Bentsion Moiseevich Vul (Obituary)

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Soviet and world physical science has suffered a great loss: on 9 April 1985 Academician Bentsion Moiseevich Vul, a prominent Soviet scientist and public figure, who made a big contribution to the modern physics of semiconductors and dielectrics died in his eighty-second year. B. M. Vul's life is an excellent example of the possibilities that socialist society provides for the development of highly gifted persons.

B. M. Vul was born on 22 May 1903 into the family of a blacksmith in the city of Belaya Tserkov'. As a youth he joined the Komsomol and took part in the civil war in the ranks of the legendary Budennyĭ Army. Recommended by the Komsomol organization for enrolling in an institution of higher learning, he studied at the Kiev Polytechnical Institute and soon after graduation (1928) he began his scientific work in Leningrad.

The early work of Vul at the end of the 1920s was devoted to the filtration of aerosols. In mid-1930s Vul again returned to the study of the filtration of aerosols in the course of passage of gas through fibrous filters. He developed the foundations of the theory of this process and this made it possible to explain the experimental observations available at the time and to point to methods of producing antismoke filters. For these investigations Vul was awarded in 1938 the Order of the Red Star.

Vul's research while a graduate student at the Leningrad Physico-Technical Institute was devoted to the study of dielectric permittivity of a mechanical mixture of TiO_2 with liquid media. Investigation of the high dielectric permittivity of rutile was continued also in Vul's later work.

During his graduate student days Vul undertook the study of the electrical breakdown strength of dielectrics. Some results of this research were included in the book "Physics of Dielectrics" compiled by young scientists of the Leningrad Physico-Technical Institute. Upon completing his graduate studies Vul at the suggestion of S. I. Vavilov—the then director of the Physico-Mathematical Institute of the Academy of Sciences of the USSR in Leningrad—organized a group, and later a laboratory for the physics of dielectrics. Here research was started on the electrical breakdown strength of compressed gases. Vul established that in a homogeneous field on raising nitrogen pressure up to 100 atm it is possible to achieve a breakdown field strength up to 10^6V/cm—the same as in solid dielectrics. This was utilized, in particular, for high voltage insulation of electrostatic generators and other installations.

During the years of World War II, while working at the P. N. Lebedev Physics Institute of the Academy of Sciences of the USSR Vul undertook the development of high frequency ceramic capacitors. By the end of 1944 this work led to the discovery of ferroelectric properties of barium titanate, a development of outstanding scientific and practical significance. Barium titanate whose structure is of perovskite type became a model material for developing theoretical and experimental investigations of the nature of ferroelectric phenomena.

BENTSION MOISEEVICH VUL (1903–1985)

In subsequent years in connection with the problems of building the first nuclear reactors Vul, at the suggestion of I. V. Kurchatov, conducted investigations of the effect of intense gamma irradiation on dielectrics, and established the principal regularities in the alteration of their properties, which are important for the development of nuclear physics and nuclear energy.

Beginning in 1948 Vul and the scientists of the laboratory directed by him embarked on research on physics of semiconductors. This transfer to a new set of problems was in response to the necessity of developing the scientific base of a new branch of technology—semiconductor electronics. In the course of this work single crystals of germanium were grown for the first time in the USSR and nonequilibrium electron processes in them were investigated which determine the functioning of crystal diodes and transistors, and

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the theory of semiconductor devices was developed. In 1952–1953 under Vul's guidance planar semiconductor diodes and triodes were produced for the first time in the USSR, and diffusion transitors were proposed and realized for the first time in world practice. This work played an important role in establishing semiconductor electronics in our country. Subsequently research work was undertaken in the field of photoelectric phenomena in germanium and silicon and laboratory samples of "solar batteries" were produced for the first time in the USSR.

