



### Dedicated to the memory of the late Prof. Dr. Marija Kosec (1947–2012)

It is not easy to write about someone who is not with us any more, especially when it is someone who left an important imprint on many people's lives. In this case it is about Prof. Marija Kosec, or Marička, as almost everyone addressed her, who passed away on December 23, 2012.

She was born on September 5, 1947, as the older daughter in a family with three brothers, in a small village called Šinkov Turn, near Vodice. She would often recall how she enjoyed helping her father and brothers in the woods or how she picked blueberries during summer holidays to earn money for school books. She won a bicycle at a competition at elementary school; I wouldn't be surprised if it was related to natural sciences, probably mathematics. After finishing chemistry secondary school she decided to study chemical technology at the Faculty of Natural Sciences and Technology, University of Ljubljana. She financed herself with a scholarship from the company Iskra and by giving lessons in chemistry and mathematics. During her studies she met Aljoša, who was later to become her husband. Together they were involved in a serious accident during research related to her bachelor's thesis when the valve of a cylinder of chlorine gas simply fell off while she was trying to open it, presumably due to corrosion, resulting in the release of chlorine gas into the laboratory. Fortunately, someone's rapid intervention and a rush to the local hospital prevented a tragedy.

After finishing her undergraduate studies in chemical technology in 1970 she obtained a position as a research assistant at the Ceramics Department of the Jožef Stefan Institute (JSI), led at that time by Prof. Drago Kolar. As a former recipient of a scholarship from Iskra, she was involved in development work related to the company, and her early research involved technical porcelain and resulted in a new composition for the low-alkaline porcelain used for insulating elements, which was

subsequently introduced into production at the company's Iskra Keramika (Iskra Ceramics).

In 1975 she finished her master's studies in chemical technology at the University of Ljubljana with a thesis on the processing and properties of piezoceramics based on  $(K_{0.5}Na_{0.5})NbO_3$  (KNN). She published her first paper (Mater. Res. Bull., 1975), which more than 25 years later was to become a seminal, highly cited paper on sintering of this lead-free piezoceramic, an environment-friendly alternative to the commercially dominant, lead-based piezoceramics, such as lead zirconate titanate (PZT).

Her PhD thesis (1982) at the University of Ljubljana was on phase relations in the  $CaO-VO_3-VO_2$  system. She performed a part of her research at the Institut für Gesteinshüttenkunde der Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen, Germany (October 1978 – April 1980). During this period she used thermal analysis to follow phase relations in the studied oxide system. She used to tell how she kept commuting from the institute in Aachen to the (present) Forschungszentrum Juelich to perform her experiments, and finally how she came back with a carload of books and memories of a fruitful period filled with discussions on science and life in general.

In the mid-1980s she became responsible for a project for the Yugoslav Military Technical Institute in Belgrade, as part of which she developed the processing of optically transparent lead lanthanum zirconate titanate (PLZT) ceramics and the fabrication of prototypes for electro-optical shutters in collaboration with physicist colleagues from the Condensed Matter Physics Department, JSI. The process of two-step sintering of ceramic elements (final diameter 75 mm) with an almost theoretical density lasted about a week, and much later she would tell how difficult it was to wait over the weekend to see if an element survived the hot-pressing cycle without cracks or not. It may be that it was in this period that she discovered her talent for ceramics processing; a talent that could perhaps be described as a mixture of the ability to precisely observe and to understand the chemical and physical background of processes occurring in the materials. Her experience in the processing of lead-based piezoelectric ceramics, such as PZT, and also early work on its lead-free alternative KNN, led to the participation of her group in the first European Framework Project (6FP) on lead-free piezoelectrics. Furt-

hermore, in collaboration with colleagues from the Condensed Matter Physics Department, Marička and her group prepared a new group of lead-free relaxors that also exhibited electro-optic properties. In another European project the group prepared extremely efficient piezoelectric single crystals of KNN by solid-state crystal growth, which was something of a world first.

In the mid-1980s the first papers on ferroelectric lead zirconate titanate thin films (with thicknesses of a few 100s of nm) from solutions (Budd, Dey, and Payne, 1985) opened a new field of research with possible applications of thin-film elements in microelectronics, and Marička started to work on this new topic. In 1993 she spent nine months as a visiting scientist in the group of Prof. Nava Setter in the Ceramics Laboratory at Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland, working mainly on the topic of ferroelectric films. Her contribution in this field was in understanding the complicated chemical reactions taking place in liquid precursors, and relating them to the properties of thin films. An outcome of this research was a decrease in the crystallization temperature of PZT thin films to as low as 400 °C, which is still among the lowest reported crystallization temperatures for thin films, and which would enable their easier integration into electronic components. In this period she actively joined the European framework supporting cooperation among scientists and researchers across Europe, COST, where she remained active for the remainder of her career. COST was an ideal environment for collaborations with research groups working on similar and complementary topics, as well as being the starting point for many long-lasting friendships.

