

D. Predicting and Reducing Liquation-Cracking Susceptibility Based on Temperature vs. Fraction Solid

by G. Cao and S. Kou, University of Wisconsin

Aluminum welds are susceptible to liquation cracking in the partially melted zone (PMZ), which is the region immediately outside the fusion zone where liquation occurs due to overheating during welding. Using the multicomponent Scheil model for alloy solidification, curves of temperature vs. fraction solid ($T-f_s$) during solidification were calculated for the PMZ and weld metals (WMs) made with filler metals of various compositions. These curves were used to predict the crack susceptibility by checking if the harmful condition of $WM f_s > PMZ f_s$ exists during PMZ solidification and reduce the susceptibility by minimizing this condition. This approach was tested against full-penetration welds of alloys 7075 and 2024, which are highly susceptible to liquation cracking. In the case of 7075, $T-f_s$ curves predicted: (1) crack susceptibility of welds made with filler metals 4043, 4047 and 4145, and (2) crack elimination through 4145 plus extra Cu. Both predictions were confirmed in circular-patch welding. Similarly, in the case of 2024, $T-f_s$ curves predicted both the crack susceptibility with filler metals 1100 and 4043 and crack elimination through 5356 plus extra Cu, and both predictions were confirmed. This approach can be used to guide the selection or development of filler metals that reduce the crack susceptibility.