Immediately after the first planar diodes and transitors were produced based on utilizing the properties of p-n junctions in semiconductors detailed investigations of the properties of p-n junctions were begun. Vul was the first to give a rigorous calculation and carried out together with scientists of his laboratory a number of experimental investigations of the capacitance of p-n junctions and proposed to utilize them as nonlinear capacitors. This led to the development of special semiconductor diodes which have found wide application in parametric amplifiers. This set of researches also includes investigations of the capacitance of p-n junctions at helium temperatures which form the beginning of the development of cryogenic semiconductor electronics.

Of considerable scientific and practical significance are Vul's papers on the study of avalanche breakdown and tunnel effect in semiconductors.

The special features of shock ionization of impurities in thin layers when the thickness of the sample is less than the mean free path of the carriers turned out to be of particular interest. As measurements have shown, the breakdown field intensity in this case increases as the mean free path is reduced, while the breakdown voltage attains its minimum value equal to the ionization potential.

In 1958 B. M. Vul together with N. G. Basov and Yu. M. Popov proposed a method of producing an inverted population of carriers in semiconductors in a strong electric field. In 1962 Vul together with scientists of the laboratory headed by him and of the Laboratory of Quantum Radiophysics of the Physics Institute of the Academy of Sciences constructed a semiconductor quantum generator.

Near the end of the 1960s complex investigations were started on Vul's initiative on the physics and technical applications of semiconductors with a narrow forbidden gap. The principal attention was focussed on compounds of the $A^{IV}B^{VI}$ type (PbSe and PbTe) and on solid solutions based on them.

The researches of B. M. Vul on the electrical conductivity in compensated semiconductors are of fundamental significance.

In connection with the development of microelectronics electron processes occurring near and at the surface of semiconductors are becoming ever more important. As a model of a "pure" surface Vul and his collaborators investigated the electrical conductivity of the cleavage planes of bicrystals and also the cleavage surface of germanium crystals in liquid helium.

In the course of his entire activity Vul as the director of the laboratory of the Institute and as the chairman of the Scientific Council of the Academy of Sciences of the USSR on the problem of "Physics and chemistry of semiconductors" developed and maintained contact with many scientific organizations working in the field of the physics of dielectrics, ferroelectrics, semiconductors and practically with all the scientific organizations of the Academy of Sciences of the USSR and other Union Republics, and with many laboratories of the institutions of higher learning and with the scientific research institutes in industry.

The scientific-organizational and community activity of B. M. Vul is very wide and varied. He participated in the civil war, and was a member of the Communist Party of the Soviet Union since 1922.

At the time of organization of the Physics Institute of the Academy of Sciences in Leningrad, and for a time after the Institute was transferred to Moscow, Vul was its science secretary, and during World War II he was the associate director of the Institute.

Vul made a significant contribution to the development of Soviet physics by his work in the position of associate academician-secretary and member of the executive of the division of general physics and astronomy of the Academy of Sciences of the USSR, as the Chairman of the Scientific Council of the Academy of Sciences of the USSR on the problem "Physics and chemistry of semiconductors", which coordinated research in this field of science in our country. In 1951 B. M. Vul was made a member of the main editorial group of the large Soviet encyclopedia and along with B. A. Vvedenskiĭ was the principal editor of the "Encyclopedic Dictionary of Physics".

Vul's activity in international scientific organizations as a vice-president of the International Union of Pure and Applied Physics and a member of the executive of the European Physical Society aided the strengthening of contacts of the scientists of the USSR and of other countries. B. M. Vul several times participated in Pugwash conferences.

B. M. Vul was awarded the title Hero of Socialist Labor. He was the recipient of five Orders of Lenin, of other orders and also of medals. B. M. Vul is the recipient of the Lenin and State prizes. At the end of 1982 B. M. Vul was awarded by the Praesidium of the Czechoslovak Academy of Sciences a gold medal for his services to science and to humanity.

The bright memory of Bentsion Moiseevich—a real Soviet scientist, a representative of the generation brought up in the years of the October revolution, will be retained for a long time in the hearts of his students and comrades, and of the entire Soviet scientific community.

Translated by G. M. Volkoff