been explained by the induced Snoek effect of the split interstitial. There existed, however, the difficulty that some authors were not able to reproduce $P_\alpha$ as should be possible if it is really an intrinsic peak ($^*$).


To clarify this discrepancy additional damping and modulus measurements have been performed with the Aachen pendulum (7). Temperature has been increased linearly at 2 Hz and a strain amplitude of 2·10^{-5}. Two aspects of these measurements are new and had not been considered before: 1) the heating rate has been varied as an additional parameter and ii) 99.999% copper samples of three different suppliers have been used, including the original Stuttgart material, kindly provided by WAGNER.

Furthermore the following improvements with respect to other measurements and interpretations have been applied and will be demonstrated in fig. 1a), where decrement and modulus are plotted as function of temperature during heating after low-temperature deformation: i) accuracy and density of measuring points have been strongly increased in order to obtain clearer results of the peak structure and ii) the modulus curve has been differentiated (which was possible only due to the very great accuracy) and is plotted as \(- (1/G) dG/dT\) in fig. 1b). In this way relaxation effects in the modulus show up also as peaks and thus allow a simpler comparison with damping, whereas the maxima of pinning rates would lead to minima in this curve.

Figure 1 shows typical results after 5% tensile deformation at 78 K and one recognizes that indeed the relaxation peaks of modulus and damping are lying at the same temperature. Furthermore the modulus curve clearly exhibits different pinning stages (IIa, IIb, IIIa and IIIb). These pinning stages cannot be obtained as easily from damping measurements. Therefore it appears necessary for further interpretation to always consider damping and modulus measurements simultaneously.

Figure 2 gives the results obtained after the same pre-treatment and deformation of 5% at 78 K but for three materials: ASARCO, Johnson and Matthey and Elmore copper, denoted by A, M and E. The single measuring points have been omitted for clarity’s sake. The comparison of the damping curves in fig. 2a) shows that \(P_2\) and \(P_3\) are reproduced very well, whereas above \(P_3\) different structures of the curves are found. The peak \(P_5\), however, the position of which for 2 Hz being indicated by an arrow at 254 K, is missing in all samples, even in the M material, in which it had been observed in the Stuttgart measurements. The corresponding differentiated modulus curves in Fig. 2b) show that the pinning stages IIa and IIb appear very similar for the three materials, but that for stage III (above 250 K) the behaviour is very different. The experience in this range makes it probable that these differences are mainly caused by differences in the impurity levels which might have been in the materials from the beginning or might have been obtained by different heat treatments, e.g. by using different gaseous atmospheres. This is indicated also by different
