

Comparison of Phase Transformation Kinetics under Ortho- and Para-Equilibrium Conditions*

J. M. Vitek¹ and E. Kozeschnik²

¹ Metals and Ceramics Division

Oak Ridge National Laboratory

P. O. Box 2008

Oak Ridge, Tennessee, U. S. A. 37830-6376

² Institute for Materials Science, Welding and Forming

Graz University of Technology

Kopernikusgasse 24

A-8010 Graz, Austria

In diffusion driven phase transformations, it is commonly assumed that local thermodynamic equilibrium prevails at the moving phase interface. If all diffusing species are sufficiently mobile, then ortho-equilibrium can be established at the interface and the assumption of local equilibrium at the interface is reasonable. However, if some components are too sluggish, for example substitutional elements in a substitutional/interstitial alloy such as steel, compositional constraints at the interface must be taken into account. A recently developed model for calculating phase equilibria under compositionally constrained conditions is described in a companion paper at this meeting. This model can be used to calculate phase equilibria for para-equilibrium conditions as well as normal, ortho-equilibrium conditions. The diffusion-controlled transformation of austenite to ferrite can then be evaluated by imposing either ortho-equilibrium or para-equilibrium at the phase boundary. The model was used to calculate the transformation path and kinetics in sample ternary steels for constrained conditions. The results are compared to similar calculations without any compositional constraints. The calculations show entirely different transformation paths before final equilibrium is achieved. The kinetics calculations under para-equilibrium conditions show a pronounced two stage microstructural evolution. A comparison with experimental information in the literature indicates that simulations based on the para-equilibrium model are more representative of phase transformation behavior in interstitial/ substitutional systems than simulations based on the negligible partitioning local equilibrium model.

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