

ACADEMICIAN CRISTOFOR SIMIONESCU – A SCHOOL BUILDER (II)¹

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Three years ago, while commemorating a decade since Cristofor Simionescu had passed away, I evoked his personality from the perspective of a school creator, laying special stress on the following aspects:

“Academician Cristofor Simionescu is a landmark to remain engraved for ever in the history of science, of the technical universities and Romanian school of chemistry and not less in the history of the city of Iasi. We find his name at the origins of some representative areas of macromolecular chemistry, polymers and graft copolymers, of cellulose chemistry, wood chemistry and their associated technologies. Academician Simionescu was one of the few scientists in the country who fully understood the place and the role of fundamental studies as a basis of what he would permanently advocate and develop – a scientific research where fundamental knowledge be valued for the benefit of the society. From this perspective, academician Simionescu manifested a permanent openness towards the new, as proved, on one hand, by the impressive amount of his scientific works and accomplished patents and, on the other, by his contribution both to the modernisation of some industries, such as lumber and paper industry, and to the initiation and support to new industrial objectives. A significant example for the city of Iasi and the region of Moldova would be the plastics and plastic fibre industry. However, in my opinion, his greatest contribution to all these sectors was the development of authentic national schools in these areas, supported by higher education programs and a corresponding rich scientific research activity.”

Now, when celebrating the centennial anniversary of the birth of academician Cr. Simionescu, I have the opportunity to continue remembering his personality, by

¹ *This evocation, occasioned by the centennial anniversary of academician Cristofor Simionescu, continues the approach initiated by the author on projection of the image of the school creator in the area of plasma-chemistry. It is also an opportunity to acquaint young generations with the conditions in which our predecessors had to perform, while emphasising their moral features complementary to their will to build for the benefit of all.*

relating some events that I have either attended or witnessed, hoping that, in this way, I could contribute to enriching the image of the personality of the educator, specialist and man of the citadel he was.

The scientific outcomes of the investigations on plasmo-chemistry, obtained shortly after he had established a mixed team made up of chemists from the "Petru Poni" Institute of Macromolecular Chemistry and physicists from the "Alexandru Ioan Cuza" University of Iasi, already mentioned in the first part of this evocation, constituted the subject of his first scientific papers and patents, issued between 1968–1971[1–3]. The developments, registered at the "Petru Poni" Institute, of certain facilities proper to plasma-chemistry pioneering for enriching the existing equipment of the Plasma Physics laboratory of the University of Iasi, and especially accumulation of professional and practical experience within a mixed team, have offered the opportunity to develop specific studies for both participating institutions, which resulted in a diversification of themes of national and international cooperation. I shall not insist on the developments registered at the Institute, aimed, on one side, at procuring new equipment and installations and, on the other, at encouraging studies dedicated to the initiation of chemical reactions in complex combinations of gases, along with the publication of numerous scientific works, elaboration of doctoral theses and participation to national and international scientific events.

This new recall text is a good opportunity to exemplify some deeds specific to academician Cr. Simionescu, as it follows hereinafter. In each and every of his initiative launched along time, one can identify a major goal, involving scientific, technological, social or mixed issues. In the case of industrial applications, the goal would be stated in the early stages of preparation of a new theme, since the industrialisation program of the country provided a large area of action. At times, nevertheless, as in the case of fundamental studies of plasmo-chemistry, several goals have been sometimes approached, but the main objective had been fully understood only a little later!

Therefore, in the early activity of the research groups, the main practical goal was that of creating a new laboratory at the "Petru Poni" Institute, the qualified staff for complementary areas and an internationally emerging research theme. However, after a few years, during a visit of the minister of education at the institute, academician Cr. Simionescu requested for his help, namely suitable conditions for the development of studies on chemical reactions in plasma, with a view to obtaining new information on the origin of the living matter. While using glow discharges through oxygen, nitrogen and water vapours mixed gases, they would aim at obtaining complex molecular structures of amino acids, proteins and other structures preceding the biological living cells. Actually, the researchers proposed the development of Oparin's model to explain the "origins of life" from an open perspective, and initiation of studies on plasma physics, which would create new experimental conditions and, implicitly, improve the existing model [4].

