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A tribute to Juras Požela (1925–2014)

Juras Požela (1925–2014) was a prominent Lithuanian physicist, organizer of science and a public man very well-known in the Lithuanian scientific community. He was the founder and the first and long-time director of the Semiconductor Physics Institute, a leading academic research institution in Lithuania. Prof. J. Požela was a President of the Lithuanian Academy of Sciences for many years, and also the former Member of the Parliament of Lithuania.

As a young scientist, J. Požela was a doctorant of the distinguished Russian physicist Abram Fedorovich Ioffe. At the Ioffe Institute in Leningrad he found the main interest of his life: semiconductor physics. His numerous scientific articles and monographs devoted to hot electrons, plasma and current instabilities in semiconductors, nanostructures and high speed transistors, and electromagnetic radiation detectors were internationally recognized and had a great impact on those fields of research. He has published over 400 scientific papers and 9 books, supervised 47 doctoral theses and was honoured by numerous prizes and awards. Juras Požela and the scientific school founded by him accustomed the Lithuanian physics to the standards of world-class science and laid the foundations of high-technology culture in the country.

In relation to his 90th year anniversary, the Editorial Board of Lithuanian Journal of Physics commemorates him by devoting this issue of our journal to semiconductor physics, publishing the articles written by his friends, students and collaborators.

In his last years J. Požela was asked to write a text for the Lithuanian encyclopedia about his most important works in semiconductor physics. Below we present a shortened version of what he thought had been his main achievements in the field:

“My scientific work was devoted to studies of electronic processes in semiconductors. Namely, the studies of electrical and optical properties of semiconductors raised a huge revolution of science and technology which essentially changed our way of life and quality of work in the second half of 20th century. I was happy to work among the scientists who discovered the basic physical principles and developed modern semiconductor electronics. It is a great luck for a scientist to evidence and participate in so fast a progress of science.

As a young researcher, I studied electrical conductivity of semiconductors in high electric fields. This topic was proposed by my scientific adviser, academician A. Ioffe, a famous physicist and organizer of science.

The study of hot electrons was the main field of my scientific interests in 1970s. Luckily, I was among those who discovered new phenomena caused by electron heating by electric field (leaving the crystal cold) in semiconductors. The works performed by me and my collaborators contributed to an important part of semiconductor physics – hot electron physics.

Making an inventory of my research, I think that my most significant works are related to the broadening of the working frequency of semiconductor devices from 10 to 10 000 GHz.

1. Experimental studies and measurement techniques related to electron heating in microwave frequency (10 GHz) electric fields.

New phenomena caused by hot electron heating: thermo and photo electromotive force, emission, current fluctuations, generation and recombination of carriers, non-linear conductivity, negative absolute resistance, non-inertial current saturation and impact ionization in high electric fields [1–4]. Discovery of the bigradient effect [5, 6].

2. Studies in 100 GHz frequency range. Main fields:

Avalanche ionization. The injection and drift of electrons and holes [7, 8]. Electron and hole plasma instabilities [9, 10]. These works stimulated the development of impact avalanche transit time diodes.

Gunn effect. Studies of the inter-valley electron transfer by Monte Carlo method [11, 12] (see also a review on experimental and theoretical studies of this effect [13]).

Electromagnetic fields in magnetized plasma in semiconductors. Plasma and current instabilities (see, e. g. [2, 14]). Application of the microwave technique for generation of helicon waves in high mobility semiconductors [15] (development of helicon spectroscopy [16]). Magnetic field sensors.

Increase of field-effect transistor efficiency. The methods to decrease the 2D electron scattering by interface phonons in a quantum well (quantization of the phonon trapping and insertion of thin phonon barriers). Development of InGaAs/InAlAs transistors (with InAs barrier) with a high limiting current amplification frequency [17]. A review on transistor physics is given in [18, 19].

3. Studies of electromagnetic wave (10 000 GHz range) interaction with phonons and free electrons in semiconductors. (a) Population inversion of heavy and light holes of hole conductive germanium [20, 21] in perpendicular electric and magnetic fields. Participation in the development of a semiconductor laser in THz range [22]. (b) Resonant thermally stimulated THz radiation emission from highly doped polar semiconductor structures [23–26].”

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