WIAP® MEMV®

Metall entspannen mit Vibration

REPORT WM MEASURE VOLTAGES 886

SIN2Y method

1 MEASUREMENT OF RESIDUAL STRESSES (SIN2Y METHOD)

For the experimental determination of residual stresses are a wide variety of destructive and nondestructive measurement methods. The most important non-destructive method represent the X-ray measurement method. This group also includes the presented under the experiment sin2y process.

Stresses first type lead to elastic distortion of the unit cell. the interplanar spacing varies due to a force acting on grid power from D0 to D, then this leads to a change in the position of the interference line, as Figure 3 illustrates.

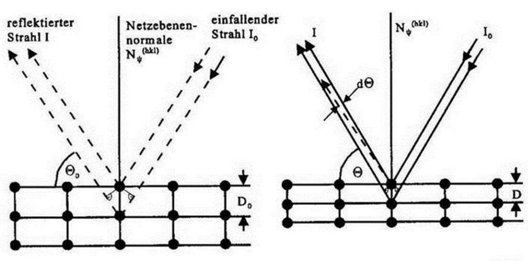

Figure 3: Bragg reflection at a stress-free (left) and a strained lattice (right)

Since the penetration depth of X-rays is low (approximately 10-20 microns, depending on material and radiation used) are recognized only near-surface regions of the sample. A possibly vorhande z component of the stress is on the surface of the absence of restraint is always zero. That is, to measure under the condition that the detected sample volume no z-voltage component is present, a two-axis (plane) state of stress in the sample surface.

Figure 4 illustrates the recording technique in the X-ray voltage measurement. While in the diffractometer recording in a conventional beam geometry only lattice planes for reflection come, which are parallel to the sample surface, is achieved by tilting of the specimen by the angle y that, in the voltage measurement including those power levels reflect that are not oriented parallel to the surface.

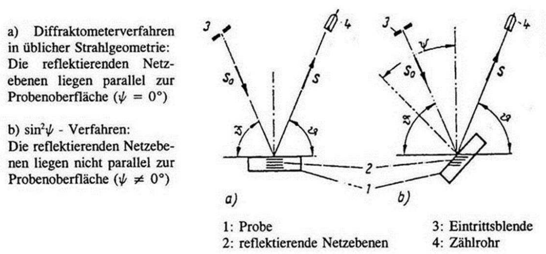

Figure 4: recording technique in the X-ray voltage measurement

In the investigation of polycrystalline materials multiple crystallites are detected by the primary beam. If one measures a sample in different directions y, we obtain the intensity of lattice planes of different orientation which have different interplanar spacings D upon application of a voltage. The result is an interference cone, as shown in Fig. 5

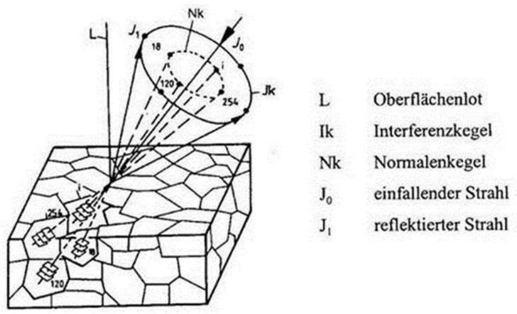

Figure 5: formation of the interference cone in many crystalline materials

For determining the tension in the solid state, the combination of the measured lattice stretching with elasticity theoretical point is necessary.

the coordinate system shown in Figure 6 with the angles j specifies one and y based on the relationship between the measured strain e j, y, and the surface-parallel main voltages S1 and S2 and the main strains e1, e2 and e3 is:

$$\varepsilon_{\varphi,\psi} = \varepsilon_1 \cos^2\varphi \sin^2\psi + \varepsilon_2 \sin^2\varphi \sin^2\psi + \varepsilon_3 \cos^2\psi$$

Linking the main strains of the principal stresses is given by Hooke's law:

$$\varepsilon_1 = \frac{1}{E}(\sigma_1 - \sigma_2)$$

$$\varepsilon_2 = \frac{1}{E}(\sigma_2 - \nu\sigma_1) \qquad \varepsilon_3 = -\frac{\nu}{E}(\sigma_1 + \sigma_2)$$

Thus, Equation 1 can be written as

$$\varepsilon_{\varphi,\psi} = \frac{\nu+1}{E}(\sigma_1 \cos^2\varphi + \sigma_2 \sin^2\varphi)\sin^2\psi - \frac{\nu}{E}(\sigma_1 + \sigma_2)$$

The introduction of Voigt's elastic constants

$$\frac{1}{2}S_2 = \frac{\nu+1}{E} \qquad S_1 = -\frac{\nu}{E}$$

Yields the fundamental equation of the X-ray method for determining elastic stresses in its most common presentation:

$$\varepsilon_{\varphi,\psi} = \frac{1}{2}S_2 \cdot \sigma_\varphi \sin^2\psi + S_1(\sigma_1 + \sigma_2)$$

With $\sigma_\varphi = \sigma_1 \cdot \cos^2\varphi + \sigma_2 \sin^2\varphi$,

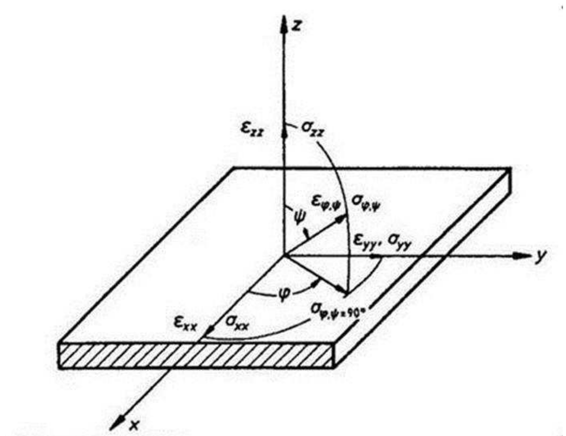

Figure 6: Definition of the coordinate system with the angles j and y

The determination of the plane stress is thus reduced to the determination of the lattice strain ej, y, which can be measured by the change in the interference line positions. Equation 5 can be regarded as a linear equation. Plotting const the elastic elongations for j =., As a function of sin2y on, the result is a straight line whose slope is proportional to the azimuth j effective voltage component sj and the ordinate is determined by the sum of the principal stresses in the surface (Figure 7) , For the separation of the principal stresses in the surface, it is necessary to measure in at least three different j-directions.

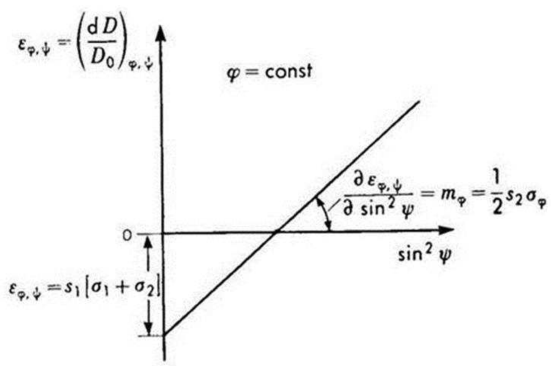

Figure 7: strain distribution in the azimuth plane j = const a flat, surface-parallel-voltage condition.

2 TASK

the voltage components parallel and perpendicular to measure X-ray to the feed direction of the laser to a laser beam cured sample. The evaluation is performed using the sin2y plot.

3 REFERENCES

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