

ACADEMICIAN ANDREI ANDRIESH – A PROMINENT PHYSICIST, SCIENCE ORGANIZER, MAN OF A GREAT HUMANITY

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ACADEMICIANUL ANDREI ANDRIEȘ, PROEMINENT FIZICIAN, ORGANIZATOR AL ȘTIINȚEI, OM DE MARE OMENIE

Rezumat. Articolul este dedicat academicianului Andrei Andrieș (1933–2012), fondatorul Școlii științifice a fizicii semiconductorilor necristalini din Republica Moldova, președinte al Academiei de Științe a Moldovei în perioada 1989–2004. Este evocată contribuția sa la determinarea proprietăților neobișnuite ale semiconductorilor calcogenici sticloși care a impulsionat interesului față de aceste materiale. Sunt consemnate sumar copilăria și tinerețea sa, familia, prietenii și oamenii cu idei similare, primii pași în știință în cadrul Institutului Fizico-Tehnic „A. F. Ioffe” din Sankt Petersburg (Rusia), fondarea echipei de cercetători și cercetările desfășurate în Institutul de Fizică Aplicată al Academiei de Științe a Moldovei, colaborarea internațională, precum și activitățile didactice, administrative și sociale. Principalele rezultate științifice obținute în echipele de cercetare conduse de academicianul Andrieș sunt citate cronologic și este menționat aportul numeroșilor săi discipoli.

Cuvinte-cheie: Andrei Andrieș, fizician, semiconductori necristalini, academician, președinte, Academia de Științe a Moldovei.

Summary. The article is dedicated to physicist Andrei Andriesh (1933–2012), the founder of the School of study of non-crystalline semiconductor materials in the Republic of Moldova, academician, president of the Academy of Sciences of Moldova between 1989–2004. It is emphasized his contribution in establishing of unusual properties of chalcogenide glassy semiconductors resulting in increasing of interests to these materials. Briefly are considered his childhood and youth, family, friends and like-minded people, the first steps into science in the Ioffe Physical Technical Institute in St. Petersburg (Russia), foundation of the research group and scientific researches in Institute of Applied Physics of the Academy of Sciences of Moldova, international collaboration as well as the didactic, administrative and social activities. The main scientific results obtained in research groups headed by Academician Andriesh are chronologically recounted and the contribution of his numerous disciples is mentioned.

Keywords: Andrei Andriesh, physicist, non-crystalline semiconductor materials, academician, president, Academy of Sciences of Moldova.

Recently, June 30–July 4, 2019, at the Technical University of Moldova held the 9th edition of the International Scientific Conference “Amorphous and Nanostructured Chalcogenides (ANC-9)”, organized in cooperation with the National Institute of Materials Physics (Romania) and the Institute of Virtual Physics (Romania), being supported by the Institute of Applied Physics, Institute of Electronic engineering and Nanotechnologies and the Academy of Sciences of Moldova. The ANC-9 International Conference was dedicated to the founder of the School of study of non-crystalline semiconductor materials in the Republic of Moldova, the late **Academician Andrei Andriesh**,

former president of the Academy of Sciences of Moldova between 1989–2004.

The main purpose of the Conference ANC-9 was conducted to provide exchanging of information in the field of research and innovation of amorphous and nanostructured chalcogenide materials, dissemination of scientific results obtained by researchers in the Republic of Moldova and promoting the image of the Country. The Conference was attended by scientists and young researchers from all the Continents and from about 20 countries, including the USA, France, Czech Republic, Romania, Latvia, Hungary, Ukraine, Russia, Spain, Australia, Argentina, Belarus, Nigeria,



Academician
Andrei ANDRIESH
(24.10.1933–04.07.2012)



Figure 1. Andrei Andriesh, the teacher of physics with his colleagues from the Lozova school (1957) [1]. Andrei Andriesh is marked in the center of the picture.

Serbia, Slovakia, Azerbaijan, Finland, India, United Kingdom, etc. This paper is also dedicated to this valuable scientist, pedagogue, citizen with a great humanity and love to his country.

