

Professor Yuri Estrin

A Scientific Biography

Early years

Prof. Estrin was born and educated in the former Soviet Union, where he received his Master's degree (1969) from the prestigious University of Science and Engineering in Moscow and his PhD degree (1975) from the Institute of Crystallography of the Academy of Sciences of the USSR (both with higher distinction). He was trained in Solid State Physics and Physical Metallurgy at the Institute of Crystallography of the Academy of Sciences in Moscow. He was employed by that Institute as a Researcher from 1969 to 1979 and worked with one of the leading theoreticians in the area of crystal lattice defects, Professor Vladimir Indenbom. This work formed the basis of Yuri Estrin's highly developed research skills and deep insights in the physical mechanisms underlying the mechanical properties of materials. It was his profound understanding of physics of strength and plasticity that caught the attention of Professor Kurt Lücke – a nestor of German Materials Science – who invited Yuri to join him at his Institute in Aachen – first as a Fellow of the Alexander von Humboldt Foundation and later as his Research Associate. Kurt Lücke, who has become Yuri's second mentor, has described him as “the most talented young researcher he had ever supervised.”

Eighties and Nineties

From 1979 to 1992 Yuri held research appointments at the RWTH Aachen and later at the University of Technology in Hamburg-Harburg. In these years, his interest turned progressively towards the experimental Materials Science, and the theoretical models of strength and plasticity he was developing in the 1980s targeted practical applications in metal forming and mechanical response of metals and alloys under service conditions. Prof. Estrin's formative years as an independent and creative researcher yielded constitutive models he developed in Hamburg-Harburg together with his colleague, Professor Heinz Mecking. These models became, and remain to this day, classics in the field. They are commonly referred to as the Kocks-Estrin-Mecking (or Kocks-Mecking-Estrin) models. In 1986, a higher doctorate (habilitation) was conferred on Yuri Estrin for a series of studies in materials modelling and in 1988 he became Professor at the University of Technology in Hamburg-Harburg.

In the mid-1980s together with Dr. Ladislav Kubin of France, Professor Estrin laid the foundations of a theory describing unstable deformation behaviour of an important group of alloys, notably structural aluminium alloys. This phenomenon, known as *dynamic strain ageing*, or the “*Portevin-Le Chatelier effect*”, is an example of complex spatio-temporal behaviour – akin to earthquake dynamics – and also has significant practical implications in metal forming. These aspects of the theory have been recognised and acknowledged by leading physicists and solid mechanics scientists. Prof. Estrin worked on this subject during his sabbatical at the University of Western Australia (UWA) and later when he joined UWA in 1992 as an academic staff member. Prof Estrin’s research at UWA focussed on a range of fields in Physical Metallurgy, including computational materials science, theory of frictional sliding, theory of plastic instabilities, magnetisation kinetics, and novel materials design. At this time he also held a position of Acting Head of Department of Mechanical and Materials Engineering and was Deputy Chair of the Academic Board and the Academic Council of UWA.

Last Decade

In 2000, Prof. Estrin was appointed Chair and Director of the Institute of Materials Science and Engineering of Clausthal University of Technology in Germany, where he worked until 2007. His research in Clausthal was primarily concerned with developing theoretical and experimental approaches to producing bulk ultrafine-grained and nanocrystalline materials for structural and functional applications, such as Al alloys and steels with exceptionally high strength or magnesium alloys with accelerated hydrogenation kinetics. The constitutive models developed by Prof. Estrin and his associates to describe the microstructure evolution under severe plastic deformation leading to extreme grain refinement have gained wide recognition by the materials community. Prof. Estrin’s work has been instrumental in promoting this area of research and adding to its international visibility. He is one of the founding members of the International NanoSPD Steering Committee (www.nanospd.org) and has recently chaired a major conference in this field, viz. the 4th International Conference on Nanomaterials by Severe Plastic Deformation (Goslar, Germany, 2008).

