



INTERNATIONAL YEAR OF THE PERIODIC TABLE
OF CHEMICAL ELEMENTS (IYPT 2019)



CENTENARY OF IUPAC (IUPAC 100)

THE 100th ANNIVERSARY OF IUPAC AS AN INTERNATIONAL HUMAN RIGHTS ORGANIZATION FOR CHEMISTS IN 2019: STATUTE, STRUCTURE AND COMPETENCE

¹Maria Atanassova, ²Radoslav Angelov

¹University of Chemical Technologies and Metallurgy (Bulgaria)

²Institute of Optical Materials and Technologies – Bulgarian Academy of Sciences (Bulgaria)

Abstract. IUPAC 100th anniversary will be celebrated in 2019 year all over the world by the chemistry community predominantly, like a globally-recognized authority on chemical nomenclature and terminology. In the view of the fact that this honoring is commemorated only once in time, the present announce reveals briefly how this organization works, its statute, structure and competence. The principal goal is to synopsise the overall mission of this so much acknowledged international union historically during one century under the key idea of creating a common language for chemistry and its long lasting impact.

Keywords: 100th anniversary; IUPAC; mission; structure; competence

Introduction

The International Union of Pure and Applied Chemistry, generally abbreviated as IUPAC, is an international, voluntary, nongovernmental and nonprofit association incorporating national chemical organizations, sciences academies or other legal entities of different countries defined the IUPAC likes international federation. Each of those federates represented the chemists from member country, named substantially Adhering Organization. As a neutral and objective scientific organization dealing with chemical problems, the IUPAC was established in 1919 year like a simple continuation of the existing International Congress of Applied Chemistry for the advancement of chemistry. As a matter of fact, this union has been formed by chemists from both industry and academia, because of the huge need from an international standardization in the field of chemistry like a branch of science.

One French name was so strongly anchored with the chemical revolution during 18th century, which almost everybody in the Earths knows, i.e. the name of Antoine-Laurent de Lavoisier. Lavoisier's revolutionary nomenclature spread throughout Europe reaching the United States so quickly and become in general use in the field of chemistry, because of no availability of coherent *modus operandi* of chemical nomenclature at this time (Fig. 1). This remarkable effort that represents the synthesis of his personal, unfortunately short (execution by guillotine at age 50), but very intensive research contribution to chemistry could be considered as the first modern textbook on the subject of chemistry.

Although approximately 71 years after the appearance of this piece of work, the first demands of common, regular, internationally accepted chemical standards were discussed in the late 1860 year during the first conference of chemistry worldwide held in Karlsruhe from 3 to 5 September i.e. International Congress of Applied Chemistry, headed by a German scientist Friedrich Kekule and organized with the great help of Carl Weltzien and Charles Wurtz (Fig. 2). The meeting was attended by approximately 140 chemists from all parts of Europe (57 from Germany, 21 – France, 18 – Great Britain, 7 each from Russia and Austria-Hungary, 6 – Switzerland, 3 each from Sweden and Belgium, 2 from Italy, and from other countries as well). It is worthy to mention the Weltzien's words herein "For the first time the representatives of a single scientific discipline have met, and it is the youngest science . . . We represent different countries and speak different languages, but we are related by our craft . . . We are gathered for the specific purpose of attempting, in good conscience, to prepare the way for unity on points of significance for our beautiful science." (Mönich, 2010). The Karlsruhe Congress was the first professional congress of a scientific discipline followed by six more in a period of 20 years: 1867 in Paris, 1872 in Moscow, 1873 in Vienna, 1876 in Philadelphia, 1878 again in Paris, and 1880 in Düsseldorf. Due to a natural dialectical move, the conference idea have evolved to creating of future IUPAC. Historically, another predecessor was an International Association of Chemical Societies (IACS) – established in Paris on April 1911.