CHILDHOOD AND YOUTH

Academician A. Andriesh was born on October 24, 1933 in Chisinau in a family of agrarians. He spent his childhood and received the primary and general education in the hometown: primary school from the Buiucani district and then the former general school no. 4 for boy, presently Cheorghie Asachi Lyceum. In 1951 Andrei Andriesh was admitted to continue his studies to Physics and Mathematics Faculty of the Moldova State University of Chisinau. He had the opportunity to be trained by excellent University professors of that time, the physicists Michael Kot, Eugeniu Perlin, Eugeniu Pokotilov and others. He graduated from this University in 1956 and has begun the life of a physicist as a teacher of physics in a village of the Lapushna country located in the center of Moldova (figure 1).

Soon, in 1957, he was employed as the assistant of the Department of Physics of Agrarian University from Chisinau, where he worked until 1959.

THE FIRST STEPS INTO SCIENCE

Due to discovery by B.T. Kolomiets and N. A. Goryunova of chalcogenide glassy (ChG) semiconductors (1950), that was a time of an intensive increasing of interest to non – crystalline semiconductor materials. In 1959 Andrei Andriesh has joined the Prof. B. T. Kolomiets’s group, from the Ioffe Physical Technical Institute in St. Petersburg (Russia) as a post graduate student. Under advise of prof. Kolomiets he has graduated the Doctorate and in 1963 has defended the

PhD theses with the title **”Conductivity and Photoconductivity of Vitreous Semiconductors in the Tl-As-Se-Te System”** [2]. In theses it was clearly shown that chalcogenide glasses cannot be effectively doped [3-5]. In figure 2 the data of Andriesh and Kolomiets for a specific glass Tl_2SeAs_2Te are plotted, calculating the density of charge carriers by using the typical mobility $\mu \sim 1 \text{ cm}^2 \text{ V s}^{-1}$ [4].

This very important conclusion has resulted in a fast increasing of interest to chalcogenide glassy semiconductors and was even mentioned by Prof. Nevell Mott in his Nobel Lecture [6], approximately as the following: the Leningrad Scholl under Kolomiets showed that the concepts of a conduction and a valence band could be applied to glasses, and, more re-

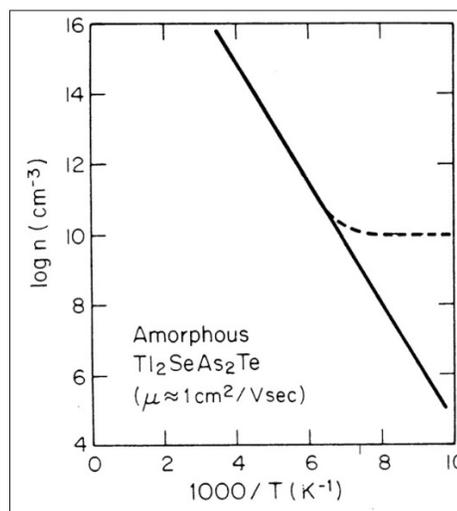


Figure 2. The carriers density of a typical chalcogenide glass versus reciprocal temperature (solid line) calculated from the conductivity data of Andriesh and Kolomiets [3] using the mobility $\mu = 1 \text{ cm}^2 \text{ V s}^{-1}$. Dashed curve represents expected behavior for very pure semiconductor e.g. Si [4].

markably, that the gap, and hence the conductivity, do not depend sensitively on composition. Besides, in his PhD theses have been reflected a lot of interesting data related to spectrum of localized states in chalcogenide glassy semiconductors.

FOUNDING HIS OWN RESEARCH GROUP, THE SCIENTIFIC ACTIVITY AT EARLY STAGE

After returning to Moldova (1962) Andrei Andriesh initiated the investigations in the field of Chalcogenide glassy semiconductors at the Institute of Applied Physics of the Academy of Sciences, which results in creation (1970) under his leadership of a scientific laboratory entitled "Photoelectrical Properties of Semiconductors" (figure 3).

