

ANATOLIE CASIAN

DEDICATED TO 70TH ANNIVERSARY



On November 17, 2005 Casian Anatolie Irradionovich (until 1995 Kasiyan), Head of Theoretical Mechanics Department of the Technical University of Moldova, Professor, DSc, Academician of the International Thermoelectric Academy, Associate member of the American-Romanian Academy of Arts and Sciences, Laureate of National Prize in the Domain of Science and Technique has celebrated his seventieth birthday.

Anatolie Casian was born in the village Colicautsi, Briceni region, Moldova. In 1957 he graduated from the Chisinau State University (now State University of Moldova), the Department of Theoretical Physics with first degree honors. During the study at University he was mentioned by Lenin scholarship. During 1957-1960 he continued postgraduate study in Theoretical Physics at the same University. In 1965 he defended the PhD thesis in physics and mathematics under the guidance of acad. V. Moscalenco. His thesis was dedicated to the theoretical study of the polaron effect in ionic crystals taking into account the Coulomb interaction between the polarons. A method of diagrams and of Green functions was elaborated for this aim. The coupled polaron-plasmon-phonon modes were investigated and the scattering of polarons on these mixed modes has been considered. This was the most modern treatment for that time.

During 1960-1969 he worked in the Academy of Sciences of Moldova (ASM) in different positions: junior and senior researcher, scientific secretary of Physical-Technical and Mathematical Section of ASM. At the same time, in 1962-1963 he studied at the Moscow State University "M. Lomonosov", under the supervision of acad. N. N. Bogoliubov. He used this time also to attend the course of prof. V. L. Bonch-Bruevich, acad. A. A. Abrikosov, acad. I. M. Lifshits. He attended all scientific seminars of prof. V. L. Bonch-Bruevich and of Professors S. V. Tyablicov and D. N. Zubarev in Mathematical Institute "V. A. Steclov". In 1967-1969 worked in Algeria as Professor of the Alger University. Here, under his supervision the assistant of Alger University Naziha Kesri has defended her doctor thesis.

At that time she was, the second Algerian woman with a doctor degree at the Alger University. Later she has defended the second thesis of DSc. After the return from Algeria, at the invitation of the Rector S. Radautsan he passes to the Chisinau Polytechnic Institute where he was the Head of Theoretical Mechanics Department until 1976. In the Institute he has continued the work on consolidation of Theoretical Mechanics Department which was begun by the founder and the first Head of Department Dr. A. Marinciuc. Since 1970 he was also the scientific secretary of the Institute Council and has contributed much to the improvement of the Council activity. In 1976-1982 he worked at Moldova Filial of the Current Sources Institute of Scientific Industrial Association "Quant", Moscow, as senior researcher, Head of laboratory, Vice-director and Director. Here he has established new scientific relations in the domain of thermoelectricity, in particular, the collaboration with prof. Z. Dashevsky that continues so far up to now. Since May 1982 till present he works again at the Chisinau Polytechnic Institute (now the Technical University of Moldova) as the Head of Theoretical Mechanics Dept. In 1988 he defended the DSc thesis (now Doctor Hability) on the subject: "Kinetic effects in semiconductors and multilayer structures, caused by dynamical screening and by interference of scattering mechanisms". Professor title was conferred on him in 1990.

In 1994 he was elected academician of the International Thermoelectric Academy and in 1999 as Associate member of the American-Romanian Academy of Arts and Sciences. He was Vice-Head of Theoretical physics council in the Academy of Sciences of Moldova, Vice-Head of the PhD and DSc thesis examination board in theoretical physics at Academy of Sciences of Moldova, he is member of International Editorial Board of "Journal of Thermoelectricity", Assistant Editor of "Moldavian Journal of the Physical Sciences", Academy of Sciences of Moldova, and member of editorial board of the journal "Physics and Modern Technologies", Chisinau.

