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Phase Transformations and Microstructural Evolution: Part II

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The activities of the Phase Transformations Committee of the Materials Processing & Manufacturing Division (MPMD) of The Minerals, Metals & Materials Society (TMS) are oriented toward understanding the fundamental aspects of phase transformations. Emphasis is placed on the thermodynamic driving forces for phase transformations, the kinetics of nucleation and growth, interfacial structures and energies, transformation crystallography, surface reliefs, and, above all, the atomic mechanisms of phase transformations. Phase transformations and microstructural evolution are directly linked to materials processing, properties, and performance. Here, aspects of liquid–solid and solid-state phase transformations and microstructural evolution are highlighted.

Materials processing and microstructural evolution begins with solidification. The first three papers explore the role of solidification conditions on microstructural evolution. In the paper titled "In Situ X-ray Observations of Dendritic Fragmentation During Directional Solidification of a Sn-Bi Alloy" by Gibbs et al., the influence of solidification conditions on dendrite fragmentation dynamics is captured, revealing the complexity associated with the initiation of morphological transitions. The second paper, "Influence of Growth Rate on Microstructural Length Scales in Directionally Solidified NiAl-Mo Hypo-Eutectic Alloy" by Zhang et al., examines how solidification conditions impact microstructural characteristics like primary and secondary dendrite arm spacings, in the context of existing theory and earlier experiments. In the third paper, "The Influence of the Melt-Pouring Temperature and Inoculant Content on the Macro and Microstructure of the IN713C Ni-Based Superalloy" by Matysiak et al., the phase transformations and microstructures produced by different solidification conditions are characterized.

The next four papers delve into solid-state phase transformations and microstructural evolution in steels. In the paper, "Correlation Between Crystal Structure Change and Transformation Strain for Mulitphase Transformations" by Clarke et al., a model validated with a ferrite + pearlite steel is presented for extracting phase transformation kinetics from dilatometry data. In the second paper, "Effect of Intercritical Annealing Temperature on Martensite and Bainite Start Temperatures After Partial Austenitization" by Erişir and Gürkan Bilir, critical phase transformation temperatures, linked to chemical and microstructural evolution in a dual phase (ferrite + martensite) steel, are measured with dilatometry after intercritical annealing in the austenite + ferrite phase field.

In the paper by Kähkönen et al., "Quenched and Partitioned CMnSi Steels Containing 0.3 wt.% and 0.4 wt.% Carbon," the quenching and partitioning (Q&P) process is used to create complex steel microstructures that contain carbon-enriched, retained austenite and martensite. The microstructures and mechanical properties are characterized for two alloys with different carbon levels after Q&P. The final paper, "Analysis of Complex Steel Microstructures by High-Resolution EBSD" by Isasti et al., highlights the use of high-resolution electron backscatter diffraction (EBSD) to characterize complex steel microstructures and substructure development important to mechanical properties.

The following papers being published in the topic "Phase Transformations and Microstructural Evolution: Part II" represent advances in our understanding of liquid–solid and solid-state phase transformations and their importance for microstructure-processing-properties–performance relationships. To download any of the papers, follow the url http://link.springer.com/journal/11837/68/1/page/1 to the table of contents page for the January 2016 issue (vol. 68, no. 1).

A. J. Clarke is the guest editor for the Phase Transformations Committee of the TMS Materials Processing & Manufacturing Division, and coordinator of the Phase Transformations and Microstructural Evolution: Part II topic in this issue.

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- “In Situ X-ray Observations of Dendritic Fragmentation During Directional Solidification of a Sn-Bi Alloy,” by J.W. Gibbs, D. Tourret, P.J. Gibbs, S.D. Imhoff, M.J. Gibbs, B.A. Walker, K. Fezzaa, and A.J. Clarke
- “Influence of Growth Rate on Microstructural Length Scales in Directionally Solidified NiAl-Mo Hypo-Eutectic Alloy,” by J. Zhang, X. Ma, H. Ren, L. Chen, Z. Jin, Z. Li, and J. Shen
- “The Influence of the Melt-Pouring Temperature and Inoculant Content on the Macro and Microstructure of the IN713C Ni-Based Superalloy,” by H. Matysiak, M. Zagorska, A. Balkowiec, B. Adamczyk-Cieslak, K. Dobkowski, M. Koralnik, R. Cygan, J. Nawrocki, J. Cwajna, and K.J. Kurzydlowski
- “Correlation Between Crystal Structure Change and Transformation Strain for Mulitphase Transformations,” by K.D. Clarke, C.J. Van Tyne, and S.-J. Lee
- “Effect of Intercritical Annealing Temperature on Martensite and Bainite Start Temperatures After Partial Austenitization,” by E. Erişir and O. Gürkan Bilir
- “Quenched and Partitioned CMnSi Steels Containing 0.3 wt.% and 0.4 wt.% Carbon,” by J. Kähkönen, D.T. Pierce, J.G. Speer, E. De Moor, G.A. Thomas, D. Coughlin, K. Clarke, and A. Clarke
- “Analysis of Complex Steel Microstructures by High-Resolution EBSD,” by N. Isasti, D. Jorge-Badiola, J. Alkorta, and P. Uranga