This name was attributed to the new founded Laboratory probably due to the initial results obtained in the group of Dr. Andriesh that dealt with internal photoeffect in chalcogenide glasses based on arsenic sulphide. Just later these materials were proposed for fabrication of either transport or injection layer in phototermoplastic and xerographic structures, developed that time in the State University of Moldova, under guidance of Dr. Lev Panasiuk.

Professor Victor Lyubin of the Ben-Gurion University (Israel) had mention later: Coming back to Moldova, Dr. Andriesh organized a laboratory in the Institute of Applied Physics in Chisinau, where he continues the research in the field of glassy semiconductors together with his true coworker Serghey Shutov and with young physicists Mihail Iovu and Dumitru Tsiulyanu, obtaining many interesting and important results, so it was clear to everybody that here, in Chisinau, the new research center of the glassy semiconductors study is created [1].



Figure 3: a) The collaborators of the Laboratory of photoelectrical properties of semiconductors (1970–1972) Dr. S. Shutov, I. Lerman, M. Iovu (first row from left to right), V. Abashkin, D. Tsiulyanu (second row from left to right); b) Andrei Andriesh discussing the results of the experiments with Serghey Shutov (right picture).

At the beginning (until 1980), the laboratory headed by Dr. Andrei Andriesh dialed with the basic investigations (optical, electrical and photoelectrical properties) of ChG in the systems As_2S_3-Sb (S. Șutov, M. S. Iovu et. al.) and As_2S_3-Ge (D. Tsiulyanu, E. Colomeico et. al.), being conducted to clarify the effect of composition on band gap and its spectrum of localized states. The last problem requires the sophisticated experiments and mostly has been carried out by the group headed by Dr. Serghey Shutov (figure 3).

The discovery of new phenomena in these materials, e.g. the electrostimulated chemical transformations and surface deformations in thin-film structures of the metal-vitreous semiconductor type (1973–1975), as well as realization of the hybrid amorphous-crystalline heterojunctions led to initiation of the quite applicative researches. To carry out these researches, in 1976 has been founded an autonomic creative group headed by Dr. Dumitru Tsiulyanu.

In this period, between 1970–1980, have been published 75 scientific papers and were received 6 patents on inventions. Besides, dr. Andrei Andriesh has defended the thesis of **Doctor Habilitat** in physics and mathematics (1975), while his disciples Dumitru Tsiulyanu (1975) and Mihail Iovu (1976) have defended the **Doctor** degree, in the same field. Three years later (1978), Doctor Habilitat Andrei Andriesh was elected as a Corresponding Member of the Academy of Sciences of Moldova.

INTERNATIONAL COLLABORATION AT EARLY STAGE

In early 70th has been founded the International Conference entitled "**Amorphous Semiconductors**", aimed to establish a closer cooperation between scientific Centers of the East European countries, which have





Figure 4. The opening of the International Conference "Amorphous Semiconductors '80", Chisinau, 1980. First row, from left to right: Prof. Kosa Somogyi (Hungary), Prof. Z. Borisova (Russia), Prof. A. Andriesh (Moldova), Prof. B. Kolomiets (Russia), Prof. R. Andreichin (Bulgaria), Prof. N. Lugnaia (Russia), Prof. L. Stourac (Czech Republic); Second row from left to right: Prof. T. Malinovsky (Moldova), Prof. E. Farhi-Vateva (Bulgaria), Prof. L. Panasiuk (Moldova); Second row from right to left: Prof. S. Dembovsky (Russia), Prof. V. Lyubin (Russia), Prof. M. Bologa (Moldova).

dealt with investigations in the field of non-crystalline materials, including the chalcogenids. The first edition of this Conference was organized in Bulgaria (Sofia, 1972), then in Eastern Germany (Reingardsbrun, 1974), Hungary (Balatonfured, 1976), Czechoslovakia (Pardubice, 1978), Soviet Union (Chisinau, 1980), Romania (Bucharest, 1982), Bulgaria (Gabrovo, 1984) and so on. The laboratory of Dr. Andriesh has actively participated to all editions of this conference and moreover, near 40 years ago, that is in 1980, hosted this Conference, entitled "Amorphous Semiconductors'80". The famous picture of this event is shown on figure 4, in which Professor B. T. Kolomiets, among the world known scientists, open the edition of the Conference held in Chisinau. Participation to these events led to establishment of a large international collaborations with research groups from entire world, first of all from Countries of Eastern Europe (but not only), such as Bulgaria, Eastern Germany, Hungary, Czechoslovakia, Great Britain, Poland and others.

