MODELING OF WELD METAL MICROSTRUCTURE*

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ABSTRACT

Since the evolution of microstructure in the weld metal is controlled by various physical processes, there is a need to understand and model these physical processes. The model should be based on various tools available for modeling microstructure developments in a wide variety of alloy systems and welding processes. The paper will describe the principles, methodology and future directions of modeling thermochemical reactions in liquid, solidification, and solid-state transformations. Examples of alloy systems considered include low-alloy steel, stainless steel, and nickel base superalloys.

Thermochemical deoxidation reactions in liquid low-alloy steel lead to oxide inclusion formation. This inclusion formation has been modeled by combining principles of ladle metallurgy and overall transformation kinetics. The model's comparison with the experimental data and the ongoing work on coupling this inclusion model with the numerical models of heat transfer and fluid flow are discussed. Also, recent advances in theoretical and physical modeling of the solidification process are reviewed with regard to predicting the solidification modes, grain structure development, segregation effects, and nonequilibrium solidification in welds.

The effects of solid-state phase transformations on microstructure development and various methods of modeling these transformations are reviewed. The paper also addresses the importance of advanced analytical techniques to understand the solid-state transformation mechanisms in welds.

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