Neutron diffraction residual stress measurements in aluminum/steel welds produced by Friction Melt Bonding

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Abstract

Residual stresses were measured using neutron diffraction (ND) measurements in Al/steel lap welded joints fabricated by Friction Melt Bonding (FMB). During FMB, rotating flat faced cylindrical tungsten carbide tool generates sufficient heat by friction to melt the aluminum locally under the tool region and subsequently creates the bond with the steel plate [1]. The ND data has been post processed using LAMP software [2] and corrected when crossing an interface using the method prescribed by Bruno *et al.* [3]. This pseudo correction enables to eliminate the artificial peak shifts (pseudo strain) caused by the partial immersion of the gauge volume in the measured material near an interface. An interface tracking is performed using both ND measurements and microstructure observations in the transverse cross-section of the sample to accurately track the Al/steel interface positions. The obtained interface positions are combined with the pseudo stress correction for the near interface measurements. The resultant of all three components of residual stresses is almost zero along the mid thickness of the steel plate validating the estimated stresses. On the Al/steel interface, stresses in the steel reveal an "M" shape distribution while, in the aluminum, stresses show a "W" shape. Residual stresses in the steel at the vicinity of the interface originate from the thermal contraction, phase transformation and the mismatch in coefficients of thermal expansion (CTE). At the vicinity of the interface, the aluminum plate presents a distribution of residual stresses similar to a superposition of arc welding combined with the effect of mismatch in CTE.

References

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