SCIENTIFIC ACTIVITY AND INTERNATIONAL COOPERATIONS IN 80TH YEARS

In 80th years of the last century, Andrei Andriesh headed the laboratory of Photoelectrical Properties of Semiconductors and held the position of the General Scientific Secretary of the Academy of Sciences of Moldova. In the scientific laboratory, the investigations were conducted to complex experimental study of the following:

1) Transient processes of the dispersive transport in ChG (S. Shutov, M. S. Iovu, M. A. Iovu).

2) Contacts phenomena in metal – ChG junctions and heterojunctions based on ChG (S. Shutov, M. S. Iovu, M. A. Iovu, A. Simașchevici, D. Tsiulyanu, E. Colomeico, E. Achimova).

3) Thermostimulated, electrostimulated and electrophotographic processes in ChG (S. Shutov, V. Abashkin, A. Buzdugan, V. Verlan, N. Gumeniuk).

4) Non-linear optical processes in Amorphous Semiconductors (V. Ciumash, I. Cojocar).

5) Surface phenomena in ChG and their application in holography (D. I. Țsiulyanu, G. M. Triduh, V. V. Bivol, E. Achimova).

6) Planar and Fiber ChG based light guides (A. Popescu, I. Culeac, V. Ponomari).

The main scientific results obtained in the Chisinau group headed by Correspondent Member Andrei Andriesh along the 1980–1990 years consist in fundamental and applicative investigation of the following:

- Non-stationary non-equilibrium processes in the wide gap bands vitreous chalcogenides (The theses of Doctor Habilitat of Serghei Shutov, 1984);

- Electrophysical and electrode processes in heterostructures and metal – semiconductor structures based on the wide band chalcogenide glasses (The theses of Doctor Habilitat of Dumitru Tsiulyanu, 1988);

- Electrical properties of the arsenic sulphide thin films (PhD theses of Mihai Cerni, 1983);

- Photoelectrical properties of thin films based on arsenic sulphide in electrophotographic regime (PhD theses of Artur Buzdugan, 1983);

- Influence of contact phenomena and dispersive transport on photoconductivity of the vitreous thin films based on arsenic and antimonite chalcogenide (PhD theses of Maria Iovu, 1984);

- Thermostimulated and photostimulated processes in arsenic sulphide and their analogues (PhD theses of Vladimir Abashkin, 1984);

- Contact phenomena, electrophysical, photographic and injection processes in vitreous thin films, isotypic hybrid heterojunctions and glassy heterostructures (PhD theses of Andrei Simashchevici, 1984; Eduard Colomeico, 1985; Elena Achimova, 1988; Valeriu Bivol, 1988);

- Photoinduced absorption of light in optical fibers from chalcogenide glasses (PhD theses of Ion Culeac, 1989);

- In parallel with scientific activity, thanks to the creative and sociable character of the leader, his personal attractiveness and his wisdom, the laboratory of the Photoelectric Properties of Semiconductors was visited by many leading scientists of that time. As a result, in a large scientific collaboration with scientists and scientific schools from the entire world, including those under leadership of Prof. B. T. Kolomiets, Academician R. Grigorovici, Prof. S. Ovshishy and Prof. N. Mott has been established.

SCIENTIFIC ACTIVITY AND COOPERATION IN AND AFTER 90TH

In 1994 the **Center of Optoelectronics**, headed by academician Andrei Andriesh, has been created at the Institute of Applied Physics, on the basis of three laboratories, namely, the Laboratory of Photoelectrical Properties of Semiconductors, the Laboratory of Physical Kinetics and Laboratory of Polyfunctional Structures POLICOM.

