B11-12 State of Strain Around the Tip of a Fatigue Crack

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An account is given of an experiment on the state of strain around a fatigue crack by means of the electroplating method(1). A β'-brass specimen having coarse grains, on which the copper electrodeposited film (about 10μ thickness) was affixed, was subjected to reverse plane bending with zero mean stress. Following on cyclic stressing, a fatigue crack was produced on the specimen and the strain pattern appeared around the crack as is seen in Fig. 1. The pattern obtained by this method is similar to that obtained by the photo-elastic coating because the most significant factor for the formation of the pattern is the maximum shear strain.

The pattern on the copper film, however, indicates the accumulated effects of the repeated strain, since a considerable number of stress cycles are necessary for the formation of the pattern. This requisite condition for the formation of the pattern, however, may give some informations on the propagation of the crack. When a crack propagates rapidly, no pattern is formed around the crack, while when a crack does not propagate or slowly propagates, there appears the pattern around the crack.

The state of strain in a number of regions on the specimen was examined by the pole figures which were constructed by x-ray transmission photographs of the copper film(2),(3). Results obtained will show that the strain state at the tip of the fatigue crack varies from region to region. Almost all (111) pole figures obtained in the other regions than the region of the crack are the same as shown in Fig.2. The vertical direction of the figure is taken parallel to the specimen axis. This pole figure indicates that such regions are subjected to push-pull strain. Fig.3 and 4 show the pole figures obtained in the regions A and B in Fig.1 respectively. Judging by these pole figures, it may be considered that the state of strain in the regions A and B seems to be a shear strain type and a combined strain type respectively.

References

(1). Okubo, H., J.Appl.Phys., Vol.24(1953),1130, Inostranja Literatura, Vol.4 (1960),119.

(2). Suzuki, M., J.Inst.Metals, Vol.92(1963-64),141.

(3). Suzuki, M. and Takahashi, H., unpublished work.

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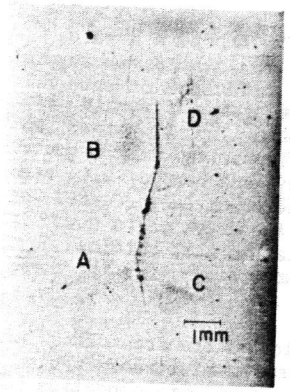

Fig.1. Strain Pattern Around the Tip of a Crack.

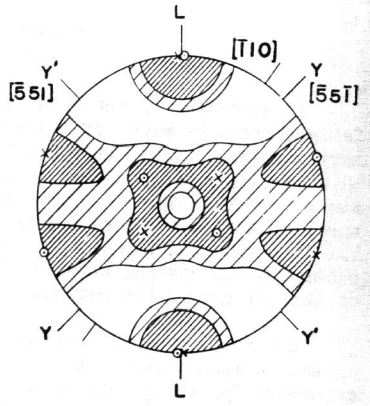

Fig.2. (111) pole figure showing the state of push-pull strain. L-L; Specimen axis, X-X; Direction parallel to the principal strain and Y-Y, Y'-Y'; Directions parallel to the maximum shear strain in this figure and following figures.

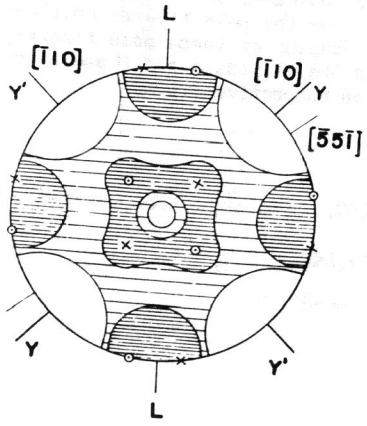

Fig.3. (111) pole figure in the region A in Fig.1.

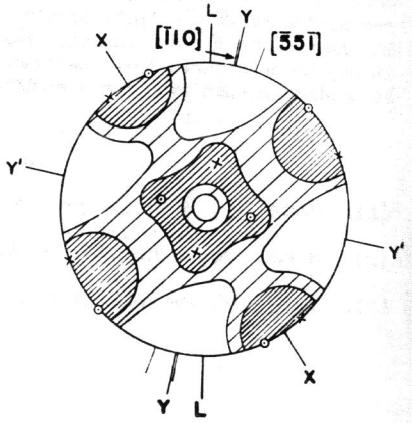

Fig.4. (111) pole figure in the region A in Fig.1.