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Focused Acoustic Waves for High-Resolution Residual Stress Evaluation

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Abstract

Traditional methods of acoustic wave propagation in materials provide residual stress measurements over a large area, limiting the spatial resolution to several millimeters. Focused acoustic waves allow measurement of elastic properties of materials with high spatial resolution. In this paper we present two approaches of using focused acoustic waves to evaluate the residual stress in localized regions. In the first method a commercial acoustic lens is utilized to generate and receive surface skimming longitudinal waves SSLW). A simple method is adopted to determine the changes in the velocity of SSLW velocity due to stress. The technique is applied to map the residual stress variation around a crack tip. The variation of SSLW velocity around a crack tip is compared with x-ray diffraction residual stress variation of the same region. In the second approach design and application of three-element-focused acoustic transducer for high precision measurement of Rayleigh surface acoustic wave (RSW) velocity is presented. Results of measurement of RSW velocity across an electron beam weld performed using three-element- transducer is presented along with x-ray diffraction residual stress measurements. The resolution and penetration depth of the focused acoustic waves and the x-ray diffraction technique for residual stress are discussed.