Structurally until recently, the Center of Optoelectronics consisted of Laboratory of Optoelectronics, headed by dr. hab. M. Iovu and Laboratory of Photonics and Registration media, headed by dr. E. Achimova along with a few groups headed by Drs. A. Popescu, V. Ciunash, V. Verlan, N. Enachi as well as Prof. D. Tsiulyanu, were providing the autonomous scientific researches. The main results obtained by this period are related to investigations of the issues:

- Charge relaxation in sandwich barrier structures based on arsenic selenide (PhD theses of Serghei Malcov, 1991);

- Non-linear propagation of the short laser impulses in chalcogenide glasses (PhD theses of Ion Cojocaru, 1993);

- Electrophysical properties of recording structures based on arsenic chalcogenides (The theses of Doctor Habilitat of Mihai Iovu, 1993);

- Correlation of structure and photostructural changes in amorphous semiconductors As-S with $As_m S_n$ structural molecular units (PhD theses of Valentin Dolghier, 1993);

- One and two photons cooperative processes in optics (The theses of Doctor Habilitat of Nicolae. Enachi, 1993);

- Electrical and photoelectrical properties of the heterostructures In_2S_3/As_2Se_3 (PhD theses of Elena Hancevschi, 1993);

- Peculiarities of the physical-chemical and optical properties of the As-S-Ge compounds at the structural-topological transitions (PhD theses of Natalia Gumeniuc, 1993);

- Non-linear optical processes in amorphous semiconductors (The theses of Doctor Habilitat of Valentin Ciunash, 1996);

- Elaboration and optimization of optical registration media based on vitreous semiconductors (the theses of Doctor Habilitat of Artur Buzdugan, 1997);

- Photoinduced phenomena in non – crystalline compounds and planar light guides on their base (The theses of Doctor Habilitat of Aurelian Popescu, 2003).

In the Center of Optoelectronics, apart from investigation of the basic physical properties of chalcogenide glasses, many applicative projects have been proposed and realized. These were the joint projects obtained via INTAS or CRDF grants, or bilateral projects with institutions from Romania, USA, UK, Germany or Ukraine.

ADMINISTRATIVE AND SOCIAL ACTIVITY IN AND AFTER 90TH YEARS

In 1994 Academician Andrei Andriesh was elected as president of the Academy of Sciences of Moldova. From this position he has provided a vast administrative and social activity. He represented the Republic of Moldova at the most prestigious academic international organizations and forums, such as International Atomic Energy Agency (IAEA), the General Assembly of European Academies (ALLEA), International Association of the Academy of Sciences (IAAS) and so on.

Academician Andrei Andriesh essentially contributed to the elaboration and development of the Informational Infrastructure Strategy and the implementation of Academic network development projects in Moldova by RENAM (Research and Education

Networking Association in Moldova) with support of the NATO Science Committee and European Commission.

FAMILY, FRIENDS AND LIKE-MINDED PEOPLE

Educated in a family of simple, diligent and modest people, in an atmosphere of high morality, mutual respect and love for work, the future academician Andrei Andriesh in all his activities was based on these human principles, emphasizing and disseminating them.

He created a friendly own family, being a happy husband and father. Lidia, the wonderful Lady of his life, due to her sensibility and loving, always was a great support for him. His son Anatoli becomes interested also in the scientific research. Academician Andrei Andriesh held the position of the president of Academy of Sciences in a very difficult period of the history, the period of transition from communism to private property. All country, including the Academy of Sciences passed through dramatic trials. Were required great efforts, responsibility and courage to sustain the functionality of the Academy, storing its property and support scientific groups.

