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Phase Transformations of Materials

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This topic on the phase transformations of materials presents selected papers from a group of leading young researchers in the field who were finalists of the Aaronson Award competition at the International Conference on Solid–Solid Phase Transformations in Inorganic Materials, (PTM 2015). The conference was held at the Westin Whistler Resort & Spa in Whistler, British Columbia, Canada, from June 28 to July 3, 2015. The Minerals, Metals & Materials Society (TMS) co-sponsored PTM 2015, which followed in the tradition of the PTM conference series to provide an important forum for presentation and in-depth discussion of recent advances made in the field of solid–solid phase transformations. Every effort was made to adhere to the high standards of the PTM conferences previously held in Pittsburgh (USA, 1981), Cambridge (UK, 1987), Farmington (USA, 1994), Kyoto (Japan, 1999), Phoenix (USA, 2005) and Avignon (France, 2010). PTM 2015 introduced the Aaronson Award, an award to be given at every PTM conference to an outstanding graduate student or young researcher in recognition of his/her exceptional contribution to the physical metallurgy of phase transformations. The award is intended to commemorate Hubert I. "Hub" Aaronson's passion to understand phase transformations as exemplified through his teaching, scientific research, and in particular, his support and mentoring of students and young colleagues in the field.

The finalists of the Aaronson Award competition presented their papers in a plenary session. The first awardee is Hao Chen (Fig. 1) who was selected for his paper on the nature of the bainitic and ferritic transformation stasis in steels. Using a Gibbs energy balance (GEB) approach, transformation stasis is rationalized by equating the chemical driving pressure to the dissipation of Gibbs energy due to solute diffusion in the fcc–bcc interface. In the paper presented here, the GEB approach is used to analyze growth mode transitions for both grain boundary ferrite and bainitic ferrite due to the role of alloying elements at the interface. In addition to transformation stasis, this approach permits one to describe the bay phenomenon. These investigations have been applied for a range of steel chemistries including commonly used alloying elements such as Mn, Mo and Si. These studies make an important contribution towards rationalizing the role of interfacial element partitioning for ferrite and bainite formation in steels. Hao Chen conducted this work during his Ph.D. studies under the supervision of Sybrand van der Zwaag at Delft University of Technology. Hao Chen is now an assistant professor at Tsinghua University in Beijing.

The other three papers in this topic represent contributions from other candidates in the Aaronson competition. These papers indicate the breadth and depth of state-of-the-art phase transformation studies. Hugo Van Landeghem investigated segregation behavior of alloying elements during the austenite–ferrite transformation through dedicated de-carburizing and de-nitriding studies, respectively, in combination with 3D atom probe tomography. This work is related to Hao Chen's study on the role of alloying elements on phase transformation in steels. Dor Amram also dealt with phase transformation in Fe-based systems, i.e. Fe-Au. His work aims at analyzing micro- and nano-scale size effects on phase transformations in general. In particular, a 'reverse size effect' was observed in Fe thin films. Based on this study, it is suggested that size effects are governed by two different length scales, i.e. the inter-defect spacing as an upper limit and the critical nucleus size as a lower limit. Yunfeng Zheng's paper, on the other hand, dealt with phase transformations in a titanium alloy. He conducted a set of systematic experimental studies to determine the role of instabilities in metastable ß-Ti alloys which may affect the scale of refined distributions of the α phase.

Matthias Militzer is the guest editor of the topic Phase Transformations of Materials 2015 in this issue, which highlights presentations from the International Conference on Solid-Solid Phase Transformations in Inorganic Materials, PTM 2015, Whistler, British Columbia, Canada, June 28 to July 3, 2015.

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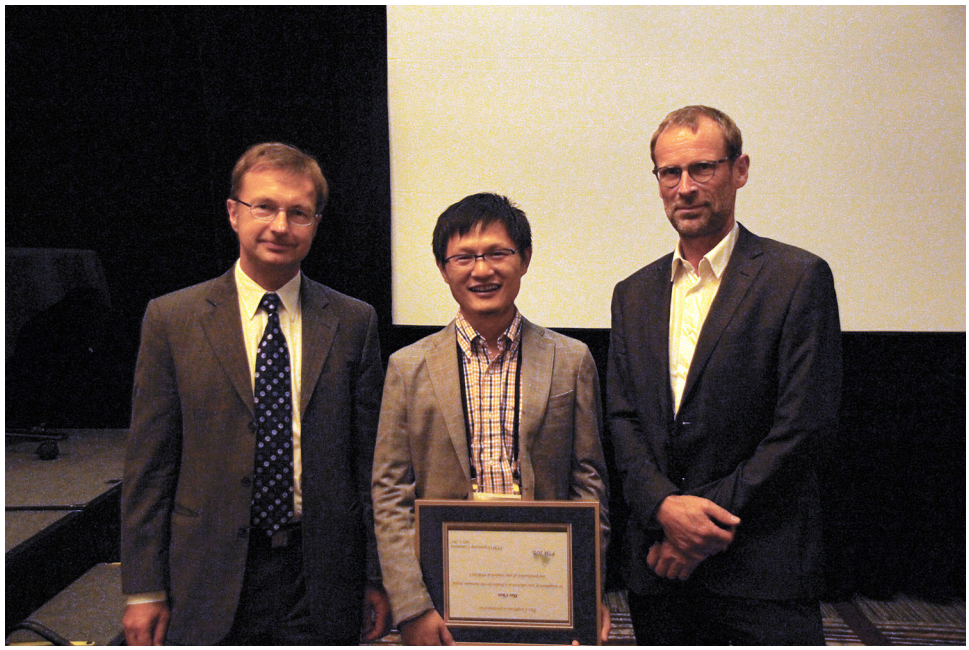