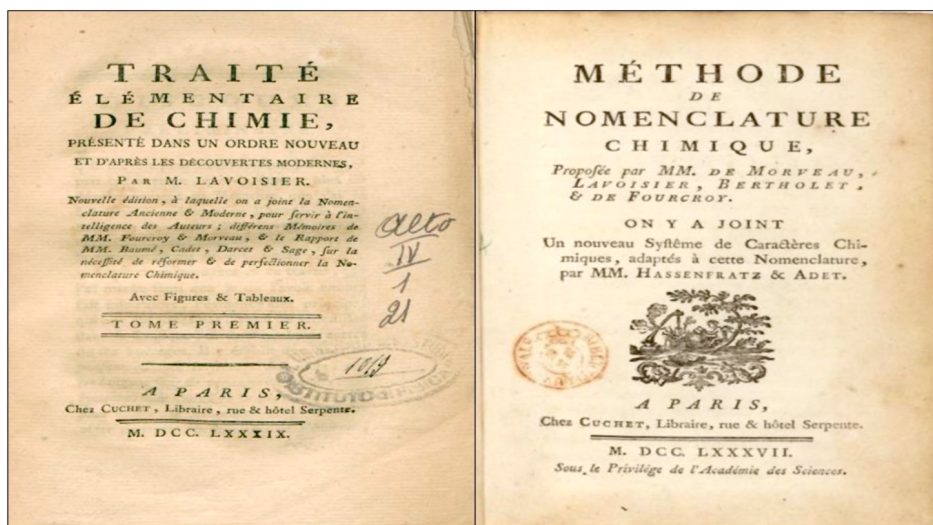


Figure 1. The editor Cuchet has published the two pioneering books i.e. “*Traité élémentaire de chimie*” written by Antoine-Laurent de Lavoisier, the so-called “father of modern chemistry” (1789, translated into English 1790 by Robert Kerr) and “*Méthode de nomenclature chimique*”, which is a collaborative work of Lavoisier with Louis-Bernard Guyton-Morveau, Claude-Louis Berthollet, Antoine-François Fourcroy, Jean Henri Hassenfratz and Pierre Auguste Adet (appeared in 1787, 314 pages).

Additionally, as a whole the IUPAC is globally-recognized authority working over chemical nomenclature and terminology, standardized methods for measurement, atomic weights and so on emerged years ago to solve this problem, or better to say, these problems (Fig. 3). Note that the particular aim of the IUPAC is to create international standards of chemistry and to systematize the existence knowledge and fascinating technological developments, depending on the information available in each chemical branch, in view of practical easiness. According to the Statute, the main objectiveness of IUPAC could be defined as: (i) to promote continuing cooperation among the chemists of the member countries; (ii) to study topics of international importance to pure and applied chemistry which need standardization or codification; (iii) to cooperate with other international organizations that deal with topics of a chemical nature; (iv) to contribute to the advancement and understanding of pure and applied chemistry in all its aspects.

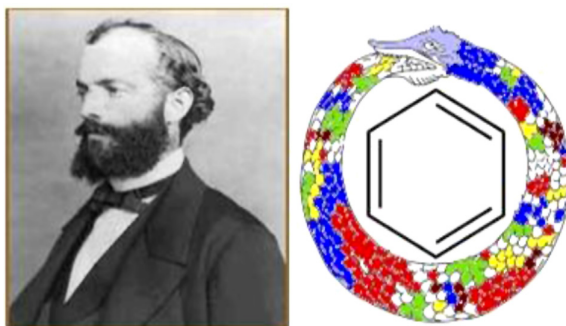


Figure 2. Friedrich August Kekulé (1829 – 1896) the principal founder of the theory of chemical structure in organic chemistry. He proposed that carbon was tetravalent and that one of the four bonds of the carbon atom could be used to join with another carbon atom in the way to form chains. Attached to this “skeleton” other atoms with other valences (such as hydrogen, oxygen, nitrogen, and chlorine) could affix themselves, thus forming inorganic molecules. Today, his name is especially associated with the concept of the six-membered carbon ring of benzene as the prototypical aromatic compound which he proposed in 1865

