

IN MEMORIAM OF EFIM BADINTER

Recently, a wonderful person, a great organizer of science, doctor of engineering Efim Badinter has passed away. He died suddenly, four months before his 80-year anniversary. His colleagues and the Moldavian scientific community hoped to celebrate this anniversary in August 2013. For several decades his name was inseparably linked to the ELIRI Institute, where he continued to work until the last days.



Brief biographical information about Efim Badinter can be found in Wikipedia:

Moldavian scientist, born in Chisinau on August 24, 1933, died on April 27, 2013, engineer, Laureate of the State Prize of the Moldavian SSR in the field of science and technology (1974), honored Inventor of Moldova.

In 1951 graduated with a silver medal the Chisinau secondary school No 40, later graduated from the Moscow Institute of Steel and Alloys. Thereafter, during two years he worked as an engineer at the “Electrostal” plant near Moscow. He then returned to Chisinau, where he worked as a senior laboratory at the Moldavian branch of the Academy of Sciences of the Soviet Union. In 1959 he was among the founders of the Chisinau Research Institute of Electrical Instruments (KNIIEP) renamed in 1996 in ELIRI Institute, where he rose from a Junior Researcher to the head of laboratory and the Deputy Director for Science, and then many years (1983-2012) worked as director. During the last months he worked again as Deputy Director for Science. His main research interests were cast microwires in glass insulation, instrumentation, electronics, microelectronics, and more recently nanotechnologies.

The mean lines of Wikipedia, even if we ignore the inherent inaccuracies, cannot give a full portrait of the man. The farther away from us are the dates and events related to Efim Badinter, the more evident is his role and importance for the ELIRI Institute.

Efim Badinter indeed started his work as a senior laboratory at the Moldavian branch of the Academy of Sciences of the Soviet Union as mentioned above, and then moved on to the Chisinau Research Institute of Electrical Instruments founded in 1959, where he worked as Junior Researcher (by the way, he was the ninth employee of the institute).

The main directions of activity of the ELIRI Institute are cast microwires in glass insulation, devices and elements on their basis, information technology, electronics and microelectronics.

Along with the development of the KNIIEP Institute, the young researcher began his scientific and administrative career. The Institute has developed, expanded and equipped with new facilities. At the same time, the young researcher relatively quickly worked his way from

Junior Researcher to the head of laboratory. As early as the 1970s, several dozen of employees worked in Laboratory no. 11.

One of the first important works of the researcher was associated with the investigation of interdependencies between the output parameters of the cast microwire in glass insulation and the input technological parameters of the casting process. Although by the mid 1960s the cast microwires of some metals and alloys, especially the resistive ones such as manganin, began to be widely used, and the Mikroprovod plant was successfully built-up in Chisinau, the casting process was not fully developed, and the theoretical description was largely absent.

In the words of the famous engineer, Honored Worker of Science of Russia, professor of the Moscow University V. S. Lensky, the complete mathematical description of the microwire casting process, taking into account the occurring thermal, metallurgical, hydrodynamic, electromagnetic and other physical phenomena is comparable in its complexity with the description of the controlled thermonuclear reaction, over which physicists around the world have been fighting for decades. Naturally, the extent of the expected results is not comparable; therefore, the forces and resources directed to meet these challenges can not be compared.

However, that does not help this practical technology branch, and its problems had to be solved. Efim Badinter realized the complexity of the description of such a process, but he did not give up, and chose, even more simplified, nevertheless a sufficiently effective method for the description of the investigated technology, namely the method of similarity and dimensionality in combination with elements of planning the experiment. The in-depth analysis of parameters and characteristics involved in the casting process (and there were more than 30), which allowed one to identify the most important of them, as well as the carefully executed series of experiments, provided conditions for obtaining semi-empirical relationships between the input and output parameters in an analytical form. Ultimately, a fairly adequate description of the process of microwire casting was elaborated, which was widely used by the next generation of engineers.

