$$\lambda_2\; 2\sin\theta_2=(\lambda_2/2)(1+\cot^2\theta)^{\frac{1}{2}}$$
$$=(\lambda_2/2)\{1+[(K-\cos\mu)/\sin\mu]^2\}^{\frac{1}{2}}$$
$$=((\lambda_2^2/4)\{1+[(K/\sin\mu)-\cot\mu]^2\})^{\frac{1}{2}}. \quad \text{(B11)}$$

...ing the trigonometric identity mentioned above and ...ting $\cot\mu=s$, the factor in brackets in the last ...mber of (B11) can be written

$$1+[(K/\sin\mu)-\cot\mu]^2=(1+K^2)(1+s^2)-2Ks(1+s^2)^{\frac{1}{2}}.$$

Using this expression in (B11) we obtain finally,

$$d=[K'(1+s^2)-K''s(1+s^2)^{\frac{1}{2}}]^{\frac{1}{2}}$$

with

$$K'=(\lambda_1^2+\lambda_2^2)/4,\quad K''=\lambda_1\lambda_2/2,$$

and

$$s=\cot\mu=(c^2+\Delta_1\Delta_2)/c(\Delta_1-\Delta_2)$$

by Eq. (B8).

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Stress-Strain Analysis of Single Cubic Crystals and Its Application to the Ordering of CuAu I. Paper II

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A stress-strain analysis of single cubic crystals is developed which utilizes the strain data supplied by the x-ray back-reflection divergent beam method. The principal strains and their directions are determined and from the principal strains and the known elastic constants the complete stress-strain configuration is obtained. Thus the maximum magnitude and the direction of the shearing strain on a given set of crystallographic planes are obtained and the set of planes on which the maximum value of the shearing maxima occurs is also determined. From a knowledge of the stress-strain configuration, the stored elastic energy of the crystal is deduced; it can be partitioned into two components, that due to shearing strains and that due to a mixture of normal and shearing strains.

The conditions under which the principal stress system coincides with the principal strain system are also investigated. Furthermore, a number is constructed that measures the distortion of the crystal in terms of the energy increments associated with the elastic constants.

The stress-strain analysis applied to the ordering of a CuAu crystal at 125°C corroborates quantitatively the qualitative results previously obtained by transmission electron microscopy. The dependence of stored elastic energy on annealing time is determined and it is shown that the first maximum and decline are associated with the maximum and decline of coherency strains set up between the ordered CuAu I nuclei and the disordered matrix. Upon increasing the annealing time, twinning occurs to relieve the tetragonality strains introduced by the ordered CuAu I domains. The second maximum is compounded by twinning on certain (110) planes and delayed ordering on other (110) planes of the matrix. The subsequent decline of the stored elastic energy is associated with twinning on all (110) planes. The shearing stress necessary to initiate microtwinning does not exceed 7×10^8 dyn/cm^2.

1. INTRODUCTION

STUDYING by means of transmission electron microscopy the ordering of CuAu I, Hirabayashi ...d Weissmann[1] have shown that at low-temperature ...ealing plate-like nuclei are formed which are ...rent with the disordered matrix and parallel to the ...01) planes. Upon prolonged annealing at low tempera...re or short annealing at elevated temperature, the ...umulated coherency strains introduced by the tetrag...ality of the ordered CuAu I structure become ...ved through twinning and the twin planes are also ...llel to the (101) planes of the cubic matrix. It was ...possible, however, to obtain by electron microscope ...niques quantitative information as to what the ...ribution and magnitude of the strains were that led ...the observed twinning during ordering. Yet such information is highly desirable if a detailed picture of the mechanism of ordering is to emerge.

The x-ray studies presented in this paper were undertaken to supplement the qualitative results of the electron microscope investigation by quantitative data. The interpretation of the quantitative results required an extension of the strain analysis[2] recently developed, which uses the strain data supplied by the x-ray back-reflection divergent beam method. Thus a complete stress-strain analysis was developed which describes the stress-strain configuration for the early ordering stages of CuAu I. It also enables one to study the changes in stored elastic energy and anisotropy of strain distribution as a function of ordering anneal. Since the developed stress-strain analysis of cubic crystals appears to have a more universal application than shown in the specific study of the ordering of

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