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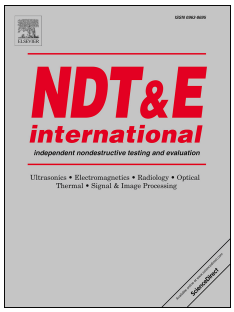

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Proposal for a direct-method for stress measurement using an X-ray area detector

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Abstract

The $\cos\alpha$ method and the 2D method are well known as X-ray stress measurements using an area detector. Although the X-ray exposure of the $\cos\alpha$ method occurs once, the accuracy of the center of the detector is required due to usage of the oblique incident X-ray beam. In the 2D method, the X-ray beams have to be applied from multiple orientations, and multiple measurements are required.

In this study, I propose a new method for X-ray stress measurement using an area detector. Its method is called the direct-method". The diffraction angles are measured with the area detector and the normal incident X-ray beam, and then the stresses are optimized by a simplex method. To examine effectiveness of the direct-method, I measured the residual stresses caused by water-jet peening. The stresses obtained were close to those obtained by the other method. It is discussed that precision of a detector center is important in usage of the area detector. In the case of the normal incident X-ray beam, the shape of the diffraction ring is an ellipse and has point symmetry at the origin. Using this property, the center of the area detector can be corrected. Further, the direct-method was applied to measuring the residual stresses coming from the grinding process. After correcting the center of the diffraction ring, the stresses which were optimized by the simplex method corresponded to those measured by the $\sin^2\psi$ method. In addition, the direct-method was extended to a $\cos\alpha$ method.

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