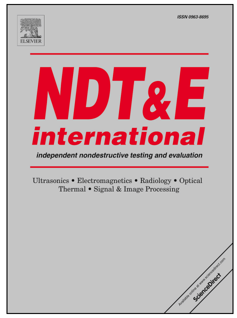

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Design and Fabrication of Direct-write Piezoelectric Ultrasonic Transducers for Determining Yielding of Aluminum Alloy

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Abstract

Direct-write piezoelectric transducers are dedicatedly designed and fabricated to generate and detect both fundamental and second harmonic Rayleigh ultrasonic waves for evaluating overload-induced plastic deformation in aluminum (Al) alloy. The Rayleigh ultrasonic signals, generated by concentric focused direct-write transducers and propagating along the Al-alloy specimens, are measured either with other direct-write transducers or laser scanning vibrometer (LSV) to obtain the fundamental and second harmonic ultrasonic signals for analyzing the acoustic nonlinearity. The results show that the acoustic nonlinearity increases over 50% when the plastic strain reaches 7.8%. In comparison with LSV, the direct-write piezoelectric transducers exhibit substantially improved consistency and repeatability in the acoustic nonlinearity measurements. Scanning electron microscopy (SEM) and X-ray diffraction (XRD) are conducted to correlate micro-structural changes with the acoustic nonlinearity in the Al alloy. The results and analyses indicate that the direct-write piezoelectric transducers with the appropriate design have significant technical advantages for acoustic nonlinearity testing and yielding determination.