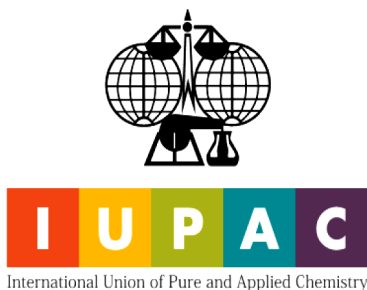


Figure 3. IUPAC's brand

Besides the above cited goals, the role and mission of IUPAC is to prompt the worldwide communication in chemical sciences in the order to united the public, industrial and academic sectors to apply as much as possible a new common chemical language. The IUPAC competence consists of the following leading topics, to stress a few points of decisive interest: (1) nomenclature of inorganic and organic chemistry – naming rules; (2) standardization of atomic weights and physical constants; (3) eiting tables concerning properties of matter; (4) establishing a commission for the review of work; (5) standardization of the formats of publications; (6) measures required to prevent repetition of identical papers.

Nowadays the global mission could be defined as objective scientific expertise for solving the critical global issues that involve every aspect of chemistry for the benefit of humankind and the world. Project activity is another main aspiration forming the scientific work of this organization. In this scheme, the proposed scientific projects by internationally task group members united by the significant ideas in various chemical activities of whole world are reviewed, approved and financially supported and further supervised. Moreover, the strategic plan or role of Union abets the enhanced communication with the chemical industry and enterprises. Ultimately IUPAC is classified as a catalyst that unites chemists worldwide by fostering sustainable development, providing a common language for chemistry, and advocating the free exchange of scientific activates. The membership network nowadays could be illustrated as it is shown on Fig. 4. All this is happing on a worldwide base of volunteers with the best skills, the scientists with strong background in chemical knowledge and technology who have made remarkable achievements in cutting-edge research.

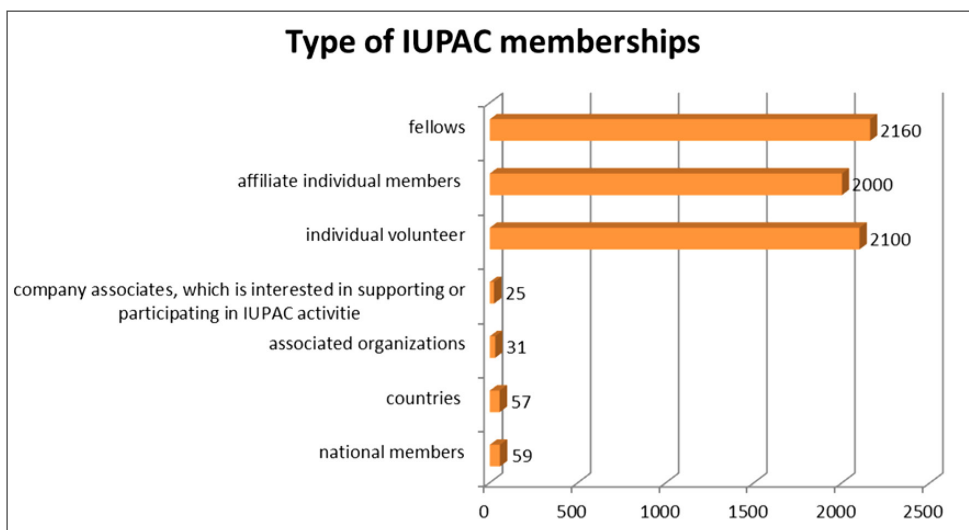


Figure 4. Approximate number of IUPAC memberships by type

IUPAC has been formed as an international federation by National chemical organization as already pinpointed above, that's way only one national organization representing country's chemists, could join the Union. As a consequence, the existence of two IUPAC member organizations issued from one country is unacceptable process. The country members may be a national chemical council,

a national society representing chemistry, a national academy of science, or any other institution or association of institutions representative of national chemical interests. The Adhering Organization is member of the Union. A country requesting admission to the Union must provide full information about itself. The members may be withdraw from the Union provided that it has fulfilled its annual financial obligations.