Fig. 1. Aaronson awardee Hao Chen (center) with his Ph.D. supervisor Sybrand van der Zwaag (right) and the PTM2015 conference chair Matthias Militzer (left).

Another important feature of PTM 2015 was the Hillert-Cahn lectureship that was awarded to Peter Voorhees, the Frank C. Engelhart Professor of Materials Science and Engineering at Northwestern University, and Professor of Engineering Sciences and Applied Mathematics. This award was introduced in 2010, and was established in order to recognize the outstanding contributions of John Cahn and Mats Hillert to the science of phase transformations in solid materials. It is awarded to a leading practitioner of the discipline at each PTM conference. Peter Voorhees has received many awards in his distinguished research career and is a fellow of ASM International, The Minerals, Metals & Materials Society, and the American Physical Society. He has published over 200 papers in the area of the thermodynamics and kinetics of phase transformations. His Hillert-Cahn lecture was entitled "Coarsening of Two-Phase Mixtures: From Particles to Bicontinuous Phases." Here, Peter Voorhees presented a theoretical analysis of coarsening experiments carried out on the International Space Station.

Overall, more than 370 delegates from 27 countries attended PTM 2015, making it a very successful conference with their contributions. The technical program of PTM 2015 followed the approach of PTM 2010 with invited and contributed presentations in six thematic sessions: (1) diffusional transformations, (2) displacive transformations. (3) advances in modelling and simulations, (4) advances in experimental techniques, (5) emerging areas, and (6) industrial applications. In addition to the Hillert-Cahn lecture by Peter Voorhees, seven plenary talks were presented: John Ågren provided an overview on the challenges to describe nucleation in the modelling of phase transformations; Tadashi Furuhara emphasized the importance of phase transformations in the development of modern high-strength steels; Sybrand van der Zwaag analyzed the role of interface composition on the austenite–ferrite transformations in steels; Tetsuo Mohri reviewed the cluster variation method as a tool to model phase transformations; Yves Brechet spoke on diffusional transformations by presenting selected examples of kinetic coupling and illustrating their significance for industrial situations; Elizabeth Holm presented an abnormal grain growth study as a microstructure phenomenon that is analogous to classical phase transformations; and George Sawatzky elucidated the type of transitions in quantum matter that resemble phase transitions. In addition to the plenary sessions, 270 oral presentations including 68 invited papers were given in 60 topic-specific sessions. Further, the poster session with more than 80 contributions was dedicated to the late Jack Kirkaldy. The majority of the presented papers have been published in the *Proceedings of PTM 2015* that are currently still available and can be obtained by contacting Debbie Burgess at the University of British Columbia (debbie.burgess@ubc.ca). Finally, China was selected as the host of the next PTM conference to be held in 2020 (PTM 2020). It is of note that four countries had made proposals for PTM 2020, further confirming the continued interest and significance of solid–solid phase transformation research as a key discipline in materials science and engineering.

The following papers being published under the topic of Phase Transformations of Materials provide excellent details and research on the subject. To download any of the papers, follow the url http://link.springer.com/journal/11837/68/5/page/1 to the table of contents page for the May 2016 issue (vol. 68, no. 5).

- "The Dominant Effect of Local Element Partitioning at the Interface on the Formation of Bainitic and Grain Boundary Ferrite" by Hao Chen and Sybrand van der Zwaag.
- "Solute/Interphase Interaction during Ferrite Growth in Fe-Si-C Ternary Alloys" by H.P. Van Landeghem, B. Langelier, D. Panahi, G.R. Purdy, C.R. Hutchinson, and H.S. Zurob.
- "Phase Transformations in Au-Fe Particles and Thin Films: Size Effects at the Micro- and Nanoscales" by Dor Amram and Eugen Rabkin.
- "On the Influence of Athermal ω and α Phase Instabilities on the Scale of Precipitation of the α Phase in Metastable β-Ti Alloys" by Yufeng Zheng, John Sosa, and Hamish L. Fraser.