The team established for the integrated laboratory within the Institute continued successfully a complex activity, rapidly recognized at national and

international level. Its outcomes can be found in the published scientific papers and patents, in the reports on the activity of the institution and, obviously, in the impressive activity report of academician Cristofor Simionescu. Further on, my attention will fall on exemplifying how academician Simionescu's initiative has influenced and even determined, in other research institutions and teams outside the Institute, re-orientation and amplification of studies in this new area of scientific research.

Therefore, studies of explicit objective on chemical reactions within plasma were initiated at the University of Iași, in the spring of 1972, by a mixed team, as a collaboration between specialists from the Department of Chemistry-Physics of the Faculty of Chemistry and specialists from the laboratory of Plasma Physics of the Faculty of Physics. The model to team organisation and functioning was the one applied in the collaboration between the Institute and the University of Iasi. Actually, like it always does, people and their motivations represent the catalyser, therefore it was no surprisingly at all to find in the new team the same physicists: associate professor, PhD, Mircea Sanduloviciu and assistant professor G. Popa, encouraged and motivated by the results obtained during their cooperation with specialists from the "Petru Poni" Institute coordinated by academician Cr. Simionescu. The Faculty of Chemistry was represented by professor docent Vasile Ababei, PhD, head of the team, and assistant professor Gelu Bourceanu.

The studies performed by the new team between 1972 and 1975 have led to relevant results on the kinetics of the chemical reactions, on the transformation of aromatic hydrocarbons into radio-frequency glow discharge and presence of water vapours and/ or oxygen [5–9]. It was under these circumstances that the first doctoral thesis on plasma-chemistry has been accomplished. The studies initiated at the University would be continued and completed as such, even after the transfer of the Faculty of Chemistry to the "Gh. Asachi" Polytechnic Institute, where a new research team dedicated to plasma-chemistry was established.

To understand and evaluate as objectively as possible the outcomes of that period and their subsequent evolution in the area under analysis, it is important to mention here the change produced in the policy of the governing party, and its consequences on the economic and social areas of the country. In the autumn of 1971, the process of intense ideologization of education and of the entire social and cultural activity would start, resulting in the isolation of the Romanian society, whose economy had been guided towards an autarchic regime. Under these circumstances, the scientific research had to align itself almost exclusively to applicative studies, with a view to support the economy and eliminate exports, while becoming financially dependent, most part of it, on the agreements concluded with the Romanian economic units.

In the institutions developing scientific activities, such as research institutes, universities and polytechnic institutes, there have been established, on one hand, laboratories pre-eminently orientated towards applicative studies and, on the other, micro-production units, known as type-C units! Their role was to have at least part of the results of the scientific research "capitalised" as a small series manufacturing

of industrial goods, consumer goods, or as research activities. All these changes, intensified in the 80's, resulted in a large diversification of the activities of these research units and in an increased number of employees in this area. Unfortunately, the negative effect of this process was a decline in quality of most of such areas. Numerous new fields of research have emerged, requiring qualified staff with expertise, whose training needed time, consistency and sustainability. On the other hand, starting with the year 1977, the process of qualitative decline was intensified by the lack of updated scientific documentation and limited cooperation with foreign specialists.

This state of affairs determined re-orientation and dissipation of the existing material and – especially – of human resources, who had to deal with finding solutions to practical and sometimes minor issues, or to some problems already solved in other countries! Due to the lack of scientific and technical information or by reason of currency savings, the research teams would now and then pledge to accomplish, even if with big delays, some parts or equipments, sometimes of low quality and more costly than if purchased from foreign prominent producers.

