

mechanical vibration to the feedback by coupling amplifier.

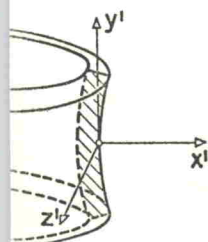
Slightly modulated reflectance, was quartz window (E) of the multiplier with setting of the monitor as achieved by using the photomultiplier anode current of $\Delta R/R$, the relative component was measured by means of a phase-locked on an x-y recorder checked with a photometer found to be correct.

Experiment

The sample will be the formed by joining the with rectangular cross is true if the influence. The cross section of the rectangular. There are tensor σ and the strain the surface of the ring radius ρ_1 and the thickness and the width b is small and the strain tensor takes

$$\begin{pmatrix} e_{xx}' \\ e_{yy}' \\ e_{zz}' \end{pmatrix}. \quad (1)$$

In our measurements the validity of Eqs. (1) measuring ρ_1 and ρ_2 of thicknesses and widths of the surface is given $2\rho_2$. On the other hand calculated using the stress tensor. Using



ing the ends of a previous section. The stress axis is z' .

The stress tensor given by (1), we found the agreement between the measured and calculated ratio to be better than 3%, provided the condition $|e_{zz}'| \leq 4d^2/b^2$ was fulfilled. In the optical measurements on Cu crystals, typical numbers were $|e_{zz}'| = 4 \times 10^{-4}$, $4d^2/b^2 = 0.4$. Thus the above condition was always met.

In the actual measurements, the crystal forms a small segment of the ring shown in Fig. 2; the distortions produced by the clamps cannot always be neglected. Measurements of ρ_1 and ρ_2 of large aluminum bars clamped at the ends in a way similar to that shown in Fig. 1 were carried out. The difference between the calculated and the measured $|e_{zz}'/e_{yy}'|$ at the midpoint of the sample was again below 3%, provided the free length of the sample (Fig. 1) was at least twice its width. Typical values for the Cu crystals used in the optical experiments are $l = 10$ mm, $b = 3$ mm, i.e., this condition was also fulfilled.

Figure 3 shows the arrangement to determine the component e_{zz}' of the strain tensor by measurement of the focal length of the cylindrical mirror, formed by the bent sample. The sample was oscillating, and the frequency of the stroboscope was tuned close to the resonance frequency of the sample. The distance between the sample and the image of the slit changed periodically with the difference frequency $\omega(\text{stroboscope}) - \omega(\text{sample})$. The amplitude of the strain at the surface is given by

$$e_{zz}' = \Delta a d (2a_0)^{-2} \{1 + [1 + (\Delta a/a_0)^2]^{1/2}\}^{-1}, \quad (2)$$

where a_0 is the position of the image for zero strain and Δa is the difference in the position for maximum extension and compression. The accuracy of this method increases with decreasing distance between lens and sample. It was about $\pm 5\%$ for the geometry used here. The components e_{xx}' , e_{yy}' of the strain tensor are expressed in terms of the measured component e_{zz}' by means of the stress-strain relation using the form (1) of the stress tensor. The elastic constants are taken from Ref. 20. Because of the sample dimensions chosen, the errors in e_{xx}' and e_{yy}' due to deviations from (1) are smaller than 3%. During the optical mea-

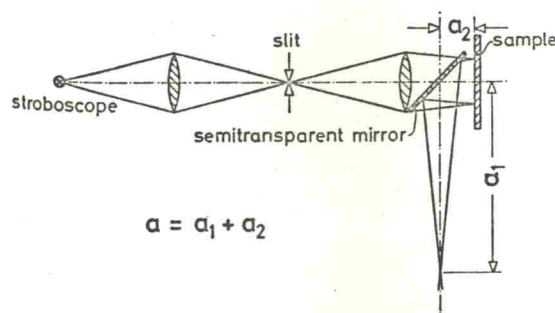


FIG. 3. The optical design which was used to determine the focal length of the cylindrical mirror formed by the bent sample.

²⁰ American Institute of Physics Handbook (McGraw-Hill Book Co., New York, 1957), Chap. 2, p. 56.

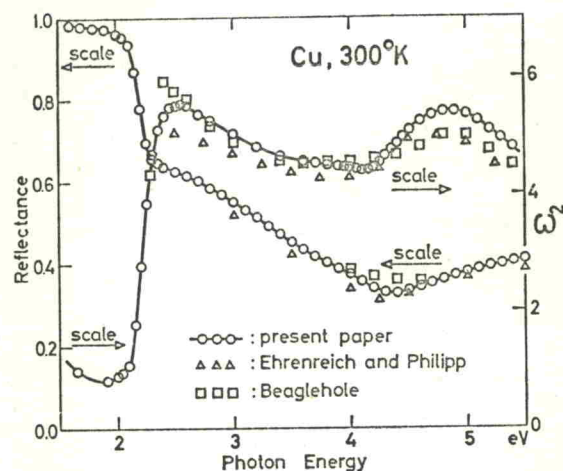


FIG. 4. The reflectance and ϵ_2 , the imaginary part of the dielectric constant of Cu at room temperature. The values determined by Ehrenreich and Philipp (see Ref. 18) and by Beaglehole (see Ref. 22) are only shown if they differ by more than 2% from the values given in the present paper.

surement, the strain amplitude and phase was monitored by a pickup capacitor, consisting of one of the magnets at the ends of the lever arms (Fig. 1), moving against a fixed, insulated piece of sheet metal.

Sample Preparation

The orientation of the samples cut from a single crystal was determined to within $\pm 1^\circ$ using Laue diagrams. The surface preparation consisted of grinding, mechanically polishing, and electropolishing²¹ the sample. The electropolishing was terminated by quickly rinsing in deionized water and alcohol. After taking the sample from the alcohol bath, the thin film of alcohol at the surface was immediately removed by a warm stream of air. The reflectance of a freshly prepared sample, measured within 10 min after the electropolishing, is given in Fig. 4. The growth of an oxide layer at the surface of the sample is responsible for the observed decrease in the reflectance with time. This decrease is most pronounced in the ultraviolet. We observed a 1% decrease at 5.5 eV within 1 h after the electropolishing.

Although the reflectance of our samples was measured in air, it deviates less than 1% from the values determined by Beaglehole,²² which were measured in a high vacuum after reducing the oxide layer at the surface. The only exception is the region around 4.3 eV. The resolution of the vacuum monochromator used by Beaglehole was not high enough to resolve finer details of the minimum at that energy²³ (see Fig. 4). Thus the oxide layer on our sample modifies the reflectance not more than 1% between 1.5 and 5.5 eV. The reflectance given by Ehrenreich and Philipp¹⁸ is slightly lower

²¹ W. J. Tegart, *The Electrolytic and Chemical Polishing of Metals* (Pergamon Press, Inc., New York, 1959), 2nd ed.

²² D. Beaglehole, Proc. Phys. Soc. (London) 85, 1007 (1965).

²³ D. Beaglehole (private communication).