Microdiffraction Characterization of Multiscale Deformation Mechanisms in the Weld Joint of a Nickel-based Superalloy

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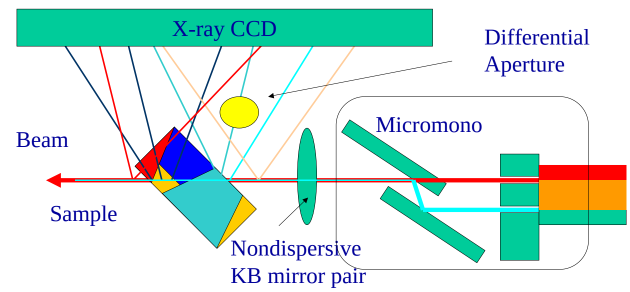
Motivation:

Nanosize $L1_2$ ordered particles are responsible for high temperature strengthening of theTMS 75 Ni based single crystal materials used for energy systems components

•Microstructural stability of blade materials used in turbine systems has become a critical issue for the reliability and economy of entire power generation systems

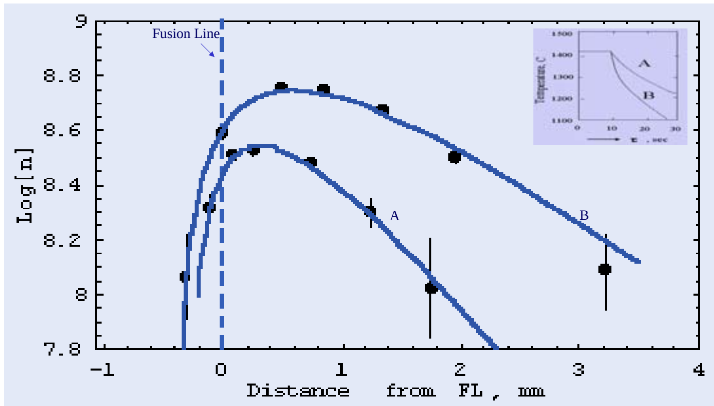
•When manufacturing fusion welds, the potential exists for defects to be introduced:

- **•Dissolution and re-growth of nanosize $L1_2$ ordered particles influences phase and microstructure stability**
- **•Centerline grain boundaries may appear**
- **•Interdendritic microporosity, liquation and solidification cracking may form**
- **•Plastic deformation may cause cracking in the HAZ**

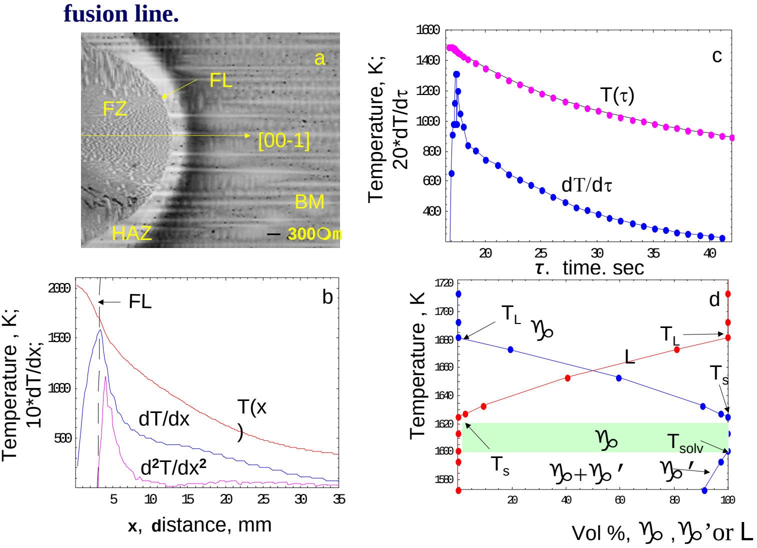


Simulated temperature distribution in the weld:

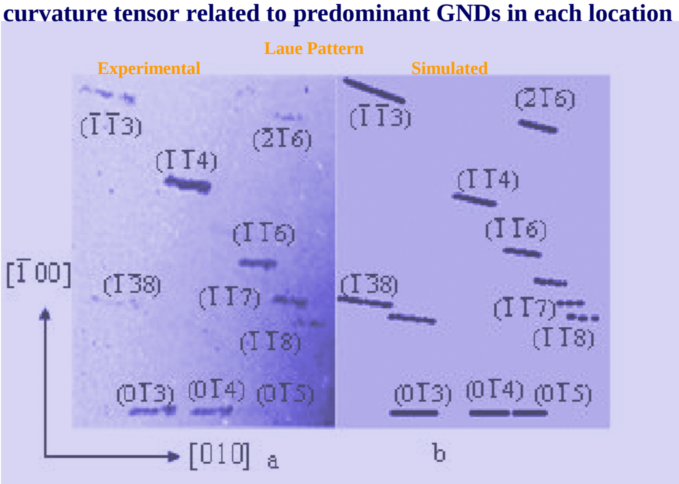
Dislocation density distribution



Simulated distributions of temperature, T(x), temperature gradient, dT/dx, and it's derivative, d^2T/d^2x, have maximal values near the fusion line.



Simulated and experimental Laue pattern determine lattice curvature tensor related to predominant GNDs in each location



Summary

•Dissolution of the nanosize $L1_2$ strengthening precipitates in the HAZ reduces yield strength
•This soft region experiences plastic deformation due to the generation of thermal stresses
•Dislocation density increases with thermal gradient and has a maximum value near the fusion line
•Splitting of Laue spots demonstrates that dislocations group together, forming sub-boundaries and causing fragmentation and local rotation in the HAZ
•Macroscopic rotation axis is perpendicular to the direction of thermal gradient [010]

References

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