Despite all these circumstances, many research teams have not abandoned their interest for the study of some fundamental phenomena and processes or for themes of great scientific interest. They have found solutions to thus combine their activities, making possible to indirectly sustain highly fundamental studies with the resources obtained for applicative researches requested by the economic units. The outcomes of the fundamental research would constitute the subject of some scientific works to be published in international magazines, being appreciated by foreign guests and creating grounds for possible international cooperations. Such an approach on fundamental studies has made the few foreign specialists that would pay visits to us that time appreciate this activity as a hobby! Which is quite true, to a certain extent. This was the solution adopted both by the "Petru Poni" Institute and by the specialists of the Iasi University where, apart from the laboratories of fundamental research, some units of micro-production have been established to solve certain technical and technological issues, and where professional knowledge and the technical endowment of the laboratories, accumulated due to the cooperation with the team coordinated by academician Cr. Simionescu, contributed decisively to the orientation of research towards directions with applicative potential.

Before 1989, the cooperation with the economic units where plasma-chemistry knowledge was required would aim at two major themes of research with direct applications in economy: i) plasma ion-nitriding and ii) activation and functionalization of polymeric surfaces by plasma treatment. Laboratory studies would aim, on one hand, at elucidating certain physical processes, such as formation and dynamics of space-charge layers on ions, thermal diffusion processes, etc., as well as the kinetics of chemical processes related to reactions of nitrogen-hydrogen, nitrogen-iron, formation of OH group and their kinetics at the intersection of gas discharge plasma and metallic and/ or polymeric surfaces. Such studies have been motivated by the need to produce new technologies with practical applications for

different industrial sectors. The obtained results have made the subject of several scientific papers published by specialized magazines [10] presented to national and international conferences [11], as well as of several patents [12–14]. Edifying indeed is that, in 1989, in Romania there were over 80 plasma ion-nitriding machines of internal production (IFTAR and FAN Bucharest), 6 of which being operated in Iasi. Their rated power was 70 KW, and the team of plasma physics at the “Alexandru Ioan Cuza” University provided for technical consultancy. Studies on the changes produced to the surface of polymeric materials under the action of glow discharge – initiated by the direct contribution of academician Cr. Simionescu – constituted the subject of numerous contracts concluded with units of the chemical industry of Iasi, Săvinești, Brăila (CFS, Mase Plastice, etc.).

This intense cooperation with industrial units has provided for financial resources to employ young researchers, some of them with industrial expertise, to develop an immaterial basis for laboratories of plasma physics, to organise scientific national (CPPA and specialised symposia of the FEPA Bârlad, CFS Săvinești) and international events (the Third Symposium of Double Layers, Iasi-Bucharest, 1987) and to conclude important international agreements, such as, for instance: i) the agreement between the University of Greifswald and the University of Iasi, signed on October 1, 1974 for the 1975–1980 period, then extended until 1993, whose distinct theme would aim at chemical reactions in oxygen plasma, and ii) the 1974 agreement between the University of Innsbruck and the University of Iasi, on a much larger theme, which also included the study of structures of space charges in plasma produced in sodium and/ or potassium vapours.

The studies performed within such national and international cooperation would have a mutual idea, that of the evolution of knowledge and the interest of the international community in phenomena and processes occurring in regions of plasma contact with other solid, liquid or gas materials. The moment in which academician Cr. Simionescu proposed and put into practice the cooperation with Sanduloviciu and in which, in 1967, the multidisciplinary team of the “Petru Poni” Institute was created, in the laboratory of Plasma Physics of the University, a phenomenon called plasmoid, which would raise the interest of the international community, was already under investigation [15,16]. Later on, when academician Cr. Simionescu stated that the study of synthesis reactions of amino acids and other elements preceding the living matter would range among the issues the chemical reactions were concerned with, prof. Sanduloviciu brought into discussion the similitude between cell division and the dynamics of plasmoid. Nowadays, the term plasmoid has a wider meaning than it used to have by then, when the aforementioned ideas had been put forward, while different formations of plasma generated by atmospheric pressure, in ionosphere or in certain zones of the outer space, are also being assimilated to plasmoids [17,18].