A procedure for measurement of microwire parameters as well as appropriate special measuring equipment was required for the development of products from the microwire. Installations for the investigation and the control of properties of the cast microwire in a wide temperature range were developed as a result of theoretical, experimental and circuit design research. According to ideas of Efim Badinter, a method of “horizontal wire” was proposed and developed on the basis of electric heating of a microwire segment horizontally mounted in a thermostat. The power needed for sample heating to a predetermined temperature is determined according to the heat transfer of the segment by means of convection through the free movement of air, as well as according to the thermal conductivity to the current leads and the radiation. At that time, there were no reliable data on heat transfer of micron-sized objects. Therefore, to provide high measuring accuracy, a theoretical and experimental investigation of heat transfer of cylinders with diameters of less than 50 μm under free convection in the interval of values of the product of Grashof's (Gr) and Prandtl's (Pr) criteria of 10^{-3} to 10^{-8} was carried out for the first time. These measurements showed that the Nusselt criterion (Nu) is not constant within this range, as previously assumed in thermal physics, but it varies according to the following dependence

$$\text{Nu} = 0.93 (\text{Gr} \cdot \text{Pr})^{0.08}.$$

Efim Badinter also made a significant contribution to these purely physical investigations. The method of “horizontal wire” was used in the development of installations of the “УИМП”

type (10 modifications) for the investigation and production control of cast microwire, drawing microwire, and micro-ribbon properties.

These installations found practical applications in the production control at the Micron plant (Chisinau) and “TbilPribor” (Tbilisi) as well as in research laboratories of the Institute of Engineering of the Russian Academy of Sciences (Moscow), Institute of Precision Alloys (Moscow), Central Research Design and Engineering Institute I. Polzunov (Saint Petersburg), Design Department of the “Vibrator” plant (Saint Petersburg), and other research institutions. The work principles and methodology inherent to these installations provided the highest accuracy of measurements, which is actually a model for such measurements. Actually, any competent engineer can equip such an installation with a microprocessor unit, with complementary modern measuring instrumentation, and connect it to a computer. However, the accuracy of measurements will anyway depend on the original method developed on the basis of the above mentioned investigations.

The installations of the “УИМП” type were supplied under license agreements to Federal Republic of Germany, Russia, Georgia, Romania and other countries. More than 50 installations were manufactured by the Institute ELIRI and the Experimental Plant of the Academy of Sciences of Moldova. Dr. E. Badinter, Dr. S. Balaban, and dr. Z. Zelikovski were awarded the S. Vavilov prize, which was the most prestigious award of the Scientific Technological Society of the Soviet Union in the field of Scientific Engineering.

In the mid-sixties of the last century, downsizing, increasing the speed, decreasing the currents, increasing the reliability under the impact of various factors on fuses became an actual task. The need to address these challenges was especially significant for special equipment. The fuses with a nominal current above 200 mA produced by the industry of the USSR, as well as by many leading foreign companies, did not meet the requirements imposed for low-current fuses. To solve these problems, the leading companies used gold drawing microwires in vacuum-sealed enclosures, which complicated and raised the price of the construction and the production technology, and did not provide the required reliability.

Then, Efim Badinter proposed to use the cast microwire in glass insulation to reduce the nominal current, to reduce the sizes, and to increase the reliability. This problem seemed to be simple. However, it was actually very, very difficult and nontrivial, confirmed by the patent received by E. Badinter for this idea.

The development of fuses from cast microwires required complex theoretical and experimental studies associated with the need to address specific features of fuses, such as the presence of glass insulation, millimeter length, micron sizes of the diameter. Simulations were performed and the main thermophysical problems describing the processes of nonstationary heating and the melting of short segments of microwires in glass insulation for different materials, geometries, and melting currents were theoretically solved. In this case, there was even a need to clarify the value of the Nusselt criterion in the interval of values of the Grashof's and Prandtl's criteria of 10^{-3} to 10^{-5} and of 10^{-5} to 10^{-9} , which has been done in the process of investigations by E. Badinter and his colleagues. Many hundreds of purely physical and constructive-technological experiments were performed to test and clarify the theoretical calculations. As a result, 5 types of fuses of 25 current values ranging from 4 mA have been developed.