If members do not fulfill their obligations under the statute and bylaws, they may be removed from the Union as a discipline of non-observation of its rules. Main financial source of IUPAC are annuals subscriptions from the members (Adhering Organization). In the time, when an organization cease to be a member, the corresponding claim to paid funds are clear off. The minimum amount of the annual subscription is decided generally by the Council. Non-payment of membership fee leads to sanctions for Adhered Organization according to the article 9 from the Statute. Furthermore, the Union may receive others financial support as gifts, bequests, legacies etc. from other sources also. The distribution of National members according their geographical region are presented in Fig. 5.

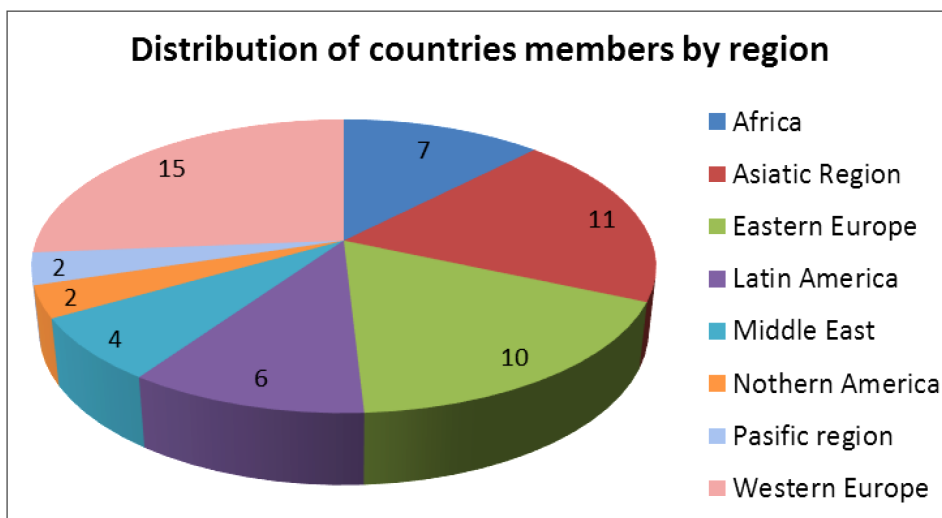


Figure 5. Distribution of countries members based on georgraphical region

Statute and structure of IUPAC

The first organization's rules are defined as far as 43 years ago (1975) in Madrid, Spain. Up to now, the rules was updated, the last time in 2015 Busan, South Korea during 45th World Chemistry Congress. Today the current Act of IUPAC is STATUTES, BYLAWS, and STANDING ORDERS, generally. According to the

preamble of IUPAC Act the members should respect each other and the Union and uphold the highest standards of transparent, responsible and ethical behavior. The IUPAC is registered in Zurich, Switzerland as consequence the applicable law of the Union is Swiss Civil Code.

The main bodies of the Union are the General Assembly as well as: *Council, Bureau, Executive Committee, Standing Committees, Divisions, Commissions. The General Assembly* of the Union is being held in each second year and consists of set of meetings of the Council and other bodies of the Union according to the Bureau's decision. The duration of office members in General Assembly is 2 years, starting on 1 January of the year following the election and shall end on 31 December of the year when the appointment is due to terminate. The Council, Bureau, Executive Committee, Standing Committees, Divisions and Commissions are held by member's delegations. The IUPAC structure is shown on Fig. 6.

