Personalia

BENTSION MOISEEVICH VUL

(On the occasion of his sixtieth birthday)

V. S. VAVILOV

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BENTSION Moiseevich Vul, who enjoys well-merited fame in broad scientific circles in the USSR and abroad, celebrated his sixtieth birthday on May 22, 1963. Vul, who is now a corresponding member of the Academy of Sciences of the USSR, began his scientific career upon graduating from the Kiev Polytechnical Institute in 1928. Working in the field of the physics of dielectrics and later the physics of semiconductors, he made a valuable contribution to these important branches of science from the standpoints of both theory and practical application.

His first series of investigations related to the electric strength of dielectrics. When he began these investigations (in the early thirties), there were no clear concepts concerning electric strength as a physical property of materials. He elucidated the role played by the surrounding medium in the breakdown of solid dielectrics and determined in what conditions reliable experimental measurements of the electric strength of materials may be made. He was the first to give a clear formulation of the distinction between electric strength and the breakdown voltage as a measure of electric strength under different experimental conditions, to discover the effect of the medium on the magnitude of the breakdown potential; and to determine the difference between impairment of electric strength and breakdown.

Great scientific importance attaches to Vul's discovery of a new form of breakdown of dielectrics, which he called step-by-step breakdown. Study of this phenomenon enabled significant advances to be made in the engineering and physics of high tension insulation. During the same period, Vul in collaboration with A. F. Ioffe investigated the use of suspensions of substances with a high dielectric constant in a liquid dielectric (oil) to suppress edge discharges and increase the breakdown potential. Vul and his collaborators also wrote papers dealing with the electric strength of solid dielectrics, more particularly, with the breakdown in rock salt crystals in the presence of photoconduction. They were the first to demonstrate that substantial changes in the concentration of "primary" electrons do not affect the electric strength of crystals of the NaCl type.

By generalizing the results of a large number of investigations of the electric strength of solid dielectrics and discovering several new phenomena, Vul was able to clarify the basic concepts in this field and to lay a sound foundation for further research.

In addition to studying electric strength, Vul elucidated the nature of the irreversible changes which occur in dielectrics in high electric fields, and established that in organic dielectrics this "aging" is the result of chemical reactions.

Vul's next large research cycle was devoted to the breakdown of gases at different pressures. He showed that breakdown voltage does not always increase with an increase in pressure and that in highly inhomogeneous fields it goes through a maximum. Study of this new effect made it possible to explain observed phenomena, taking into account the pressure dependence of space charge diffusion.

Investigation of the breakdown of gases at high pressures (about 100 atmospheres) showed that the breakdown voltage for small intervals exceeds 1,000,000 V/cm. This investigation was supplemented by study of the electric strength of electric engineering components (including porous materials), which made it possible to explain the pressure dependence of breakdown voltage.

This research was very valuable from both the scientific and the practical standpoint, and served as the basis for subsequent utilization of compressed gases as an insulating medium in high voltage engineering. After Vul completed these investigations at the Physics Institute of the Academy of Sciences, they were used as a basis for similar investigations abroad. While studying the electric strength of compressed gases, Vul also carried out a series of experiments on the electric strength of air at pressures below atmospheric pressure, discovering interesting physical regularities in respect of discharges in inhomogeneous electric fields and in high-frequency fields. The results of these experiments were communicated to industrial enterprises and were used in evolving electric and radio devices for high-altitude aviation.

As a departure from his work with dielectrics, Vul studied the filtration of aerosols and propounded a theory of this process, which was later substantiated by experiment.

The third group of studies carried out by Vul in collaboration with the members of the physics of dielectrics laboratory he had organized was concerned with the investigation of solid dielectrics with a high dielectric constant. This research, which was initiated early in the Second World War, became widely known.

