Inaugural Samsonov Memorial International Lecture on Inorganic Materials

Department of Materials Science and Engineering
Indian Institute of Technology Kanpur

UNUSUAL PROPERTIES OF NANOSIZED MATERIALS

Speaker

Professor Dr. Ir. Eric J. Mittemeijer
Director of the Max Planck Institute for Intelligents Systems, Stuttgart, Germany

Day : 26th of March, 2012; Place : Lecture Hall - 17 (LHC); Time : 3:30 PM

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 Speaker

Professor Dr. Ir. Eric J. Mittemeijer is currently Director of the Max Planck Institute for Intelligent Systems (formerly Max Planck Institute for Metals Research) Stuttgart, and Full Professor (chair holder) at the Institute for Materials Science at the University of Stuttgart. He obtained his PhD degree from the Foundation for Fundamental Research of Matter. Thereafter his research has been focussed on the relation between properties and structure of new materials (e.g. nanomaterials) and, in particular, surface layers, and phase transformations of metastable materials. He has founded and led the department "Phase Transformations" at the Max Plank Institute for Metals Research since 1998. He has published **600** *papers in international scientific journals.*

About the Donor

Dr. 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 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. After retiring from IIT Kanpur (in 2001), Professor Upadhyaya currently resides in *Varanasi.*

Samsonov Memorial International Lecture Series on Inorganic Materials

Second Annual Lecture

Department of Materials Science and Engineering
Indian Institute of Technology Kanpur

SINTERING RESEARCH : PAST, PRESENT, AND FUTURE

Speaker
Dr. G. S. Upadhyaya
Formerly Professor at the Department of Materials Science and Engineering
IIT Kanpur

Day : 1st March, 2013; Place : Lecture Hall -16 (LHC); Time : 3:30 PM

Professor G.V. Samsonov (1918-1975)

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Professor Upadhyaya himself has initiated this lecture series in the memory of his past mentor Professor G.V. Samsonov.

Samsonov Memorial International Lecture Series on Inorganic Materials

Third Annual Lecture

Department of Materials Science and Engineering
Indian Institute of Technology Kanpur

Nanostructured Materials in Extremes

Dr. Rostislav A. Andrievski
Institute of Problems of Chemical Physics, Russian Academy of Sciences, Moscow

Day : 11 February, 2014; Place : Lecture Hall -16; Time : 3:30 PM

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.

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About the Speaker

Professor Dr. Rostislav A. Andrievski is currently the Principal Scientist at the Institute of Problems of Chemical Physics, Russian Academy of Sciences, Moscow. He obtained his PhD degree from the Institute of Metal- Ceramics & Alloys at Ukraine Academy of Sciences. His research interests are nanostructured materials, super-hard films, high melting-point compounds, consolidation of nanomaterials, and stability of nanomaterials. He has supervised 33 PhDs, and published 430 scientific publications including 11 books. He is member of four international editorial boards. Corresponding Membership of the Kirghiz Academy of Sciences, and Full membership of the International Institute for the Science of Sintering, are among the major honours he has received.

About the Donor

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Abstract

The scientific interests of well known scientist Prof. G.V. Samsonov applied to not only aspects of synthesis and properties of materials but covered their behavior in extreme conditions such as at radiation, deformation and corrosion. In continuation of these important traditions, my lecture offers a review of the recent advances in theoretical/experimental data on the nanostructured materials (NMs) behavior at high temperatures as well as in radiation, corrosion and deformation environments.

Modern technique progressively increases demands in working conditions and so new development of structural/functional NMs must be familiarized by extreme environments taking in mind the high level of temperatures in radiation, corrosion, and deformation conditions. The high level of physical/mechanical properties of NMs is due to a nanometric grain size and correspondingly a large share of interfaces, triple junctions, and quadruple points as well as an availability of segregations, nonequilibrium phases, residual stresses, nanopores, and other defects. Thus, almost all NMs are far from equilibrium state. It follows from general considerations that the thermal activation and other effects such as radiation, corrosion, deformation, and others, can stimulate and enhance the diffusion, relaxation, recrystallization, and homogenization processes with partial or total annihilation of nanostructure and degeneration of high level properties. In this connection, the NM stability is one of the important problems in the new NM development for extreme conditions.

Information about thermal, radiation, and corrosion stability of NMs is discussed in details. The great attention is taken to the nanograins size effect and attendant factors such as grainboundary structure, abnormal grain growth, segregations, residual stresses, and others. Many NMs such as based on metals, alloys, compounds, semiconductors, dielectrics, carbon, and composites are considered. Some little-explored and unexplored problems are pointed.

References

1. Andrievski R.A. Behavior of radiation defects in nanomaterials. Review on Advanced Materials Science 29 54-67 (2011).
2. Andrievski R.A. The role of nanoscale effect in the interaction between nanomaterials and environment. Protection of Materials and Physical Chemistry of Surfaces 49 528-540 (2013).
3. Andrievski R.A. Review of thermal stability of nanomaterials. Journal of Materials Science DOI 10.1007/s10853-013-7836-1.