A. Casian participates actively in scientific investigations, has more than 200 scientific publications, including two monographs and 6 manuals for students. He supervised more than 20 scientific projects. The last years he participated as a team leader at realization of 4 International projects: INTAS-96-535 (01.10.1997-31.03.2000); USA Grant N00014-97-C-0219 (23.06.97-29.02.2000) supported by Office of Naval Research, USA; CRDF-MRDA grant No ME-3010 (01.09.2001-31.03.2003); INTAS-01-0184 (01.06.2002-31.05.2005)". All these projects were carried out successfully. He participated with reports at many international scientific conferences. A. Casian received the Diploma of the best paper at 7th International Forum on Thermoelectricity, Kiev, 1996; the Diploma of 1st degree and the Prize of Technical University Senate for scientific achievements (1998, 2000). He is Laureate of National Prize in the Domain of Science and Technique (2004).

The name of A. Casian is well known in large ranges of scientific community. He was invited to the Ben-Gurion University, Beer-Sheva, Israel (1996 and 2002) for two weeks; to H. Poincare University, Nancy, France (1997 and 1998) and to Institute Nationale Polytechnique de Lorraine, Nancy, France (2000) (for one month each year), to office of Naval Research, Washington, USA (1999) where he has presented a report to a technical Council; to University of California-Riverside (2002) for one week; to Observatoire des Micro et Nano Technologies, Paris, France (2005) where he presented a seminar about the thermoelectric organic materials. Under his guidance 7 PhD theses were defended (two theses in Algeria) and 2 theses are in stage of preparation.

The domain of scientific activity of Prof. A. Casian is rather large: fundamental problems of the crystal lattice dynamics and of the theory of semiconductors; transport and thermoelectric phenomena in low-dimensional quantum well structures; thermoelectric

properties of quasi-one-dimensional organic crystals. One can mention several research directions where he has obtained new and valuable results.

1. Theory of kinetic and optical phenomena in polar semiconductor in the conditions of dynamic screening.

The effect of electron and electron-hole plasma on the kinetic and optical properties has been investigated. The Keldysh's diagram method and the Klimontovich's method of the density matrix were developed in order to obtain the generalized kinetic equations that take into account not only the interactions of electrons and holes with the longitudinal optical phonons and ionized impurities, but also their Coulomb interaction. On this basis it was demonstrated that the dynamic screening leads to the increase of electron-plasmon-phonon interaction (anti-screening). As a result, at intermediary concentrations, when the plasmon-phonon resonance takes place, the carrier mobility achieves a minimum value as a function of carrier concentration, determined by the anti-screening of interactions. This result is important for optimization of the semiconductor device function. In the spectra of infrared absorption in the proximity of plasmon-phonon resonance a phenomenon of anti-resonance and a supplementary structure of three peaks appear. They can serve for the determination of crystal parameters.

2. Thermoelectric effects in the structures with many p - n -homo and heterojunctions.

A new mechanism of the thermoelectric tension arising on the potential barrier of the junction, determined by the thermo diffusion of carriers has been proposed. This leads not to the diminution, but to the growth of the potential barrier and to the appearance of a thermoelectric tension with the sign contrary to the usual photoelectric tension. The experiments have confirmed this conclusion of the theory. It has been demonstrated that into the structures with p - n and p - n - n -junctions maxima of the thermoelectric tensions can appear, much greater than at the ends of the structure. This fact must be taken into account for the security of reliability of microelectronic devices, working in not isothermal conditions. A thermo transistor model for the detection of infrared radiation has been proposed.

3. Kinetic of current of non equilibrium carriers in the detectors of ionizing radiation.

The form of current impulse of the detector has been investigated, taking into account the duration of irradiation impulse, the carrier capture by shallow traps and their anew thermal liberation into the band. The optimal parameters of detector were determined in order to obtain the maximum of current amplitude and the minimum prolongation of the back edge of pulse.

4. Optical, transport and thermoelectric properties of some low-dimensional structures.

The effect of coupled plasmon-optical phonon vibrations on the optical and transport properties was investigated. It was found that into a large frequency interval the absorption coefficient of infrared radiation grows by more than ten times in comparison with the case when the presence of electronic plasma is neglected. New supplementary maxima in the absorption spectrum were predicted determined by the intersubband electron transitions.