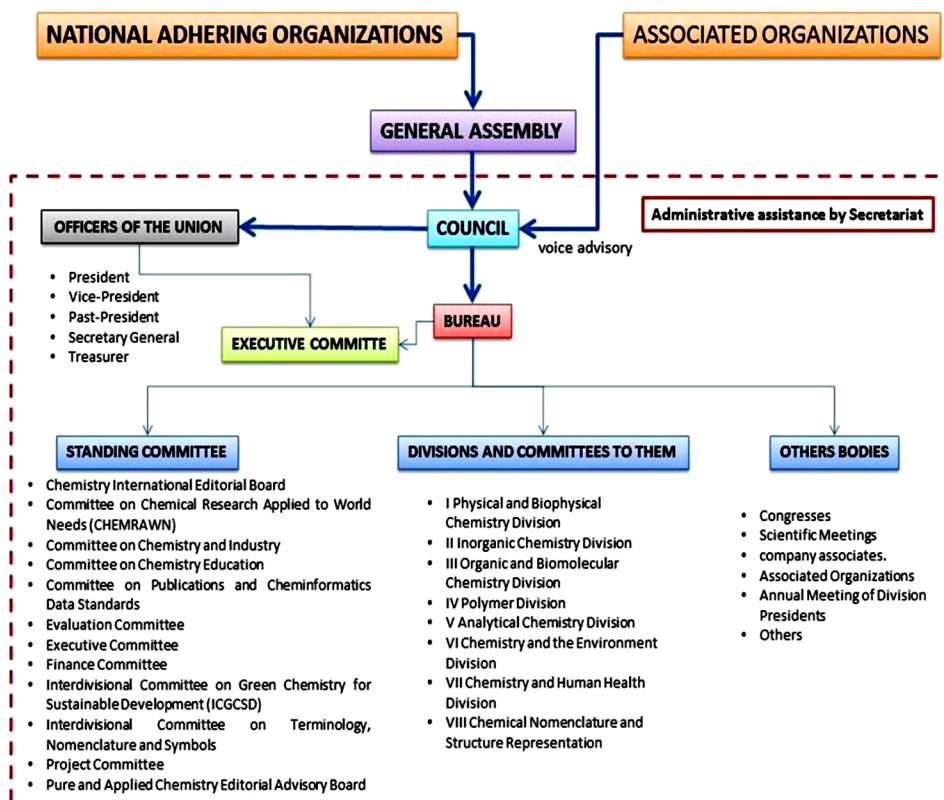


Figure 6. Organization chart of IUPAC

Each adhering Countries elect its delegates for every Council meeting. Regular meetings of the *Council* are held every two years as a part of the General Assembly. The decisions of the Council are valid when they have been voted during the meetings. The distance voting is not permitted and voting by proxy, too. The abstaining delegates are not recorded as vote. The official language is English of course and all documents that have been discussed are only in English. The Council competence includes the following topics: (1) to elect the Officers of the Union and the Elected Members of the Bureau; (2) to discuss and determine the general policy of the Union; (3) to approve the Statutes and Bylaws of the Union and changes therein; (4) to approve the terms of reference of the Bureau, Executive Committee, Standing Committees, Divisions, Commissions, and all other bodies of the Union as prescribed in the Statutes and Bylaws; (5) to determine every four years, the one language in which the official records of the meetings of the Council, Bureau, and Executive Committee shall be kept and published; (6) to receive and consider reports by the President on the state of the Union, as well as by the Bureau, Executive Committee, Division Presidents, and other bodies of the Union; (7) to ratify decisions taken by the Bureau and Executive Committee between General Assemblies; (8) to consider and adopt or reject the accounts of the Union; (9) to examine and establish the budget of the Union for the next two financial years; (10) to determine the dates and place of General Assemblies; (11) to take such other actions as are required in the exercise of its authority under the Statutes and Bylaws.

Only the Divisions and others IUPAC bodies can present recommendations *apropos* scientific nature, which acceptance could be guarantee by a simple majority of all delegates present at the regular meeting. In the case when the regular meeting was not conducted, the Bureau itself may approved the recommendations in nomenclature, symbols, terminology, and conventions. Postal and electronic voting may be held only with procedure determined by the Bureau. *The Bureau* consists from President, Vice-President, Secretary General, Treasurer, the immediate Past-President, and Presidents of Divisions, who's all, named Officers, and no less than ten other members elected additionally by the Council. The office term of the elected Bureau members by the Council members is four years. All Bureau members have full voting powers with the following main responsibilities: (1) to ensure the strict observance of Statutes and Bylaws; (2) to prepare the agenda for meetings of the Council and in particular to make provisions for elections; (3) to make recommendations there on to the Council; (4) to attend the meetings of the Council; (5) to implement the decisions of the Council and execute the program of the Union as directed by the Council; (6) to take steps to ensure that IUPAC World Chemistry Congresses are held; (7) to take decisions about the holding of scientific meetings as proposed by Divisions and Standing Committees; (8) to take all other steps necessary for the good conduct of the affairs of the Union.