The idea set forth, related to the similitude between cell division and a plasmoid has been followed by prof. M. Sanduloviciu along all his research activity. Plasma formations of a plasmoid type, of a ball lightning type or of a positive glow

type and others are generally associated to other plasma specific structures, known as double layer; this is the zone which separates the plasmoid from its surrounding gas environment. The study on double layer within plasma was one of the dominant subjects of the team coordinated by prof. Sanduloviciu.

However, prior to evoking some facts and achievements related to the search for the “origin of life”, while following somehow their historical development, I should here recall an event which, to my knowledge, has not yet been presented in a written document. An event which would reveal both some luminous and less pleasant aspects of people’s life which, either out of knowledge, sometimes of fear and mostly of carelessness, are being forgotten.

In 1984, the papers sent by the members of the plasma physics team of the University of Iasi to the Second International Symposium on Double Layers in Plasma have been accepted for presentation. More than that, the Honorary President of the symposium, professor Birdsall, would invite the plasma physics team of our university to present, in a seminar organised within the same manifestation, their experience in the field of applications of electric discharge in gases and on the role of layers of space charges in these applications. The theme proposed aimed directly at their expertise in ion nitriding. At that time, the plasma physics team of the Iasi University had already published several works on the structures of space charges, particularly the special case of double layers, which was the very topic of the symposium. On the closing session of the symposium there were proposed three centres and personalities for the organisation of the third symposium, namely Oxford (prof. J. Allen), Bochum (prof. H. Schamell) and Iasi (prof. M. Sanduloviciu). With a majority of votes of the people present, at the second Symposium of July 1984, held at the University of Innsbruck, Austria, a decision was made to organize the next symposium at the University of Iasi.

I will not go further into details on all elements related to obtaining legal approval for such a manifestation, to its organisation and to other elements specific to those times, along those three years that had elapsed since the decision of 1984 until April 1987, when the third symposium took place.

I will only limit my discussion to one single edifying fact, characteristic to those times, when academician Cr. Simionescu had a decisive role in saving a more than critical situation while making a proof, once more, of his human and moral qualities. The approval to organize the third international symposium at the University of Iasi had been received in December 1986 by an official letter signed by comrade Matache, director of the National Council for Science and Technology! A week before opening of the afore-mentioned symposium, we have been informed over the telephone by a “director of some hotel and restaurants enterprise” of Bucharest that the symposium would not to be held in Iasi but in Bucharest, without specifying its venue, too! In that moment, it was academician Cr. Simionescu who offered his support to obtain approval for organizing the symposium in the Small Hall of the R.S.R. Academy of Bucharest. For our younger readers, we need to

specify that the event was to be held early in April 1987, only two months after the students of the Iasi University, to whom students from the other higher education institutions of Iasi had joined, had triggered, on the evening of February 17, a protest, asking for “*light to be able to learn and hot water to be able to wash ourselves*”! These were the times. Do we still need to add something more to this account?

Following the events of December 1989, the scientific research activities suffered major changes, caused by the new trends manifested in the society. Destructuring of the centralised system, extinction of some entire sectors of production and, implicitly, of some important funding sources for scientific research, led to re-orientation of structures of scientific research and themes, most of them largely dependent on the state budget. The political and economic changes had nevertheless created new opportunities, among which the possibility to attend international programmes and projects of scientific research by institutions and researchers of Romania, the establishment of new scientific and technological cooperation at either institutional or personal level, the access to international scientific literature and participation to international scientific events.

