

**B. Effect of Filler Alloys on HAZ Cracking in Pre-Weld Heat Treated IN-738 LC GTA Welds**

*by K. Banerjee, N.L. Richards and M.C. Chaturvedi, University of Manitoba*

**ABSTRACT**

The effect of filler alloys, C-263, Rene-41, IN-718 and FM-92 on HAZ cracking susceptibility of cast IN-738 LC by GTA welding was studied. In addition autogenous welds were also made on the IN-738 parent material. Alloy IN-738 is a high temperature Ni-based superalloys used at temperatures up to 980°C, precipitation hardened by the  $\gamma'$  ( $\text{Ni}_3\text{Al}$ , Ti) phase. The pre-weld treatments consisted of the standard solution treatment at 1120°C for 2 hours followed by air cooling, and a new heat treatment which was developed to improve the HAZ cracking resistance of IN-738 LC. This heat treatment consisted of solution treating at 1120°C followed by air cooling then aging at 1025°C for 16 hours followed by water quenching. Welds were observed to suffer intergranular HAZ cracking, regardless of the filler alloy, however, the autogenous welds were most susceptible to HAZ cracking. In general, the cracking tendency for both the heat treatments was maximum for C-263 and Rene-41 fillers and it decreased with the use of FM-92 and IN-718 filler alloys. The HAZ cracking was associated mainly with constitutional liquation of  $\gamma'$  and MC carbides. On some cracks liquated low melting phases Zr-carbosulphide and Cr-Mo borides were also observed to be present. The cooling portion of the weld thermal cycle induced precipitation hardening via  $\gamma'$  phase in the  $\gamma$  matrix of the weld-metal. The HAZ cracking increased as the weld metal lattice mismatch between  $\gamma'$  precipitates and  $\gamma$  matrix of the weld and its hardness increased. However, the weld-metal solidus and solidification temperature range, determined by high temperature differential scanning calorimetry, did not correlate with the HAZ cracking susceptibility. It is suggested that the use of filler alloys with small  $\gamma'$ - $\gamma$  lattice mismatch and slow age hardening response would reduce the HAZ cracking in IN-738 LC Superalloy welds.