Samsonov Memorial International Lecture Series on Inorganic Materials

Fourth Annual Lecture

Department of Materials Science and Engineering
Indian Institute of Technology Kanpur

Superplasticity to Nano-Glasses: A Generalized Picture for the Structure of Grain Boundaries and Interfaces in Solids

Prof. K A Padmanabhan

School of Engineering Sciences & Technology, University of Hyderabad, Hyderabad 500 046 & Research Advisor, TCS

Day : **20 February, 2015** Place : **PBCEC Main Hall** Time : **3:30 PM**

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 Speaker

Prof. K A Padmanabhan is at present a University Chair Professor at the School of Engineering Sciences and Technology, University of Hyderabad and a Research Advisor to TCS. He received his PhD from the University of Cambridge, U. K. in 1972. A former Director of IIT Kanpur and Dean of Academic Research at IIT Madras, he has over 40 years of research & development, consulting and teaching experience in materials science and engineering. He is the first Indian engineer to be conferred the ScD degree by the University of Cambridge, U.K. for his "research contributions", and the first Indian to be awarded the 'Forschungspreis' (career research award, 1994) of the Alexander von Humboldt Foundation, Germany. He has authored 2 expert level books, edited 10 books, authored 4 book chapters, 10 patents and more than 270 research papers in refereed international journals .

About the Donor

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. After retiring from IIT Kanpur (in 2001), Professor Upadhyaya currently resides in Varanasi.

ABSTRACT

Frontiers in advanced materials development have shifted into highly disordered systems. However, grain/interphase boundaries/interfaces of different misorientations, free volume fractions, curvatures and irregularities are found in both 2D and 3D materials of all crystalline or amorphous/glassy types. Therefore what is the central idea on which a description of these structural features should be based? In our opinion, a structural/basic unit (crystalline / non-crystalline of any scale), which depends on the interatomic (including electronic) interactions, spatial distribution of atoms and electrons, the number of atoms and the free volume fraction present in the structural/basic unit, the composition and the experimental conditions should serve the purpose. As it is extremely difficult to develop a quantitative model taking the effects of all the above variables into account, slightly defective material boundaries may be treated as planar and models developed using the concepts of crystallography. But, for the highly disordered boundaries found in most engineering materials a description in terms of a representative volume, a non-long-range-periodic basic unit or a combination of such units whose configurations depend on the above listed variables is advocated. *All approaches* that have been adopted to date implicitly assume that the real problems are so complicated that their solution in entirety is impossible –"anirvachaniyam" – that which cannot be described in words -, as said in our Indian philosophy on the nature of this Universe. Possible directions for future research are speculated upon.

Samsonov Memorial International Lecture Series on Inorganic Materials

Fifth Annual Lecture

Department of Materials Science and Engineering
Indian Institute of Technology Kanpur

Chemical interactions with the atmosphere during sintering of metallic powder compacts

Prof. Herbert Danninger

Technische Universität Wien (Vienna University of Technology), Vienna, Austria

Day: 10 February 2016 Place: L-9 Time: 3:30 PM

Abstract

In addition to the physical aspects of sintering, the transport within the metallic phase, also chemical reactions have to be considered. All metal powders that have ever been exposed to air are covered by surface layers containing oxides which are however bonded with varying strength, depending on the thermodynamic stability of the respective oxides. In order to grant sound interparticle bonding, these surface layers have to be removed or at least penetrated during sintering. In many sintered materials, this removal is attained by interactions with the atmosphere, either with reducing components such as H_2 or by reduction with elements contained in the specimen itself, such as carbon, the atmosphere removing the reduction products. Here, it has to be distinguished between the "free" atmosphere and that within the pore space of the powder compact; only the former can be markedly influenced from outside. It is shown that these deoxidation processes occur in clearly defined temperature intervals that are defined by the stability of the oxides. Problems will arise if these deoxidation intervals intersect with the temperature range for densification. Furthermore, heterogeneous oxygen affinity within the compact has to be considered, as e.g. in compacts from mixes: here "internal guttering" may occur, that is oxygen transfer from the base powder particles to those of the alloy elements through the atmosphere, which renders complete deoxidation more difficult. Such phenomena may however also occur in pre-alloyed powders, in this case rather diffusion of the oxygen-affine alloy elements being the controlling mechanism. Finally it is shown that removal of carbon from sintered steels, the dreaded surface decarburization, can occur not only through oxygen or oxygen compounds but in certain temperature ranges also by H_2 if specific alloy elements are present.

About the speaker

Herbert Danninger is Full Professor for Chemical Technology of Inorganic Materials at Technische Universität Wien (Vienna University of Technology), Vienna, Austria, and currently Dean of the Faculty of Technical Chemistry. He has been active in powder metallurgy for more than 35 years and is author of more than 400 publications on powder metallurgy topics as well as several books and book chapters. He has worked mainly on high strength and high density sintered steels, with particular focus on sintering, microstructural characterization and high cycle fatigue. He served as co-chairman of the Powder Metallurgy World Congress 2004 in Vienna, Austria. Currently he is chairman of the "Gemeinschaftsausschuss Pulvermetallurgie", the PM association of the German-speaking countries. Herbert Danninger received the "Skaupy lecture" award of the "Gemeinschaftsausschuss Pulvermetallurgie" in 2006 and was elected Fellow of APMI in 2010. He holds an honorary doctoral degree of Technical University Cluj-Napoca (Romania).

Professor G.V. Samsonov (1918-1975)

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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)