

## **B. Deformation Strains In Single Crystal Alloy Welds**

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Repair welding of single crystal nickel base superalloys is a crucial technology needed for economical reuse and repair of used and defective turbine components. The final performance of these welds is closely related to microstructure evolution in both heat-affected-zone and weld metal regions. In this research, the interaction between microstructure evolution and dislocation movement in the HAZ region was investigated with Laue diffraction and transmission electron microscopy.

A single crystal TMS-75 alloy rod in standard heat treated condition was investigated. Spot welds were made on these rods with different cooling conditions with following welding parameters: 17.5 Volts and 110 Amps. The microstructure was characterized with optical microscopy and transmission electron microscopy. The deformation strains as a function of distance from the fusion line was characterized with Laue diffraction analysis for two different cooling rates.

The Laue diffraction analysis showed that the single crystalline nature was maintained in the fusion zone region which is manifested by the presence of sharp diffraction spots. In contrast, the diffraction spots were elongated indicating the presence of elastic/plastic strains. The extent of elongation was higher in rapidly cooled welds, in comparison to slowly cooled welds.

Transmission electron microscopy analysis showed rapid decrease in dislocation content with increasing distance from fusion line and was in qualitative agreement with Laue Diffraction analysis. In addition, the results show complex interaction between dislocation and the gamma prime precipitates was analyzed. The results have large implications on the cracking behavior during repair welding of single crystal superalloys.

Laue diffraction analysis indicated a large increase in dislocation density close to the fusion line of a spot weld made on single crystal nickel base superalloy. The results, so far, shows complex interplay between deformation and microstructural evolution in the HAZ of nickel base superalloys and have implications on weld cracking behavior.

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