Bentsion Moiseevich Vul (on his eightieth birthday)

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The outstanding physicist and one of the founders of modern solid-state electronics, Bentsion Moiseevich Vul, celebrated his eightieth birthday on May 22, 1983.

B. M. Vul's first work at the end of the 1920's concerned aerosol filtering in electrostatic air filters. In the mid-1930's, B. M. Vul again returned to the study of aerosol filtration by passing gas through fibrous filters. He laid the foundations of the theory of this process, which explained the experimental observations available at the time and indicated methods for making antismoke filters. B. M. Vul was awarded the Order of the Red Star for this work in 1938.

B. M. Vul's first investigations as a graduate student at the Leningrad Physicotechnical Institute concerned the dielectric permittivity of a mechanical mixture of TiO_2 with liquid media. This first encounter with the high dielectric permittivity of rutile was manifested in B. M. Vul's future work.

During his years as a graduate student, B. M. Vul studied the electrical strength of insulators. Some of the results of these investigations were published in the book Physics of Insulators, composed by the young coworkers of the Physicotechnical Institute, in a chapter written together with A. P. Aleksandrov. After completing his graduate work, B. M. Vul organized at the suggestion of S. E. Vavilov—director of the Physicomathematical Institute of the USSR Academy of Sciences—a group and then a laboratory dedicated to the physics of insulators. The investigations of the electrical strength of compressed gases were begun here.

B. M. Vul established that in a uniform field it is possible to increase the breakdown field intensity up to 10^6 V/cm—the same as in solid insulators—by increasing the nitrogen pressure to 100 atm. This result was used, in particular, for high-voltage insulation of electrostatic generators and other installations.

During the war years, B. M. Vul was concerned with the development of high-frequency ceramic capacitors. At the end of 1944, this work led to the discovery of the ferroelectric properties of barium titanate, which was of enormous scientific and practical value. Barium titanate, which has a simple perovskite structure, became a model crystal for the development of theoretical and experimental investigations of the nature of ferroelectric phenomena. Barium titanate is now considered to be the progenitor of a very diverse family of ferroelectric substances.

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In subsequent years, under the suggestion of I. V. Kurchatov, in connection with the development of the first nuclear reactors, B. M. Vul conducted investigations of the action of intense gamma radiation on insulators and he established the basic characteristics of the change in their properties, which were important for the development of nuclear physics and nuclear power.

Beginning in 1948, B. M. Vul and coworkers in the laboratory he headed expanded reserach on the physics of semiconductors. The switch to a new subject occurred in response to the need to develop the scientific foundations of a new branch of technology—semiconductor electronics.

During the course of this work, germanium single crystals were grown for the first time in the USSR and the nonequilibrium electronic processes occurring in them, which determine the operation of crystal diodes and transistors, were investigated and the theory of semiconducting devices was developed. In 1952–1953, under B. M. Vul's leadership, the first junction semiconducting diodes and triodes in the Soviet Union were created and the first diffusion transitors in the world were made. This work played a large role in the development of semiconductor electronics.

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Later, research on photoelectric phenomena in germanium and silicon was expanded and the first laboratory samples of "solar batteries" in the USSR were made.

Immediately after the creation of the first junction diodes and transistors, based on the use of the properties of $p-n$ junctions in a semiconductor, detailed investigations of the physical properties of $p-n$ junctions began under the leadership of B. M. Vul. He gave the first exact calculation of and performed together with his coworkers at the laboratory a number of experimental investigations of the capacitances of $p-n$ junctions and he proposed that they be used as nonlinear capacitors. This led to the development of special semiconducting diodes, which are widely used in parametric amplifiers. This work also includes investigations of the capacitance of $p-n$ junctions at helium temperatures which served as the beginning of the development of cryogenic semiconductor electronics.

B. M. Vul's work on avalanche breakdown and the tunnel effect in semiconductors are of great scientific and practical value.

The properties of impact ionization of impurities in thin films, when the thickness of the specimen is less than the mean free path of carriers, turned out to be very interesting. As measurements showed, the intensity of the breakdown field in this case increases as the mean free path decreases, while the breakdown voltage reaches 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 for creating a population inversion of carriers in semiconductors in a strong electric field. In 1962, B. M. Vul and his coworkers at the laboratory he headed and the Laboratory of Quantum Electronics of the Physics Institute of the USSR Academy of Sciences created a semiconducting laser.

At the end of the 1960s, on the initiative of B. M. Vul, comprehensive investigations on the physics and technical applications of semiconductors with a narrow forbidden band were begun. Attention was focused on $A^{IV}B^{IV}$ type compounds (PbSe and PbTe) and solid solutions based on them.

B. M. Vul's work on the study of electrical conductivity in compensated semiconductors is of fundamental significance.

In connection with the development of microelectronics, the importance of electronic processes occurring near and at the surface of semiconductors is increasing. As a model of a "clean" surface, B. M. Vul and his coworkers investigated the electrical conductivity of the cleavage plane of bicrystals as well as the cleavage face of germanium crystals in liquid helium.

Throughout his career. Bentsion Moiseevich, as the director of the Laboratory of the Institute and chairman of the Scientific Council on the Physics and Chemistry of Semiconductors, developed and maintained contacts with many scientific institutions concerning work on the physics of insulators and ferroelectrics and with practically all scientific institutions of the Academies of Sciences of the USSR and of the Republics of the Union and with many laboratories in higher educational institutions and industrial scientific-research institutions concerning the physics of semiconductors.

B. M. Vul's scientific-organizational and social work has been extensive and diverse. He participated in the civil war in the ranks of the Red Army and he has been a member of the Communist Party of the Soviet Union since 1922.

Bentsion Moiseevich was the scientific secretary during the organization of the Physics Institute of the Academy of Sciences in Leningrad and immediately following the Institute's move to Moscow. During the Second World War he was deputy director of the Institute.

Bentsion Moiseevich made a great contribution to the development of Soviet physics with his work as the deputy academician-secretary and member of the Executive of the Division of General Physics and Astronomy of the USSR Academy of Sciences and as chairman of the Scientific Council on the Physics and Chemistry of Semiconductors, which coordinates research in this branch of science in our country. In 1951, B. M. Vul was appointed member of the main editorial board of the Bol'shaya Sovetskaya Entsiklopediya (*Large Soviet Encyclopedia*) and, together with B. A. Vvedenskiĭ, he was the editor-in-chief of the Fizicheskiĭ slovar' (*Physics Dictionary*).

Bentsion Moiseevich's work in international scientific organizations as vice president of the International Union of Pure and Applied Physics and member of the executive committee of the European Physical Society strengthened ties between scientists in the USSR and other countries. B. M. Vul participated many times in the Pugwash conference.

The title Hero of Socialist Labor was conferred on B. M. Vul. He has been awarded nine orders and medals. B. M. Vul is a laureate of the Lenin and State Prizes. At the end of 1982, B. M. Vul was awarded a Gold Medal by the Presidium of the Czechoslovak Academy of Sciences for service to science and humanity.

From all our hearts, we wish dear Bentsion Moiseevich good health and further creative successes.

Translated by M. E. Alferieff