NAUM DAVYDOVYCH MORGULIS, THE FOUNDER OF THE KYIV SCIENTIFIC SCHOOL OF PHYSICAL ELECTRONICS (to the centenary of his birthday)

On May 2004, there will be a centenary of the Naum Davydovych Morgulis' birthday.

Naum Davydovych was born in 1904 at the town of Letychiv (now the Khmelnytska region of Ukraine), but spent all his adult life in Kyiv. In 1926, he graduated from the physical department of the Kyiv Institute of Public Education and, for a year, was a lecturer of the vocational technical courses for workers.

In 1927, N.D. Morgulis entered the post-graduate courses of the scientific research chair of physics, which was afterwards transformed into the Institute of Physics of the Academy of Sciences of the Ukrainian SSR. At the same time, he began a pedagogical activity, being a lecturer of the Kyiv Polytechnic Institute and, since 1932, Professor of the Kyiv State University. Here, he created and headed, since 1937, a specialization and the chair of electrophysics, renamed later on to the chair of physical electronics, up to his death in 1976.

In the Institute of Physics, N.D. Morgulis worked until 1961. Here, he created and stood at the head of the department of physical electronics. He obtained the scientific title of Professor in 1934, earned a doctorate in physical and mathematical sciences in 1936, and was elected as a Corresponding Member of the Academy of Sciences of the UkrSSR in 1939.

As early as at the beginning of the 1930s, Naum Davydovych started a new, at that time, scientific direction of physical electronics, both at the Institute of physics and the Kyiv University, thus having become a founder and a leader of the Kyiv scientific school of physical electronics.

N.D. Morgulis began his activity in the field of physical electronics at the moment when this scientific direction was rapidly developed. His first scientific publications, appearing at the end of the 1920s and at the beginning of the 1930s, dealt with the studies of emission properties of tungsten and thoriated thermionic cathodes, which were used in the first home-made electron valves, as well as with the processes occurring in photocathodes of the earliest photocells. He preserved the interest in emission phenomena for many years and made a sound contribution to the studies of physical processes in thermionic and photoemissive cathodes.

The principal and fundamental idea of the semiconductor nature of the effective electron emitters, put forward by N.D. Morgulis as early as in 1936 and concerning oxide-coated cathodes, obtained then a comprehensive experimental and theoretical substantiation in his following works and the works of his adherents. This idea has played a crucial role in researching and unveiling the physical-chemical processes which take place in effective electron emitters. In particular, a profound understanding of those

processes in oxide-coated cathodes, attained as a result of researches carried out at the Kyiv University, has allowed one to radically improve the technology of their fabrication as early as in the 1950s. This made it possible to forecast the performance of oxide cathodes in electron valves and to prolong substantially their lifetimes.

Developing an idea of the semiconductor nature of electron emitters, N.D. Morgulis has formulated, at the beginning of the 1950s, a fruitful concept about the influence of the band structure peculiarities of semiconductors on their emission properties. This stimulated further developments in researching the emission phenomena in semiconductors and resulted in elaborating a theory of the Schottky effect in semiconductors by N.D. Morgulis, in the framework of which the famous formula concerning a decrease of the effective work function in electrical fields was derived. This concept allowed the better understanding of the mechanisms of functioning not only of thermionic cathodes but, also those of photo-, secondary-, and field-emission ones, and led, in particular, to the development of the maiden theory of tunnel emission from semiconductors.

The disciples of N.D. Morgulis, researchers of the Institute of Physics, proved, for the first time, the bulk character of the photoelectron emission from Ag—O—Cs cathodes, determined their energy spectrum and composition, as well as the spectrum and composition of Sb—Cs cathodes. Substantial advances were achieved due to the so-called "wedge method" proposed by N.D. Morgulis. Making use of this method, the optical constants of photocathodes and mean free paths of excited electrons in them were determined. The method turned out very useful also for the investigation of secondary-electron emission, studied at the Kyiv University.

A very important direction, where the Kyiv scientific school of physical electronics achieved significant advances, comprised the studies of surface phenomena. Still before the World War II, N.D. Morgulis has published a number of fundamental works dealing with this problem. In the 1950s, the regular studies of electron-absorption phenomena on a metal surface were resumed under his leadership. The introduction of ultrahigh vacuum facilities into the research practice, with the Kyiv school being an initiator of using the advantages of high-vacuum technologies in experimental investigations in the USSR, created a basis for the study of surface phenomena under high-purity conditions. A combination of ultrahigh vacuum technology with such methods as LEED, EELS, and mass-spectrometry allowed one to reveal the nature of many adsorption processes occurring on the surface, and the influence of various factors on the structure and electronic properties of adsorbed monofilms.

The obtained information concerning the surface phenomena was successfully applied at the Kyiv University and the Institute of physics during the common investigations of the film *L*-cathodes, new objects at that time, which were started to be used in powerful vacuumized electronic devices and had both the enhanced durability and the resistance to ionic bombardment and the action of harmful gases. Those researches allowed one to elucidate the unknown, at that time, mechanisms of activation of such cathodes and of the onflow of an active substance to the surface, as well as the behavior of an active film affected by various factors. As a result of those investigations, recommendations concerning the improving of the fabrication technology of the *L*-cathodes and the optimization of their operational modes, have been elaborated. The recommendations were introduced into practice and had a great economic effect.

