

Residual Stress Analysis of Vareststraint-tested B206 Aluminum Alloy Samples

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The Vareststraint test is the most commonly used method to evaluate the hot cracking susceptibility of alloys during welding. Evaluation of hot cracking susceptibility is critical in the quest to eliminate such defects. In this study, residual stress analysis was carried out on Vareststraint-tested B206 aluminum alloy samples with varying degrees of hot cracking severity. The degree of hot cracking severity was systematically manipulated by grain refinement via titanium additions. In all, two samples were analyzed using neutron diffraction: a 0.02 wt% Ti sample and a 0.05 wt% Ti sample, which corresponded to a 'cracked' sample and a 'crack-free' sample.

Representative profiles of residual stress for each sample are shown in Figures 1 and 2, respectively. For each plot, the residual stress along the base metal, HAZ and fusion zone are presented. The location of the weld bead (i.e. the location during the Vareststraint test where the arc is stopped and a load is applied) is shaded in the graphs for each condition.

In the case of the 0.02 wt% Ti sample ('cracked' sample), the hot cracks triggered significant stress relief at the weld bead region, which in turn lowered the overall magnitude of stress in the sample. Areas of complete stress-relief are evident in Figure 1 along the fusion zone and HAZ. In contrast, the profile for the 0.05 wt% Ti sample ('crack-free' sample) in Figure 2 did not reveal any areas of stress relief. Instead, a high tensile stress was observed along both the fusion zone and HAZ of the weld bead, followed by a region of compressive stress. This trend was likely attributed to the differences in solid fraction between the molten weld pool (i.e. beneath the arc) and the trailing semi-solid material. Such differences in solid fraction likely resulted in the contraction of these regions to occur in opposite directions, which in turn generated opposing stress states. Further, since the sample did not crack, the stress remained 'locked-in' and no relief is observed in the profile.

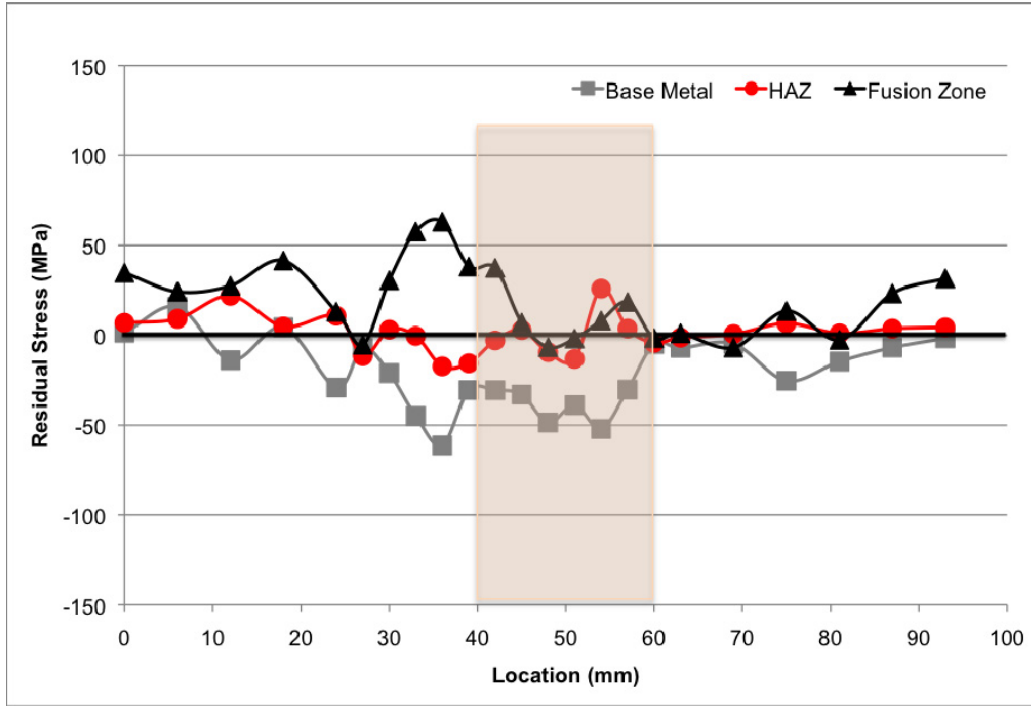


Figure 1. Residual stress profile along cracked sample.

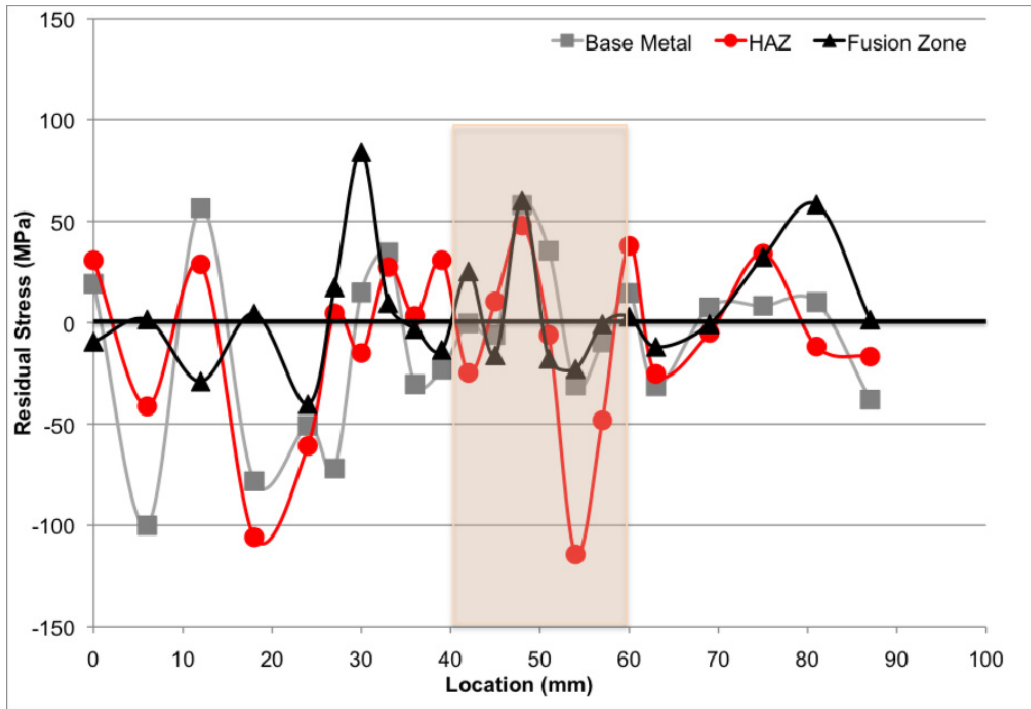


Figure 2. Residual stress profile along crack-free sample.