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MEASUREMENTS OF RESIDUAL STRESS FIELDS IN FRACTURE COUPONS AND RELATION TO OBSERVED FRACTURE PROPERTIES

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This paper describes tests carried out to measure residual stress fields in fracture test coupons and to relate those residual stress fields to observed fracture properties. A set of nominally identical fracture toughness test coupons were prepared from a single rolled plate of 7075 T6 aluminum alloy. Following fabrication, residual stresses were induced in coupon subsets using laser shock peening. Each coupon subset had a unique laser peening treatment design, such that following fatigue pre-cracking, the stress intensity factor due to residual stress varied from positive to neutral to negative over the coupon subsets created. The contour method was used to measure residual stress on the crack plane, and provided a two-dimensional map of the laser shock induced residual stress field. Slitting was used to measure through-thickness average residual stress on the crack plane as well as the residual stress intensity factor as a function of crack length. Application of the contour and slitting methods to identically prepared samples allowed for a useful comparison of the residual stress fields provided by the two methods. Measured residual stress fields enabled a forecast of expected coupon behavior under monotonic loading (which would produce a crack-growth resistance curve) and under constant amplitude cyclic loading (which would produce crack growth rate data). Subsequent fracture toughness and fatigue crack growth tests provided data that are in good agreement with the expected coupon behaviors.