Zhores Ivanovich Alferov (on his sixtieth birthday)

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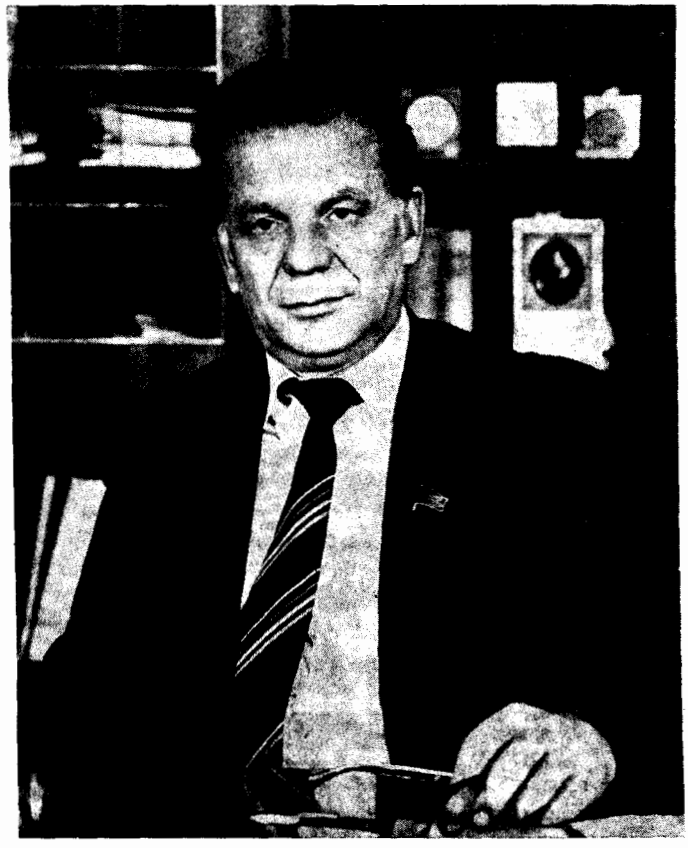
Academician Zhores Ivanovich Alferov, an outstanding Soviet physicist and science administrator, Director of the A.F. Ioffe Physicotechnical Institute of the USSR Academy of Sciences and a member of the Presidium of the Academy is celebrating his sixtieth birthday on March 15, 1990.

Zh. I. Alferov was born in the city of Vitebsk. His father, I. K. Alferov, took part in the October Revolution and commanded a regiment during the civil war, becoming later one of the leading managers in the cellulose and paper industry. The elder brother of Zhores Ivanovich, Marks Alferov, volunteered in 1941 at the age of 17 and fought for his country in the defence of Stalingrad; he was killed in 1944 during the fighting in the Korsun-Shevchenkovski region. Zh. I. Alferov graduated from his school in Minsk with a gold medal in 1947 and went on to higher studies at the V. I. Ul'yanov Electrical Engineering Institute in Leningrad, which he completed with distinction.

The interest in physics drew Zh. I. Alferov in 1953 to the famous Physicotechnical Institute in Leningrad. He was invited by V. M. Tuchkevich to join his laboratory where extensive investigations of semiconductor devices were proceeding. Alferov took active part in the research on p-n junctions and made a significant contribution to the development of the first Soviet transistors, photodiodes, and germanium power rectifiers. This work revealed certain permanent characteristics of the scientific work of Alferov: deep understanding of the physics of the investigated process and a striking ability to apply the results in the development of devices and in the solution of specific physical, technological, or industrial problems.

From 1962 Alferov with a small group of colleagues began to investigate heterojunctions and heterostructures. Already by 1967 he established a fundamental result that determined the future success in this field. He was able to fabricate a heterojunction which was close to an ideal structure, i.e., free of defects at the junction. This was achieved in the GaAs–AlGaAs system, formed by epitaxial methods, because of the near-identity of the nature of the crystal lattices, lattice periods, and thermal expansion coefficients of the two components of the system. Extensive investigations of heterojunctions and heterostructures were then undertaken and this made it possible to determine their principal physical characteristics. In particular, superinjection was observed and this process created a carrier density in a narrow-gap semiconductor exceeding the equilibrium density in a wide-gap material. Electron confinement in heterostructures, associated with variation of the width of the energy bands and ensuring localization of carriers, and optical confinement, due to the difference between the refractive indices of the layers and ensuring waveguide localization of electromagnetic waves, were discovered. This discovery provided means for effective control of the motion of carriers and of light fluxes.