The Bureau cannot select or remove the officers of Union members as well as to establish the Executive Committee. *The Executive Committee* is limited to eight members (President, Vice-President, Secretary General, Treasurer, and the immediate Past-President, other members are elected by the Bureau from among its Elected Members). The period of service of an elected member is four years. The role of Executive Committee is to give orders to facilitate the main responsibilities of the Bureau. The mandate of the president is two years without the possibility to be reelected. The president is administrative head of the Union, including Council, Bureau, and Executive Committee and *ex officio* is a member of all Union bodies.

To assist in the IUPAC administration, Executive Committee appoints the Executive director and other administrative staff from the IUPAC Secretariat located in Research Triangle Park, North Carolina, United States of America.

Divisions ensure the real scientific work of the Union and are responsible to the Bureau. They can be created and modified only by the Council and the members are appointed by the Council, which procedure activities are governed by the Bylaws. In each division it may be create the Commissions, which have to be approved lately by the Council. It may be formed Joint Commissions between Divisions and/or others international scientific organizations after Council decision (Fig. 7). The IUPAC Divisions represent the chemistry branches and today the total number is eight: *I Physical and Biophysical Chemistry Division, II Inorganic Chemistry Division, III Organic and Biomolecular Chemistry Division, IV Polymer Division, V Analytical Chemistry Division, VI Chemistry and the Environment Division, VII Chemistry and Human Health Division and VIII Chemical Nomenclature and Structure Representation*. Each Division is administrated by Division Committee, consisting IUPAC members, Associate Members, and National Representatives with appropriate expertise. The main function of Divisions Committee is liaison between the Bureau and the various bodies constituting the Division, so the essential role of Division Committee in this sense is: (1) to initiate, approve, and manage projects; (2) to plan and organize scientific meetings and engage in other activities that are deemed useful in furthering the objectives of the Division; this includes the approval of Union sponsorship of scientific meetings; (3) to manage a budget for a Division in accordance with a procedures prescribed by the Treasurer; (4) to advise the Bureau for recommendations to the Council on scientific matters; (5) to propose to the Council through the Bureau the establishment of Commissions to be attached to it and to appoint the membership and the initial officers of these, the appointments having to be approved by the Council; (6) to propose to the Council through the Bureau the dissolution of existing Commissions when required; (7) to supervise the work of its Commissions and other bodies.



Figure 7. 14th Annual Meeting of the Subcommittee on Solubility and Equilibrium Data (SSED, Division V) held in conjunction with the 30th International Conference on Solution Chemistry in Prague, Czech Republic, 30 August 2015

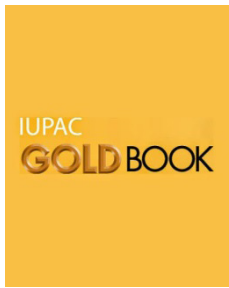
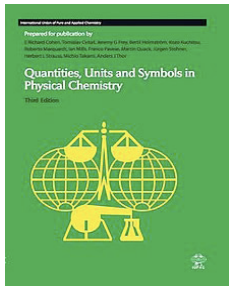
The purpose of Each *Commission* is to study the topics of international scientific or technical significance requiring agreement, standardization, or codification in some aspect of pure or applied chemistry. The commission must consist of IUPAC Members, Associate Members, and National Representatives, with full voting rights. The main role of the **Standings committees** is to discuss the chemistry problems and to support the main activities of Officers and Bureau. An impressive list of current committees together with detailed comments may be note in this place: Chemistry International Editorial Board and Committee on Chemical Research Applied to World Needs with mission to disseminate of chemical knowledge deemed useful for the improvement of human's life. Committee on Chemistry and Industry, which activates are concentrated to communication, collaboration with international chemical industries, including pharmaceutical, agrochemical and all other related industries and to initiate, maintain a portfolio of projects with implications for industry. The Committee on Chemistry Education has monitoring the chemistry education activities throughout the world and disseminate information relating to education, including the public appreciation of chemistry. There are Committee on Publications and Cheminformatics Data