Under these circumstances, the plasma physics team has modified and updated the characteristics of its scientific profile. Emphasis has been gradually laid on the study of some fundamental processes of physics, while still preserving to a large extent the themes in which scientific and technical skills of the team members had been trained, while they still could take advantages of the existing material basis. The changes have been accelerated by the extraordinary dynamics of the international collaborations. The TEMPUS and ERASMUS European projects dedicated to the collaboration between European universities and mainly to students’ training, complementary to COPERNICUS, FP5 – FP7, EURATOM and to other scientific research projects, to which various bilateral cooperation programs between the University of Iasi and several European universities have been then added, resulted in fruitful exchanges of specialists, doctoral students and students, in common approach of studies and accomplishment of doctoral theses and joint degrees. To the development of these exchanges and to the international recognition of the plasma physics team of our University, the experience accumulated by its members, specialists trained in the field of plasma-chemistry coordinated by academician Cr. Simionescu, had contributed to a large extent. I would only mention, as examples, the doctoral theses accomplished in the laboratories of plasma physics and/ or by joint degrees with partners from France, Austria, England or Japan, whose themes were strictly related to physical and chemical processes in plasma of electric discharge in gases.

The area of plasma-chemistry has given the opportunity to expand the investigations of the plasma physics team of the University of Iasi towards other systems, to produce plasma through dielectric barrier discharge or microwave discharge, as well as towards the approach of numerical methods for the study of complex phenomena of discharges in gases.

Moreover, the results having been related to practical applications and especially to the multitude of chemical reactions and their effects on interacting surfaces, living tissues included, permitted the research team to propose and finally establish two new specialised sections at the Faculty of Physics, namely: i) Technological Physics, and ii) Medical Physics and Biophysics. Both sections would benefit from the skills acquired by the members of the plasma physics team in the field of plasma-chemistry. Thus, new methods and techniques of action of the physical factors on the matter have been settled, as a result of the continuous multiplication of the cooperation among the specialists of the "Petru Poni" Institute and the physicists belonging to the plasma physics team of the University, initiated more than half century ago by academician Cr. Simionescu.

As already mentioned in the first part of this evocation, one of the referential results obtained by the plasma physics team led by prof. M. Sanduloviciu, following studies on double layer of plasma and its associated non-linear phenomena developed for five decades, again a result of the cooperation he started in 1967 with academician Cr. Simionescu, was synthesised by prof. M. Sanduloviciu in the following manner:

"... I have set forth, in several works published in collaboration with other specialists, the hypothesis that the model of the ball of fire (whose electrostatics is being governed by the laws of quantum mechanics) can explain the origins of life under conditions of the presence of some substances which chemically react as soon as oxygen emerges" [19].

While referring to the results obtained by prof. M. Sanduloviciu, academician Ioan Ioviț Popescu would give him, in the same anniversary document [19], the following characterisation:

"His area of expertise is the physics of the «ball of fire» formed in electric discharge in gases, a replica at laboratory scale of the «ball lightning» in atmospheric discharge. The international scientific community accepted his ideas and experience on laboratory plasma globe, whose autonomy, growth, multiplication and communication characteristics are similar to biological cells (see Erzilia Lozneanu and Mircea Sanduloviciu, Minimal-cell system created in laboratory by self-organization, published in Chaos, Solitons & Fractals, 2003, volume 18, page 335). These fundamental researches open a completely new perspective on the way in which life can appear within some microseconds of electric discharge in a favourable atmosphere".

I have here presented only part of the studies and results obtained by the school of plasma physics of the University of Iasi, which had the chance to enjoy the experience, erudition and that initial impulse, so necessary when approaching a

prospective research domain. Such an impulse has been generously given by academician Cr. Simionescu to the future team of plasma physics established by professor dr. docent Mircea Sanduloviciu, thus providing answers to the numerous challenges specific to searchers for more thoroughly knowing and understanding the world and – why not? – even the origins of life!

All I have recalled here: the development, at the University of Iasi, of the original idea promoted by academician Cr. Simionescu related to chemical reactions in plasma, would not have been possible without a proper understanding of how phenomena occur, and without the support assured to these scientific collaborations by each and every management team of the “Alexandru Ioan Cuza” University of Iasi and of the Faculty of Physics along the periods hereinbefore evoked.