Over the years at Clausthal, Professor Estrin has maintained his links with UWA and, together with colleagues in the UWA School of Civil Engineering, has engaged in developing new principles of design of materials and structures based on the so called topological interlocking of the constituent elements. This work has attracted significant interest from materials engineers, as the assemblies based on the concept of topological interlocking possess unusually high resistance to failures and open up interesting avenues for producing multifunctional hybrid materials by combining dissimilar materials within an integrated structure. Currently, there is substantial activity in this area of research worldwide. Prof. Estrin holds three patents relating to interlocking-based design; a fourth one is pending. Most recently, he has been given a task to establish a Centre for Advanced Hybrid Materials at Monash University and received substantial funding for the Centre.

While still in Clausthal, Prof Estrin developed collaborations with colleagues at Monash University and has become an external member of the newly established ARC Centre of Excellence for Design in Light Metals. In 2007, he moved to Melbourne to take up a position as Professor in Physical Metallurgy at Monash University in conjunction with the CSIRO Division of Materials Science and Engineering (now Division of Process Science and Technology) and also became a Chief Investigator in the Centre of Excellence. In this capacity, Prof Estrin serves as a promoter and facilitator of collaborative research between Monash University and CSIRO. A recent Science Review of CSIRO Division of Materials Science and Engineering commended Prof. Estrin on his work in this role.

At Monash and CSIRO, Prof. Estrin's work has continued to be focussed on theoretical modelling of processes leading to ultrafine crystallinity of metallic materials and mechanical properties of nanomaterials and also on architecturally designed engineering materials. His latest focus is in developing metallic bioimplant materials with enhanced mechanical properties and improved biocompatibility. This includes production of nanostructured titanium for permanent implants, such as dental implants, and ultrafine magnesium alloys for biodegradable vascular stents or resorbable bone implants. A concise description of this work can be viewed in a popular online article at <http://www.azonano.com/details.asp?ArticleId=2453> . Professor Estrin's current work in this area involves collaborations with materials scientists, engineers and cytobiologists in several countries. Of particular interest in this regard is accelerated growth and proliferation of osteoblast cells and stem cells on the surface of titanium processed by specially designed techniques of severe plastic deformation. Several international companies have expressed interest in developing and commercialising these processes.

Achievements of Note

While the research interests of Prof. Estrin are very broad, his research in the following five areas brought him most recognition and had the greatest impact:

- 1) Physically based constitutive modelling of metals and alloys;
- 2) Theory of strain localisation and plastic instabilities in metallic materials;
- 3) Theoretical and experimental work on production of bulk ultrafine-grained materials;
- 4) Theory of strength, plasticity and thermal stability of nanomaterials;
- 5) Geometry inspired materials design as exemplified by materials with topologically interlocked elements.

Professor Estrin has authored about 400 scientific publications in the most reputable Materials Science journals and conference proceedings and has been particularly active and productive in recent years.

Professor Estrin's research work has brought him international acclaim and numerous awards, such as the appointments as an adjunct professor in two Departments of UWA and one at Postech – an elite university in South Korea. He has been a member of a number of editorial boards of scientific journals and organising committees of high-rank international conferences.

For his scientific achievements Prof. Estrin received such prestigious distinctions as:

- an Alexander von Humboldt Award (1999);
- a KOSEF Award (Korea, 2005);
- the title of World Class University Professor, Seoul National University, Korea (2009);
- entry in the ISI Thomson Reuters' "Highly Cited" list in the 'Materials Science' category as one of only seven Australian scholars in that field
- an honorary doctorate (Doctor honoris causa) of the Russian Academy of Sciences (2008).

The latter distinction is particularly remarkable, as the election process is extremely involved and competitive, and Prof. Estrin appears to be the only Australian to receive such an honorary doctorate from RAS. As a further sign of international recognition of Prof. Estrin's scientific standing, he was recently offered an ongoing visiting appointment as a World-Class University Professor in the Department of Materials Science of Seoul National University. Professor Estrin's inclusion on ISI Thomson Reuters' Highly Cited list, which highlights the top 250 most preeminent individual researchers in the Materials Science category, is the most recent example of his academic excellence and contribution to science.