The technology of manufacturing miniature fuses on the basis of cast microwires was introduced at the Micron plant in Chisinau and at the pilot production of the ELIRI Institute with

an annual production volume of more than 0.5 mln. The production of micro-modular fuses abroad started much later.

Many engineers and researchers of the Institute (Yu. Lapsker, I. Lazurevskaia, L. Loktionova, T. Lyubchak, I. Starush, and others) participated in the research, development and organization of the pilot production of fuses; however, E. Badinter was always their leader. The high technical level of development led to their wide application, which was one of the factors to ensure reliable operation of a series of technical equipment and devices of space, missile, and other areas of technology. It was this work that formed the basis of the candidate's dissertation of E. Badinter, by that time head of the laboratory.

It is known that a talented leader is not afraid of surrounding himself with equally talented staff. It was true for Efim Badinter. Many interesting scientists and engineers worked in his lab, each of them being a head of a separate group or direction. He managed to make a creative atmosphere in the lab, which allowed solving complex scientific and engineering problems on a tight schedule.

It suffices to say that during 10 years when E. Badinter was the head of the lab, seven of its employees defended their dissertations, which was a very high rate for an applied profile institute in Moldova.

For the first time in the world, in the ELIRI Institute in collaboration with the Institute of Applied Physics of the Academy of Sciences of Moldova, many semiconductor materials microwires (Ge, Ge-Si, Bi-Sb, InSb, InSb-BiSb, Bi₂-Te₃, etc.) were obtained and studied. The study of these microwires became a basis for several theses of Moldovan physicists. Even without directly participating in these studies, E. Badinter was always interested in their results and rendered assistance to young researchers in a new direction for the institution. At that date, the Kishinev Research Institute of Electrical Instruments (KNIIEP renamed afterward in ELIRI Institute) issued its periodic collection of articles, organized All-Union Scientific and Technical Conferences (the international relations were limited in Soviet times). Respectively, the multitude of publications reflect this period of E. Badinter's life. In general, most of the major areas of the ELIRI Institute activities during the entire period of its existence can be traced by the publications of E. Badinter. During his working career, dr. E. Badinter published more than 200 scientific publications, including 4 monographs (being a single author in 2 of them); he is an author of 120 patents, some of them registered abroad.

The works in which E. Badinter participated directly or supervised being the head of lab cover a wide range of elaborations and products of great practical importance. We can tell a lot of detail about each of these directions of activity; however, we are limited to the volume of this paper. Therefore, we can only briefly list the main of them, those involving the cast microwire:

- tensoresistors with a single wire (with S. Balaban and Z. Zelikovski as co-authors);
- biomedical electrodes (with I. Shnaiderman as co-author);
- thermoelectric current transducers for the conversion of alternative current into thermoelectric power, which are primary measuring converters in devices for measuring voltage and power in a wide frequency range (with co-authors);
- Hot-Wire Anemometer sensors and speed transducers of different construction for investigation of microstructures of the temporal and spatial variable fields of air stream velocity (with I. Starus as co-author);
- thermoresistors based on Ni microwire;
- tensoresistive transducers of pressure, force, and mass.

Apart from that, many other sensors and more complex devices have been developed under supervision and with a direct participation of E. Badinter. More than 250 new products have been

implemented. A characteristic feature of all these elaborations was the fact that they were brought to the practical implementation, implemented in mass or limited production, and were produced for many years by plants in Russia, Ukraine, Lithuania, Georgia, and many other countries. The developments of the ELIRI Institute, including unique measuring devices (for instance the installation included into the international Ohm standard in Saint Petersburg), associated with E. Badinter were exported to 25 countries. Many of them are used in metrological centers of different countries up to date.