Research on ferroelectric thick films (thickness range of a few 10s of  $\mu\text{m}$ ) is one of the most important achievements of Marička and her group. In 1992 the German printing company MAN Roland Druckmaschinen patented the process of ferroelectric printing and in order to prove the concept, ferroelectric thick films with a thickness of a few 10s of  $\mu\text{m}$  with almost theoretical density were needed. At that time there was almost no knowledge on ferroelectric thick-film processing. Marička and her colleagues succeeded in processing films with the required materials and functional properties and patented the processing of such films. The integration of ferroelectric and piezoelectric thick films on different substrates was later the topic of a number of European framework projects. Integrated medical ultrasound transducers were developed in collaboration with colleagues from the University François Rabelais, Tours, France, and pressure sensors with the Slovenian companies HIPOT RR and HYB. Throughout her career Marička endeavoured to connect basic research with applied research, development and industry.

In the period 1997–2001 she was Head of the Ceramics Department, JSI, and since 2002 the Head of the Electronic Ceramics Department. During 2007–09 she was the President of the Scientific Council of the Jožef Stefan Institute. From 2004 to 2009 she was also the Director of the Slovenian Centre of Excellence “Materials for Electronics of Next Generations and Other Emerging Technologies”, and from 2009 to 2012 of the Centre of Excellence “Advanced Materials and Technologies for the Future” (NAMASTE).

Since 1999 she was a Professor of Materials Science at the University of Ljubljana. She was always active at the Jožef Stefan International Postgraduate School since its establishment in 2004 and also served as its Vice-President. She was a visiting professor at EPFL, Switzerland (1995, 2001), Shizuoka University, Japan (2005), and for shorter periods at a number of other universities

and institutes. She was also an Adjunct Professor at Xi’an Jiaotong University, China. She was an inspiring advisor to many Ph-D students at the University of Ljubljana, the Jožef Stefan International Postgraduate School and the University of Oulu, Finland.

She served as a member or chair of many scientific societies, committees or advisory bodies, both in Slovenia and abroad. She was the only female member of the Academy of Engineering Sciences of Slovenia since its establishment in 1995, and in 2005–06 acted as its president. Since 2001 she was a member of the Ferroelectrics Committee at the IEEE.

She was the author or co-author of more than 300 scientific papers in international journals and about 15 chapters in books. She gave more than 150 invited talks at international conferences and at different research institutions, including Max Planck Institute, MIT, Tokyo Institute of Technology, and at important Japanese producers of electronic components, including Murata, TDK, Panasonic and Toshiba. In 2000 she chaired the Electroceramics Conference, in 2003 the European conference “Processing of Electroceramics” and in 2006 the 4<sup>th</sup> European Microelectronics and Packaging Symposium. As a strong supporter and also the President (1996–2005) of the Society for Microelectronics, Electronic Components and Materials (MIDEM) she chaired the 48<sup>th</sup> International Conference on Microelectronics, Devices and Materials with the Workshop on Ceramic Microsystems (MIDEM) in September 2012; however, due to her rapidly progressing illness she was not able to take an active part in the event.

In recognition of her achievements she was awarded the title Ambassador of Science of the Republic of Slovenia (2003). She was the recipient of the Zois Award, the highest national science award in 2006. In 2009 she received a Puh Recognition for the implementation of her research results in industry. In 2010 she received the Ferroelectrics Recognition Award, IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society for her significant contributions to processing science and the technology of ferroelectric powders, bulk ceramics, thin and thick films.

Above all, she enjoyed life. In addition to numerous professional duties and achievements, which required her full commitment and, clearly, a lot of time and energy, she enjoyed many outdoor activities. As a young woman she collected medals at skiing competitions at the JSI. She spent her holidays hiking and mountaineering with her husband and friends. They discovered the wilderness of the Andes, Kilimanjaro and Siberia, to name just a few. Her knowledge of mushrooms was extensive. Once during an excursion of the whole department to Pokljuka she had an improvised lecture on mushrooms and without further ado picked enough for everyone to taste. At home, she loved her flower and vegetable garden and took great care of it.

The world of science has lost not only a great scientist, but also a woman who was able to accept challenges and solve them with optimism and a positive approach. She is greatly missed by her colleagues and friends, both at home and abroad.

In this special issue of *Acta Chimica Slovenica*, dedicated to the late Prof. Marija Kosec, you will find fifteen articles written by colleagues and friends from Slovenia, and from some friends from abroad who worked for some time in her group, covering the topics of materials science and chemistry of materials.

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