The fabrication of ideal heterojunctions by Zh. I. Alferov, the development of their fabrication technology, and studies of their physical properties provided the basis for manufacture of an extensive range of new semiconductor devices. Very soon (in the late sixties and early seventies) Alferov's laboratory produced the following devices: heterolasers with a low lasing threshold and the first realization of cw lasing at room temperature, highly efficient light-emitting diodes, photodiodes, phototransistors, thyristors, distributed-feedback lasers, and solar cells.



ZHORES IVANOVICH ALFREROV

In the early seventies Alferov and his colleagues formulated the principles of fabrication of "ideal" heterostructures from multicomponent (quaternary) solid solutions of III-V compounds (in particular, InGaAsP heterostructures). In the middle seventies these principles were used in construction of lasers emitting in the visible and infrared ranges. In the seventies and eighties Alferov and his team also carried out extensive investigations of solar cells made of heterostructures, which led to the development of photoelectric converters of concentrated solar radiation (characterized with efficiencies up to 27% when the degree of concentration was a factor of 300–500). These solar cells provide the base for a new generation of solar cells.

The division organized by Zh. I. Alferov developed successfully and applied various technologies of heterostruc-

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ture fabrication, including liquid, metallo-organic, and molecular beam epitaxy, which led recently to a new generation of optoelectronic components based on heterostructures. These include quantum-well injection lasers operating in the infrared and at shorter wavelengths and characterized by record-high conversion efficiencies, single-mode distributed feedback lasers, picosecond lasers and photodetectors, and optoelectronic integrated circuits for ultrafast computers. The research of Alferov thus provided the foundations for a basically new branch of electronics utilizing heterostructures and likely to have a very wide range of applications (this is now known as band engineering).

Alferov paid much attention to the training of young scientists. Together with V. M. Tuchkevich he organized in 1973 an industrial-oriented Chair of Optoelectronics at the Leningrad Electrical Engineering Institute. It produced many graduates in optoelectronics who then worked successfully in the laboratories of the Physicotechnical Institute. This was followed by the creation of industrial-oriented chairs at the Physicotechnical Institute and at the Leningrad Polytechnic Institute. In 1988 these were joined to form a special Physicotechnical Faculty at the Polytechnic Institute; Zh. I. Alferov became the Dean of this Faculty. The next step in the improvement of the selection and training of physicists was creation of an industrial-oriented foundation Physicotechnical School at the Physicotechnical Institute with the very active participation of Alferov. The studies at the Physicotechnical Faculty and at the Physicotechnical School were closely linked to the laboratories at the Physicotechnical Institute.

Alferov has carried out major science administration tasks also outside the Physicotechnical Institute. He is a member of the Presidium of the USSR Academy of Sciences, Chairman of the Presidium of the Leningrad Scientific Center of the Academy, member of the Bureau of the Division of General Physics and Astronomy of the Academy, Editor-in-Chief of the journal "Fizika i Tekhnika Poluprovodnikov," and Chairman of the Council on Physics and Chemistry of Semiconductors of the Academy.

The scientific work of Zh. I. Alferov is known widely. He and his team were awarded the Lenin Prize in 1972 for "fundamental research on heterojunctions in semiconductors and development of new devices on this basis." In 1984 the State Prize of the Soviet Union was awarded for "isoperiodic heterostructures of multicomponent (quaternary) solid solutions of III–V semiconductor compounds." The work of Alferov was frequently recognized by government prizes and he received his first order in 1959 for participation in work on nuclear-power submarines. In 1972 Zh. I. Alferov was elected a corresponding member of the USSR Academy of Sciences and in 1979 he became a full member.

The very high international ranking of Zh. I. Alferov among the physicists in the Soviet Union, Japan, West Germany, and in socialist countries resulted in the award of many international prizes and medals (including the Gold Medal of the Franklin Institute in the United States in 1971), and membership of a number of academies outside the Soviet Union.

Zh. I. Alferov is a member of the Communist Party of the Soviet Union and a member of the Bureau of the Leningrad Provincial Committee of the Party. He was a delegate at the Twenty-Seventh Congress of the Party and in 1989 was elected to represent the USSR Academy of Sciences as a national deputy of the Soviet Union. Alferov is continuing the old physicotechnical tradition going back to A.F. Ioffe: he combines scientific and public activities.

It would seem that the extreme load of the various duties would leave Academician Alferov with not a minute of free time. However, Zhores Ivanovich is still managing to participate actively in cultural life and social work. He meets a wide range of people from various specialities living in various cities and countries, and is capable of recounting these meetings with artistry and in a fascinating manner. He is very interesting company, an excellent storyteller, and a careful listener, always ready to help with word and deed.

On his sixtieth birthday we heartily wish Zhores Ivanovich Alferov good health and more successes in advancing Soviet science.

Translated by A. Tybulewicz