When the technology of microelectronics began to be implemented in the Institute and a relevant department was created, E. Badinter as Deputy Director for Science and afterwards as Director General was fully involved into all the details of thin- and thick-film technology and skillfully adjusted the work of this department during many years. At any high position, he was not limited to only the administrative activities, and he never lost touch with the rank and file employees. He always offered them methodological assistance, going deeply into all the scientific and technological elaborations and problems of the lab, while many new investigations and elaborations were started on his initiative and were often carried out under his direct supervision. The reliance on young scientists was his characteristic feature, and perhaps this helped him in maintaining creativity and scientific longevity for many years.

After the collapse of the USSR and the transition to a market economy, many institutes of applied profile not included in the system of the Academy of Sciences and not funded by the state started were closed one after the other; the preservation of ELIRI in the 1990s seemed a miracle. It would be no exaggeration to say that E. Badinter was the principal author of the miracle. This was certainly not possible without the support of leading experts of the institute, but the merit of the Director-General was undeniable. He was establishing the necessary links. He was engaged in marketing and was attracting potential customers from abroad. He initiated groundwork projects, often almost on the enthusiasm of employees. By using the past experience and not being afraid of new lines of work, the employees of the institute under the leadership of their Director took up any topics, which allowed the institution to survive and the employees to get salary and to remain in their positions.

Listing the achievements of the Institute, one should note that the staff of the Institute was awarded the State Prize of Moldova in science and technology. The Institute is an owner of more than 500 inventions, 80 foreign patents, including in the USA and Japan. Five employees were awarded the title of distinguished inventors of Moldova. In the last decade, members of the Institute, including E. Badinter, were awarded 7 medals (gold and silver) at International exhibitions of Inventions abroad. In 2009, the International Agency for Intellectual Property awarded an Innovative Enterprise prize to the ELIRI Institute. This is also the great merit of E. Badinter.

In recent years, 90% of all the works performed have been associated with orders from foreign companies from the USA, England, Germany, China, the Republic of Korea, Israel, and Russia. Achievements of the Institute contributed to obtaining international grants from the USA and Europe: 3 CRDF grants, 1 STCU grant, and 1 FP7 grant. This made it possible to partially equip the institution with modern equipment. The goal of the last FP7 grant is to increase the scientific and technological level of the ELIRI Institute for its integration into the European scientific community. The Institute is the project coordinator. Research centers from Portugal, Germany, Romania, and Israel and the State University "Alecu Russo" from Chisinau, Moldova participate in this project. This grant also provided an opportunity to acquire modern equipment as well as to be acquainted with the best international practices. Vice-President of the Academy

of Sciences of Moldova I. Tiginyanu was the initiator of this project; however, there is a great merit of E. Badinter in the preparation and obtaining of the grant.

The intuition of E. Badinter as an organizer of science has never failed. When one of the employees of the institute put forward the idea to construct filiform nanostructures, few believed it, but E. Badinter was the first who supported the idea and contributed to the promotion of the project to implement filiform nanostructures in collaboration with the Institute of Electronic Engineering and Nanotechnologies “D. Ghitu” of the Academy of Sciences of Moldova. One should mention here the understanding and support from the Academy of Sciences of Moldova, and especially of academician V. Kantser, who also positively evaluated this new idea. Although the implementation of filiform nanostructures is still only scheduled, for instance, in the preparation of biomedical electrodes, and tangible benefits from their use are yet to come, E. Badinter tirelessly supported the work in this direction, even when the institution was in financial difficulties.



It must be noted that he always knew that "man shall not live by bread alone." In our era impregnated with pragmatism, along with the main objective of providing the Institute with orders and payment of salaries to employees, he tried to keep a high scientific level and the prestige of the institution, demanding the same from the employees.

We note here that the ELIRI Institute is working on a full self-financing scheme and does not receive absolutely no direct financial support from the State.

This alone puts the scientific manager of the ELIRI Institute, which E. Badinter was for many years, among the most notable and extraordinary personalities of our country in the field of science and technologies.

His memory will long remain in the hearts of all his colleagues and partners who knew him and worked with him.

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