REFERENCES

1. Cr. SIMIONESCU, N. ASANDEI, F. DENES, M. SANDULOVICIU, G. POPA, *Études sur la polymérisation dans le plasma*, European Polymer Journal, 1969, **5**, 427–433.
2. Cr. SIMIONESCU, N. ASANDEI, F. DENES, M. SANDULOVICIU, G. POPA, *Procedeu de obținere a polimerilor pe bază de acrilonitril cu proprietăți de semiconductor în plasma de radiofrecvență*, 1969, 52.088.
3. Cr. SIMIONESCU, N. ASANDEI, F. DENES, M. SANDULOVICIU, G. POPA, *Procedeu pentru obținerea polimerilor în plasmă*, 1971, 53.689.
4. Cr. SIMIONESCU, F. DENES, *Originea vieții*, 1983, Publishing House of the Academy of R.S.R., București, 110 p.
5. G. BOURCEANU, V. ABABEI, G. POPA, M. SANDULOVICIU, *Transformation on the Toluene-water mixture in the H.F discharge plasma. I.*, Rev. Roum. Chem., 1974, **19**, 207–211.
6. G. BOURCEANU, V. ABABEI, G. POPA, M. SANDULOVICIU, *Transformation on the Toluene-water mixture in the H.F discharge plasma. II.*, Rev. Roum. Chem., 1975, **20**, 627–631.
7. G. BOURCEANU, G. POPA, M. SANDULOVICIU, V. ABABEI, *Phenol obtention from benzene in Oxygen Plasma Generated by H.F. Discharge. I.*, Rev. Roum. Chem., 1976, **21**, 1405–1415.
8. G. BOURCEANU, V. ABABEI, G. POPA, M. SANDULOVICIU, *Phenol obtention from benzene in Oxygen Plasma Generated by H.F. Discharge. II. The Phenol Formation Mechanism*, Rev. Roum. Chem., 1977, **22**, 459–465.
9. G. BOURCEANU, V. ABABEI, G. POPA, M. SANDULOVICIU, *Phenol obtention from benzene in Oxygen Plasma Generated by H.F. Discharge. III. Kinetics of the Process in Pulse and Steady-State Regime*, Rev. Roum. Chem., 1977, **22**, 1390–1394.
10. O. PETRUS, G. POPA, S. KUHN, *Experiment planning, mathematical modelling, nonlinear optimization of the ion-nitriding process in a glow discharge plasmas*, Plasma Chem. and Plasma Process., 1982, **2**, 167–183.
11. M. GHEORGHIU, M. SANDULOVICIU, G. POPA, D. TURCU, *Considerations on plasma modification of polymer surface cohesion*, Proc. Inter. Conf. Plasma Sci. Technol., 1986, Beijing, 484–489.
12. M. SANDULOVICIU, G. POPA, FI.TUFESCU, C.RĂUTU, *Metodă și dispozitiv de detecție ultrarapidă a arcului în instalațiile de niturare ionică*, Patent Nr.778.732/1980.
13. G. POPA, G. BOURCEANU, *Metodă și dispozitiv de corodare selectivă a polimerilor în plasmă*, Patent Nr.79.590/1981.
14. G. POPA, M. GHEORGHIU, V. ANIȚĂ, C. RĂUTU, *Metodă și dispozitiv de metalizare a materialelor polimere*, Patent Nr.85.803/1984.

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15. M. SANDULOVICIU, M. MELICA, I. POPESCU, *Oscilații de tensiune într-o descărcare electrică în gaze arefiate, întreținută printr-un câmp de înaltă frecvență*, An. St. Univ. Iasi, 1962, **XVIII**, S1b, 147.
 16. G. POPA, M. SANDULOVICIU, *Schwingungseigenschaften einer Resonanz Hochfrequenzladung*, An. St. Univ. Iasi, 1968, XIV, S1b, 135.
 17. <https://en.wikipedia.org/wiki/Plasmoid>.
 18. <https://www.plasma-universe.com/plasmoid/>.
 19. *Profesorul Mircea Sanduloviciu la vârsta de 90 de ani*, G. POPA, M. TOMA (Eds.), 2017, 100 p.