In the 1930s, N.D. Morgulis started to study the processes of surface ionization and neutralization. He worked out one of the earliest quantum-mechanical theories in this field of science. In particular, not long before the Great Patriotic War, he obtained the important experimental results concerning the surface ionization of Cs on W, and built the first ion microscope-projector. Soon N.D. Morgulis came back to this issue in connection with the investigation of physical processes in a short diode with a tungsten thermionic cathode in the presence of Cs vapors. It has been shown that such a diode can be converted to an efficient generator of electric power. As a result, a new principle of the thermal energy conversion into the electric one with a significant efficiency and a high power density per unit of the heated body surface. Those researches commenced a new promising trend in energetics, a thermionic energy conversion.

In the 1960s, regular studies have been begun at the Kyiv University under the leadership of N.D. Morgulis concerning the principles of energy conversion taking advantage of plasma and magnetohydrodynamic methods. Making use of a wide variety of techniques, N.D. Morgulis together with his collaborators determined the main parameters of the employed low-temperature plasma, in particular those of the cesium plasma, which is used in thermionic energy converters.

Those investigations resulted in the invention of a new technology for producing the quiescent plasma, the

so-called "photoresonance" method, where the ionization is performed by the irradiation of cesium vapors by resonance photons. A diploma, obtained in 1997, fixed the priority of N.D. Morgulis and his collaborators in that discovery.

A significant contribution has been made by N.D. Morgulis into the study of physical phenomena in gas discharges. His doctorate thesis dealt just with the investigation of cathode sputtering in a gas discharge. Here, one of the earliest theories of that phenomenon has been worked out and the idea of the cathode sputtering as a nonequilibrium process has been substantiated. Soon those researches were continued making use of labeled atoms.

N.D. Morgulis supported and developed, to all his best, the studies of gas discharges carried out at the Institute of Physics, which led to the creation of efficient ionic sources and powerful ionic beams, and to the better understanding of phenomena connected to plasma-beam instabilities. He was an initiator of the researches of the plasma-beam interaction and the creation of plasma amplifiers and ultrahigh frequency generators at the Kyiv University. There, the processes in plasma panels, used to reproduce luminous images, were also studied.

Some of N.D. Morgulis' disciples continue to work in the field of plasma physics at the Institute of Nuclear Researches of the National Academy of Sciences of Ukraine.

Another kind of N.D. Morgulis' activity, not less important and fruitful, was his pedagogical work. His lectures always kept pace with contemporary physics and technology, his presentation of a subject was simple and understandable, his logic perfect, his examples illustrative and striking. Everybody who attended his lectures will never forget them. But Naum Davydovych was not only an excellent lecturer, but also an outstanding teacher and instructor. His method comprised a lecture course accompanied by regular consultative seminars, i.e. colloquia, where both the explanations to the presented material were given and the mastering and understanding of the subject by students were checked. He was a fastidious teacher, so to obtain a high mark at his exam, one had to work regularly and persistently during the whole term.

The lecture course was accompanied by rather difficult laboratory works, which sometimes, depending on the ability of a student, transformed into genuine scientific researches. In the post-war years, N.D. Morgulis introduced an educational method at the Faculty of Radiophysics, where the students of the senior courses carried out their course papers and graduation theses at the laboratories of scientific research institutions, dealing with real issues of investigations similarly to true scientists.

A creative atmosphere, which was characterized by a hard work of students, especially graduate ones, and post-graduates, was typical of the chair. The same situation was also typical of the Department of Physical Electronics at the Institute of Physics at that time.

A collaboration of N.D. Morgulis with disciples and employees was characterized by the absence of guardianship in trifles. He gave only general instructions, thoroughly encouraging subordinates to independence and initiative. As a result of such a behavior, his disciples and pupils became soon self-sufficient researchers, capable to pose and resolve involved scientific problems.

Hundreds of students, who later became high-skilled collaborators of scientific and industrial institutions, have graduated from the chair or have gone through the specialization under the guidance of N.D. Morgulis. He was a supervisor of about 30 Ph.D. and 7 doctorate theses. Those people soon became the heads of departments at the Institute of Physics and chairs at the Kyiv University. Among the N.D. Morgulis' disciples, there are Academicians of the National Academy of Sciences of Ukraine — N.G. Nakhodkin, A.G. Naumovets, and Yu.P.Korchevyi — and Corresponding Members — P.G. Borzyak, Yu.P. Ptushynskyi, and O.K. Nazarenko. Many of Naum Davydovych's disciples became laureates of the State Prizes and heads of leading scientific and industrial institutions. Now, it is the disciples of his disciples who defend the Ph.D. and doctorate theses and continue nice traditions of the Kyiv school of physical electronics.

N.D. Morgulis was not only an outstanding scientist and instructor, but also a talented organizer of science and education. As has been mentioned, it was he who created the Department of Physical Electronics at the Institute of Physics and the relevant chair at the Kyiv University. Namely N.D. Morgulis was among the founders of the Faculty of Radiophysics at the Kyiv University, and namely he laid the foundation of the scientific and educational style which prevails there till now. He organized a Problem Laboratory of Physical Electronics which combined several chairs of the Faculty of Radiophysics in its scientific activity.

The merits of N.D. Morgulis were highly recognized by the scientific community in Ukraine and beyond even at his life. This allowed him to organize a number of large scientific conferences on emission electronics and low-temperature plasma physics in Kyiv, thanks to which

Kyiv became an outstanding scientific center in those branches.

N.D. Morgulis was a man of high ethical principles, fastidious to both himself and the others. The highest-rank vocation for him was his professional activity of scientist and teacher. He left a profound trace in science and a thankful remembrance in the hearts of several generations of his disciples.

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