Vul and his colleagues investigated in detail the dielectric properties of titanium dioxide (rutile) and its compounds with different metals, mainly those belonging to Group II of the periodic table. They were able to elucidate significant correlations between the value of the dielectric constant and the composition and crystal structure of the dielectric. They found methods for controlling the value of the dielectric constant and its temperature dependence and means of reducing the loss angle in the region of high frequencies.

The results obtained were not only of scientific interest but also proved immediately useful in industry, in particular in evolving and producing microwave ceramic capacitors.

Vul and his co-workers in the laboratory discovered the ferroelectric properties of barium titanate, a discovery which became known the world over and led to the creation of a new category of dielectrics, with properties as different from those of other dielectrics as the properties of ferromagnetics differ from those of other conductors.

The first investigation, which established the extraordinary properties of barium titanate, was followed by a great many others, both in the USSR and abroad. These investigations, a large share of which was carried out by Vul and his collaborators, developed and confirmed the original results. It was generally acknowledged that Soviet physicists were the first to make this discovery.

An interesting offshoot of this work was the study of piezoelectric phenomena in barium titanate, the practical application of which offered new possibilities in engineering. Of particular interest is the magnitude of the piezoelectric modulus of barium titanate, which is 100 times larger than the modulus of quartz. Ceramic piezo-elements made of barium titanate are now being used in ultrasonic flaw detection and in other fields.

In connection with development of electric equipment for atomic reactors, Vul investigated the effects of intense gamma-irradiation on dielectrics, using natural sources of up to 1 gram equivalent of radium. Subsequent tests were also carried out at piles. In the course of these investigations, the basic laws governing the conductivity of dielectrics under the influence of gamma-radiation were established for the first time.

In 1948 Vul and the workers of the laboratory he headed in the P. N. Lebedev Physics Institute, in addition to continuing their work on ferroelectricity, also undertook research in the physics of semiconductors, including fundamental research on semiconductor electronics. In the course of these experiments, germanium single crystals were grown for the first time in the USSR and non-equilibrium electronic processes in this element were investigated; these processes are fundamental to the operation of crystal diodes and transistors. Under Vul's direction and with his active participation, semiconductor diodes and transistors were constructed for the first time in the Soviet Union, and the experience gained in their construction and testing was immediately utilized by industry. Intensive research was done on photoelectric effects in germanium and silicon, leading to the realization of silicon photocells for Soviet "solar batteries." Vul further suggested a new principle of utilization of semiconductor equipment which led to the creation of parametric semiconductor amplifiers.

Lastly, late in 1962 the workers of the laboratory headed by Vul, jointly with the workers of the laboratory of quantum radio physics of the Physics Institute of the Academy of Sciences of the USSR, constructed the first semiconductor quantum generator in the USSR.

These achievements in the field of semiconductor and quantum electronics were made possible by the searching investigations carried out during the past decade by Vul and the staff of his laboratory (known today as the laboratory of the physics of semiconductors of the P. N. Lebedev Physics Institute). Of outstanding interest are their investigations of the processes of impact ionization in semiconductors and also their study of the tunnel effect and other phenomena in degenerate semiconductors.

Vul has published some 100 papers. The laboratory of which he is the head is an important center for the training of young scientists. Vul's students include a number of doctors of sciences and a great many candidates of physics and mathematics.

Vul has always taken an active part in organizational work as well. For many years, ever since the founding of the P. N. Lebedev Physics Institute, he was the Institute's scientific secretary and deputy director. At present he is the head of the Scientific Council on Semiconductors at the Division of Physics and Mathematics of the Academy of Sciences of the USSR.

Vul has been a member of the Communist Party of the Soviet Union since 1922. He has taken an active part in the establishment and the work of the party organization in the Academy of Sciences.

In 1938, he was awarded the Order of the Red Star, in 1945 and 1953 the Order of Lenin, and in 1946 a State prize. On May 21, 1963, for his services in the field of physics and on the occasion of his sixtieth birthday, Bentsion Moiseevich Vul was awarded the Order of Lenin for the third time.

Translated by Valentine S. Rosen