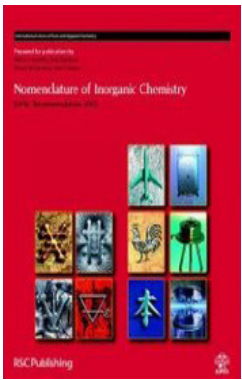
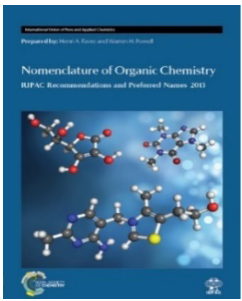
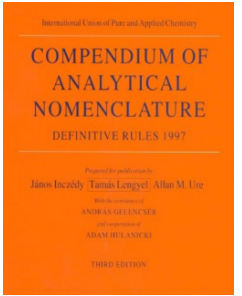
Standards, Evaluation Committee, Executive Committee, Finance Committee, and Interdivisional Committee on Green Chemistry for Sustainable Development as well as the Project Committee and Pure and Applied Chemistry Editorial Advisory Board. Furthermore, Interdivisional Committee on Terminology, Nomenclature and Symbols has invited various guests from Bureau International des Poids et Mesures, International Organization for Standardization, International Union of Biochemistry and Molecular Biology, International Union of Crystallography, International Union of Nutritional Sciences, International Union of Pharmacology, International Union of Pure and Applied Physics.

Needless to say, that the Committee is responsible for every IUPAC document concerned with terminology, nomenclature, symbols, and other conventions. Before recommending any material for publication, the Committee has to be ensuring that full consultations and consensus has been done among all IUPAC bodies and international organization.

As a whole, nine types of books published in a different color, Fig. 8, have been printed as a result of work activities of Interdivisional Committee on Terminology, Nomenclature and Symbols under IUPAC supervision. Therefore, the exact book matters are presented in Table 1.

Table 1. Color books of IUPAC

Nº	Name	Topic	Version	Picture
1	Gold Book	Chemical terminology	2014 (online access)	
2	Green Book	Quantities, Units and Symbols in Physical Chemistry	2011 (online access)	

3	Red Book	Nomenclature of Inorganic Chemistry	2015	
4	Blue Book	Nomenclature of Organic Chemistry	2013	
5	Purple Book	Compendium of Polymer Terminology and Nomenclature	2008	
6	Orange Book	Analytical Nomenclature	1998 (online access)	

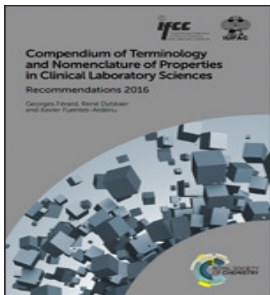
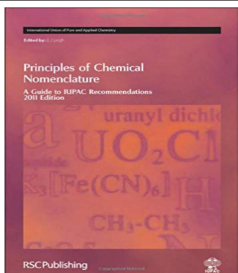
7	Silver Book	Compendium of Terminology and Nomenclature of Properties Clinical Laboratory Sciences	2016	
8	White Book	Biochemical Nomenclature	1992	
9		Principles of Chemical Nomenclature	2011	



Figure 8. The Nomenclature of Inorganic Chemistry, IUPAC Recommendations 2005, the Red Book, is available in Bulgarian language since 2009. The organization of the project and discussion of adaptation problems were overseen by the National Bulgarian Committee of IUPAC. The adaptation and translation involved significant problems owing to the grammatical differences and the different alphabets of the two languages



Figure 9. Prof. Christo Balarew has reported “The role of ice on the spontaneous decomposition of $\text{Na}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$ ” during International Symposium on Solubility Phenomena and Related Equilibrium Processes (ISSP18), 16 July 2018, Tours, France

