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EDITORIAL

Special Issue Dedicated to Late Dr. Srikumar Banerjee

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Dr. Srikumar Banerjee has left an indelible mark, and all those working in the fields of metallurgy, materials science and materials engineering gratefully acknowledge his contributions, mentoring and encouragement.

Dr. Srikumar Banerjee always believed in first developing an in-depth, fundamental understanding on a given subject. His early work on zirconium-based alloys, in predicting the habit planes of different variants of martensite using phenomenological theory of martensite and experimentally confirming these using transmission electron microscopy, is the first example of his approach to develop an in-depth understanding. However, he also had a broader perspective and looked at these fundamental approaches across different alloy systems. He studied both zirconium and titanium alloy systems and examined the internal structure and crystallography of martensitic transformations. Another example of his insightful and fundamental work is establishing the structure of the ordered omega phase in a totally new way and laying the foundation of a new class of hybrid transformation which later developed as one of his lifetime pursuits in research. His study of in situ ordering in Ni-Mo alloys under high-voltage electron microscope brought a paradigm shift in the understanding in the field of order–disorder phase transformation. As a postdoctoral fellow, he visited School of Engineering & Applied Sciences in the University of Sussex, Brighton, in 1978. At the University of Sussex, he worked on rapid solidification of Zr-based alloys and showed the occurrence of many interesting phase transformations including the formation of Zr-based metallic glasses. In the rapidly solidified Zr-Al alloys, he showed the formation of an ordered omega phase in a totally new way and laid the foundation of a new class of hybrid transformation which became a topic for research for a long time. His profound knowledge about phase transformations very much impressed Late Prof. R. W. Cahn (FRS) and Professor Brian Cantor. These two were Professors in University of Sussex at that time. After his tenure in Sussex, Dr. Srikumar Banerjee came to Max-Planck Institute, Institut fuer Metalforschung—Institut fuer Physik, Stuttgart, Germany, and at KFA Forschcungszentrum, Juelich, Germany, as a Humboldt Fellow. The subject of his investigation here was the order–disorder reaction in Ni-Mo alloys under electron irradiation in a high-voltage electron microscope and thermal activation. These observations by him showed experimentally for the first time that irradiation-induced transformations can be reversible. When these results were published in Acta Materialia, it was very much appreciated by scientific community and he was given one of the most prestigious "Acta Metallurgica

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outstanding paper" award. The concept of spinodal ordering emerged from his proposition of combining two mutually exclusive processes, viz. ordering and clustering. He proposed that if these are expressed in the form of concentration waves, both the tendencies can be combined and the wavelength will decide which of the tendencies will eventually prevail. He made a comprehensive study on both displacive (martensitic and omega) and diffusional (chemical ordering, precipitation, spinodal decomposition and eutectoid decomposition) transformations encountered in these alloy systems. He was particularly interested in the phenomenon of Portevin le Chatelier effect in metals and alloys. He was the first to show the interplay between dislocation motion and dynamic precipitation resulting in deformation band formation leading to serrated flow behaviour. He showed this first in plastic flow behaviour of a β-titanium alloy (Ti-15% Mo) and later on showed the occurrence of the same phenomena in many other alloys. He focused also on phase transformations in extreme pressure like radiation, shock and static pressure and rapid heating as well as rapid cooling. These were not only of interest to him from a scientific viewpoint but also from technological viewpoint particularly in the nuclear industry. These studies yielded several original findings such as the order–disorder transitions in alloys experiencing the competition between multiple super-lattice structures, displacive beta (bcc) to omega (hexagonal) transformation and mixed mode transformations.

And the applied researcher in Dr. Srikumar Banerjee always looked to relate the developed fundamental understanding to the properties of materials. Therefore, structure–property correlation in different alloys was a subject very close to him. He studied all the possible phase transformations in zirconium-based alloys, their structure–property correlation and texture development making him unique in zirconium metallurgy. Much of his research in this area came out in the book entitled Phase Transformations, Volume 12, Examples from Titanium and Zirconium Alloys, published by Pergamon press, 4th July 2007, which he coauthored with Dr. P. Mukhopadhyay. His expertise and knowledge helped in zirconium-based alloy processing in Nuclear Fuel Complex (NFC) and made the country fully self-reliant in zirconium alloy development and manufacturing. Besides his contribution to flow sheet development for manufacturing Zr-2.5Nb pressure tubes in NFC, he ensured that the scientific work done in BARC also translated to technology in other areas. Studies in his group on martensitic transformations and shape memory effects have resulted in the development of shape memory couplings which are extensively deployed in Indian Light Combat Aircraft (Tejas). A plant for the production of shape memory alloy components is set up by Aeronautical Development Agency in Bangalore with the technology provided by BARC.

Dr. Banerjee became Head, Metallurgy Division in 1990, Associate Director in 1996, Director, Metallurgy Group in 2001, and Director, Bhabha Atomic Research Centre (BARC) in 2004. As Director of BARC, he coordinated research and development activities in physical, chemical, materials and biological sciences, design and developments related to the next generation of nuclear reactors, and applications of radiation and isotope technologies in health care, agriculture, food preservation and treatment of municipal waste. In November 2009, he was elevated to the position of Secretary, Department of Atomic energy, Government of India, and Chairman, Atomic Energy Commission, and continued in this position up to April 2012. He continued to promote international scientific collaborations and academic activities of the department.

Subsequently, he was Homi Bhabha Chair Professor in BARC for five years and he intensified his research in the field of metallurgy of actinide systems and evolving nuclear fuel cycle. He was also chancellor, Homi Bhabha National Institute (HBNI), and chairman of the Board of Research in Nuclear Sciences (BRNS) under the department of atomic energy, India. He was involved in the research councils and governing boards of several national institutes and research laboratories, in supervision of PhD students and extensively lectured on materials science and nuclear energy. He also took courses at various academic and research institutes, e.g. HBNI and various Indian Institutes of Technology.

Dr. Srikumar Banerjee was a recipient of many national and international awards and honours. Dr. Srikumar Banerjee was a fellow of all the science and engineering academies of India and also the World Academy of Sciences, Italy. He was bestowed with 12 honorary doctorates. He was a recipient of the prestigious Bhatnagar Award. Among the international awards, mention can be made of Alexander von Humboldt Research Award (2004), William J. Kroll award of ASTM (2012), R W Cahn award of Journal Nuclear Materials and Presidential Citation of American Nuclear Society (2012). The Government of India honoured him with a Padma Shri in 2005.

Dr. Banerjee had collaborated with a large number of researchers, in India and abroad. This special issue of Transactions of IIM is a tribute to him from some of his collaborators, friends as well as by young researchers. There are twenty-two articles—all in the broad topic of structure–property correlations in alloys, a topic very close to the heart of Dr. Srikumar Banerjee.