Invited paper to be presented at TMS Annual Meeting 2002, Seattle, Washington, Feb. 15-21, 2002.

Applications of Computational Thermodynamics to Welding

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Computational thermodynamics and the Calphad method, pioneered by Larry Kaufman, offer the potential of describing phase stability in multi-component systems as a function of alloy composition and temperature. Such information is critical for predicting weld microstructures, including the fusion zone, where base metal dilution with filler metals takes place, and the heat-affected zone, where high temperature exposure alters the base metal microstructure. When combined with diffusion-controlled kinetics analyses, computational thermodynamics can describe the evolution of microstructure in the entire weldment. This paper will review the numerous applications of computational thermodynamics in welding, including calculations of phase stability, solidification behavior, microsegregation effects, and inclusion formation. Examples of these calculations for predicting microstructure and properties of weldments in a wide range of materials, including steels and nickel-base superalloys, will be provided. This research was sponsored by the Division of Materials Science and Engineering, U. S. Department of Energy, under contract DE-AC05-00OR22725 with UT-Battelle.

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