The high morality, wisdom and patriotism of the President, as well as the support of friends and like-minded people resulted in preservation of the main scientific organization of Republic of Moldova, that is Academy of Sciences. In this respect it should be mentioned a number of scientists from the Republic of Moldova, such as Academicians Sergiu Radautsan, Dumitru Ghitsu, Mircea Bologna, Vsevolod Moscalenco, Sveatoslav Moscalenco, Valeriu Cantser, Leonid Culiuc, Gheorghe Paladi, Vasile Anestiade, Alexandru Ciubotaru, as well as the personalities from abroad – Stanford R. Ovshinsky (USA), Radu Grigorovici (Romania), Victor Lyibin (Israel), Guy J. Andriaenssens (Belgium), Alexander P. Voitovich (Republic of Belarus), Boris E. Paton (Ukraine). These personalities have encouraged and supported the President to overcome the groundless accusations conducted to diminish the value of science, neglecting the generally known reality.

ACHIEVEMENTS

The list of achievements of Academician Andrei Andriesh is very large and diverse. He was an author and coauthor of about **500** scientific papers and **30** patents. They include the books “**Vitreous Arsenic Sulfide and its alloys**” (1981), “**Nonstationary Currents in Disordered Solids**” (1983), “**The Vitreous**

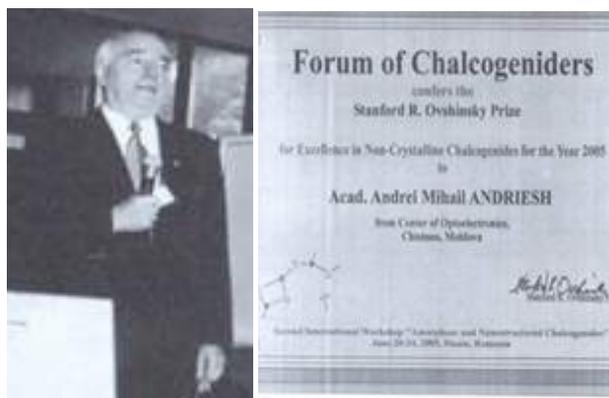


Figure 5. Acad. Andrei Andriesh the full member of Academy of Sciences in field of Physics of Non-Crystalline Materials.

Semiconductors in the Photoelectric Systems of Recording of Optical Information” (1988), “**Physics of Chalcogenide Glasses**” (1996), **Physics and Applications of Non-Crystalline Semiconductors in Optoelectronics** (1997) etc.

He was the **only** full member of an Academy of Sciences elected in field of Physics of Non-Crystalline Materials. Besides, he was a Member of the Engineering Academy of the Russian Federation, Honorable Member of the Romanian Academy of Sciences. Due to the significant scientific results, in 2005 he became the winner of the “Stanford R. Ovshinsky” Award of Excellence in the field of chalcogenides (figure 5).

DISCIPLES

Under general advising of Professor Andrei Andriesh, each research group from his either Laboratory of Photoelectrical properties of semiconductors or Research Center of Optoelectronics had their own scientific plan of activity and their own research projects, together forming a solid creative team. Due to such excellent management a number of remarkable scientific results have been obtained: **8 doctors habilitate and 17 doctors** became highly skilled scientists, which activate in research institutions, universities and industrial companies of different countries of the world.

Among the scientific researchers mentioned above, one became Corresponding Member of Academy of Sciences, 4 of them became Professors and 15 received the title of “Associated Professor” or “Scientific Researcher”. Some of them are shown on the picture in figure 6. Presently the followers of academician Andrei Andriesh continue the work of the lifetime of this wonderful man, a patriot and a prominent scientist.



Figure 6. The disciples and colleagues of Academician Andrei Andriesh (2003). From left to right, in the first row: the author of this paper Prof. D. Tsiuleanu, Prof. M. Iovu, Dr. Elena Hancevschi, Dr. Hab. Elena Achimova, Dr. Maria Iovu; in the second row: Dr. V. Dolghier, Dr. Hab. V. Ciumash, Dr. V. Abashkin, G. Triduch, Dr. E. Colomeico, Dr. V. Bivol, Prof. A. Popescu; in third row: Prof. S. Shutov, Dr. S. Sergheev, Prof. A. Buzdugan.

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Figure 7. Group photo of International Conference on Amorphous and Nanostructured Chalcogenides, ANC-9, dedicated to the 85 anniversary of the Academician Andrei Andriesh. Chisinau, 1 July 2019.