It is of tremendous relevance to be aware that IUPAC has organized very actively international Congresses and other scientific meetings in the frame of its main task – free worldwide communication between the chemists, Figs. 9 – 10. As an illustration, the Subcommittee on Solubility and Equilibrium Data (SSSED) organizes biannual conferences since 1984 under IUPAC sponsorship, which 10th edition was taken part during 2002 in Varna, Bulgaria (Lorimer, 2002). The Franzosini Award was established by the former Solubility Data Commission in the late 1988, during its 14th annual meeting held in Guildford, Surrey, United Kingdom during the third International Symposium on Solubility Phenomena (ISSP). The “Paolo Franzosini Endowment Fund” was created in 1988 under the proposal of A. Kertes, from the generous donation of Franzosini’s family on the 24th January 1985. In the list of award recipients are two Bulgarian researchers, i.e. Rumen Duhlev – 1989 and Stefan Gradinarov – 1992. It is well known, the relations with industry is a part of the target plan of the Union, that’s way the industrial companies, research and development institutions including laboratories, scientific societies, or any other bodies could join to the IUPAC (company associates). Finally, international organizations whose aims and activities are in harmony with those of the Union, may join to the Union also as Associated Organizations, only by Council decision.



Figure 10. Afternoon tea at ISSP18, 18 July 2018, Tours (France). Participants from 34 countries have attended the symposium (Azerbaijan, Algeria, Australia, Bulgaria, France, Germany, Oman, Spain, Sweden, Russia, USA, Czech Republic, United Kingdom, Portugal, Japan, South Korea, South Africa, Poland, Morocco, Canada, China, Botswana, India, Netherlands, Taiwan, Israel, Malaysia, Pakistan, Finland, Denmark, Ukraine, Ireland, Hungary and Mexico)

Starting with elaboration of Nomenclature of organic and inorganic chemical compounds, IUPAC has become over years a world Union of all chemists, defending their interests – one universal chemistry language. Citing Linus Pauling's herein: "Life....is a relationship between molecules". Unfortunately, this is not possible without a chemical bond, a lasting attraction between atoms, ions or molecules that enables the formation of chemical compounds. The bond may result from the electrostatic force of attraction between oppositely charged ions like in ionic bond or through simple sharing of electrons as in covalent bonds, etc. Although the strength of chemical bonds and types varies considerably, there are will be always certain bonds between chemists encompassing all branches, united with the aim to create outstanding intellectual accomplishments for the service of Mankind.

Today, maybe IUPAC is one of the largest non-political scientific organizations in the world. With its highest expertise in chemistry, the Union is working over communication in chemistry and solving international problems in the scientific, industrial and policy sector in the field of chemistry. Nowadays, IUPAC is a signifi-

cant factor on the stage of international relations, which is a guarantee of its solidity and efficacy. As an international non-political organization the IUPAC observes the basic policy of political nondiscrimination and affirms the rights of chemists of any country without regard to race, religion, or political philosophy. Similarly, IUPAC encourages the highest standards of communication, transparency, diversity, and ethical behavior. Therefore, it should be noted that with its objective scientific chemical expertise the Union protects also the human rights and consolidates the world peace.

Cheerful Birthday of IUPAC!

Acknowledgements. Dr. Atanassova would like to express her gratitude to IUPAC for the support of the project “Critical evaluation of equilibrium constants of 4f metal mixed complexes with acidic (chelating) ligands in combination with various organophosphorus O-donor molecules”. BASF Bulgaria is deeply acknowledged for the financial support of Bulgarian subscription in IUPAC during last years.

REFERENCES

- Lorimer, J.W. (2002). 10th international symposium on solubility phenomena Varna, Bulgaria. *Chem. Int.*, 24(6), 31 – 32.
Mönich, M. (2010). The first international gathering of chemists. *Chem. Int.*, 32(6), 10 – 14.

✉ **Dr. Maria Atanassova**

Department of General and Inorganic Chemistry
University of Chemical Technologies and Metallurgy
Sofia, Bulgaria
E-mail: ma@uctm.edu

✉ **Mr. Radoslav Angelov**

Institute of Optical Materials and Technologies “Acad. Jordan Malinowski”
Bulgarian Academy of Sciences
Sofia, Bulgaria
E-mail: radoslav_angelov@abv.bg