Optimal parameters and maximum values of the thermoelectric power factor and of thermoelectric figure of merit in n - and p -type PbTe/PbEuTe quantum wells were determined theoretically, on the base of a more realistic model without the use of adjustable parameters. It was taken into account the anisotropy of effective masses, the multivalley character of bulk semiconductors, the dependence of effective masses on the quantum well height and width, the presence or the lifting of valley degeneracy, the effect of carrier penetration into barriers, and the coupling between longitudinal motion of carriers along the well and transversal motion across the well. Further, the nonparabolicity of the energetic bands was considered and a more precise envelope function approximation for the calculation of electronic states

based on anisotropic two band model of the Kane type was developed. Electronic thermal conductivity in these quantum-well structures has been also analyzed. Recommendations for practical applications were elaborated.

5. Thermoelectric properties of quasi-one-dimensional organic crystals.

A new transport model has been proposed, which consists in the realization of interference of two main electron-phonon interaction mechanisms in quasi-one-dimensional organic crystals. One mechanism is connected with the fluctuations of the transfer energy of the electron from one molecule to another due to the intermolecular vibrations. The other mechanism is connected with the fluctuations of the polarization energy of molecules surrounding the conduction electron. As a result, the relaxation time becomes a sharp function of carrier energy of the Lorentzian form. If the organic crystal is rather perfect and has pronounced quasi-one-dimensional properties, the Lorentzian may be very high and narrow. Consequently, in the conduction band a narrow strip of energetic states around the resonance energy appears for which the relaxation time is considerably increased. The carriers in these states will have high mobility. On the other hand, sharp dependence of the relaxation time on carrier energy will ensure high values of the thermopower. The electronic thermal conductivity of such materials has been also investigated and it was shown that it is much less affected by the above mentioned interference. Thus, such quasi-one-dimensional organic crystals are very favorable for thermoelectric applications. The thermoelectric figure of merit of these materials will be much greater than that of known inorganic materials.

Some main publications of A. Casian:

- [1] A.I. Casian, Kinetic effects in Semiconductors of Different Dimensionality (in Russian) – Chisinau. *Stiintsa* Publishers, 1989. - 122 p.
- [2] I.I. Balmus, Z.M. Dashevsky, A.I. Casian, Thermoelectric Effects in Multilayered Semiconductor Structures (in Russian) – Chisinau. *Stiintsa* Publishers, 1992. -144 p.
- [3] A. Casian, I. Sur, A.A. Balandin, Modeling of the Electrical Conductivity in Multivalley PbTe/Pb_{1-x}Eu_xTe Quantum Wells (chapter in *Nanoscience and Nanoengineering*, Series in Micro and Nanoengineering, V.3). Ed. by E. Andronescu, et al. –*Romanian Academy of Sciences* Publishers, Bucharest, 2002.
- [4] A.I. Casian, Thermoelectric Properties of Electrically Conducting Organic Materials (Chapter in *Thermoelectric Handbook: Macro to Nano-Structured Materials*). Ed. by M. Rowe, CRC Press, FL, USA, 2005 (in print).
- [5] A. Casian, I. Sur, H. Scherrer, Z. Dashevsky, Thermoelectric properties of *n*-type PbTe/PbEuTe quantum wells, *Phys. Rev. B* 61, 15965 (2000).
- [6] A. Casian, V. Duscic, Iu. Coropceanu, Huge carrier mobilities expected in quasi-one-dimensional organic crystals, *Phys. Rev. B* 66, 165404-1 (2002)
- [7] I. Sur, A. Casian, A. Balandin, Electronic thermal conductivity and thermoelectric figure of merit of *n*-type PbTe/Pb_{1-x}Eu_xTe quantum wells, *Phys. Rev. B* 69, 035306-1 (2004).

Editorial Board of “Moldavian Journal of the Physical Sciences” and Physical Society of Moldova heartily congratulate Anatolie Casian on the occasion of his jubilee and wish him good health and new creative achievements in the pedagogic and scientific activity.