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10 years of research on diffusion in high-entropy alloys: recent advances, remaining challenges and perspectives

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Offline Venue: **Lecture Hall - 13**

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About the Speaker

Prof. Dr. Sergiy Divinski leads the radiotracer laboratory at the Institute of Materials Physics, University of Münster, Germany. He received his graduate degree in solid state physics from Moscow Institute of Physics and Technology (PhysTech, Russia) in 1987 and his PhD degree in solid state physics from the Institute of Metals Physics (Kiev, Ukraine) in 1990.

In 1998 he joined the Institute of Materials Physics, University of Münster, Germany, first as the Alexander-von-Humboldt Fellow. The research activities are concentrated on kinetic and thermodynamic properties of interfaces in solids, including intergranular and interphase boundaries and grain boundary phase transitions, diffusion phenomena in intermetallic (including multi-principal element) compounds, effects of ordering on diffusion kinetics and diffusion mechanisms, interfaces in severely deformed materials. He teaches graduate and postgraduate courses on Diffusion in Solids, Numerical methods in Material Science and different aspects of Materials Science. He has co-authored more than 250 refereed articles in various international journals, several book chapters in the field of Diffusion in Solids and a textbook titled "Thermodynamics, Diffusion and the Kirkendall effect in Solids". Prof. Divinski serves as Editor-in-Chief of "Defect Diffusion Forum" and is a member of the advisory boards of several international conference series (DIMAT, DSL, iib).

Abstract

Single-phase multi-principal element alloys, termed as high-entropy alloys (HEAs), provide a new design concept for materials development. The "sluggish" diffusion concept, considered originally as one of the core effects of HEAs, boosted an interest from many diffusion groups and helped to generate an extensive data set. In this overview, the current state-of-the-art of diffusion research in the multi-principal element alloys is presented. Whereas tracer diffusion might be considered as sluggish when the diffusion rates in FCC CoCrFeMnNi HEA are analysed, the concept becomes ambiguous when the element diffusivities in the FCC Ni_x(CoCrFeMn)_{1-x} alloys are considered. In BCC HfTiZrNbTa and HfTiZrNbV HEAs, self-diffusion rates are not retarded with respect to the diffusivities in unary BCC elements. In HCP AlHfScTiZr HEAs, Ti diffusion is recently found to be significantly enhanced with respect to that in pure HCP elements even when considered at the same homologous temperatures. The interplay of the crystalline structure, atomically resolved lattice distortions and diffusion rates in multi-principal element alloys is discussed. Finally, a new pathway for high-throughput determination of concentration-dependent tracer diffusion coefficients in multi-principal element alloys is presented.



Professor G.V. Samsonov (1918-1975)

Professor Grigorii Valentinovich Samsonov was born on 15th February 1918 in a town near Leningrad (now St. Petersburg). After earning his first degree at the Nonferrous Metals Institute in Moscow, he joined Soviet Navy. At the end of the Second World War, he was stationed in the Soviet occupied zone of Austria. It was here he became intimately connected with the extensive refractory metal and their compounds.

After the cessation of the war, Samsonov returned to Moscow and resumed his higher studies and research under the guidance of Professor M. A. Merson (Institute of Steel and Alloys), a noted powder metallurgist of the then USSR. After completion of his Ph.D. degree, Samsonov joined the Institute of Metalkeramika (powder metallurgy) in the Ukrainian Academy of Science at Kiev as a senior scientist. The Institute was later renamed 'Institute of Materials Problem'. Within few years, he was elevated to the post of Deputy Director. Simultaneously, he was invited to head the Powder Metallurgy Department of Kiev Institute of Technology. Samsonov's scientific activity began with the synthesis of inorganic compounds. Soon he extended his area in the study of structure-properties-processing-performance relations of inorganic materials. By structure he included all types: electronic, atomic, micro- and macro, although the electronic structure fascinated him the most. To achieve this goal he insisted on the crucial bond between chemistry and physics. Samsonov authored nearly 1500 papers and authored/edited 50 books and monographs. One of the seminal books authored by Samsonov is 'Configurational Model of Matter'. Probably, there is no paper on refractory compounds, where he is not referred. The inorganic compounds in which Professor Samsonov contributed were carbides, nitrides, borides, silicides, germanides, selenides, phosphides, etc. He has also investigated in detail the hard cermets based on refractory compounds. His numerable past students are spread throughout the world.



About the Donor (1939-2020)

Prof. Gopal Shankar Upadhyaya joined the department of Metallurgical Engineering (now Materials Science and Engineering) at the Indian Institute of Technology Kanpur as Professor in the year 1976. Prior to that he was Associate Professor at the University of Roorkee (now IIT Roorkee) from 1964-1975.

He was awarded doctorate degree from the Kiev Institute of Technology, Ukraine in 1969 under the guidance of internationally renowned Materials Scientist Professor G.V. Samsonov. Professor Upadhyaya's publications list exceeds 300 papers and 16 authored/edited books. He has served on the Advisory Boards of practically all the major conferences and journals in powder metallurgy. Professor Upadhyaya's past graduate and doctorate students are actively engaged in powder metallurgy research and industry. He retired from IIT Kanpur in 2001. Professor Upadhyaya passed away on 19 July 2020 in Varanasi due to age-related ailments. He is survived by his wife and two sons.

Previous Speakers

- 2012 : Professor E.J. Mittemeijer (Max Planck Institute for Materials Science, University of Stuttgart, Stuttgart, Germany)
- 2013 : Professor G.S. Upadhyaya (Formerly, Professor IIT Kanpur)
- 2014 : Professor R.A. Andrievski (Institute of Problems of Chemical Physics, Russian Academy of Sciences)
- 2015 : Professor K.A. Padmanabhan (Formerly Director IIT Kanpur)
- 2016 : Professor H. Dannerger (Technische Universität Wien, Vienna, Austria)
- 2017 : Professor P. K. Rohatgi (University of Wisconsin- Milwaukee, USA)
- 2018 : Dr. S. V. Kamat, (Defence Research Development Organization, India)
- 2019 : Dr. Janusz S. Konstanty, Professor at AGH-University of Science & Technology, Krakow, Poland
- 2020 : Dr. Amol A Gokhale, Professor at Indian Institute of Technology, Bombay
- 2021 : Dr. Anil K. Sachdev, Principal Technical Fellow and Lab Group Manager at GM Global R&D Center, Warren, Michigan