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Perspective

Language of Chemistry: Making IUPAC Nomenclature Available in Spanish

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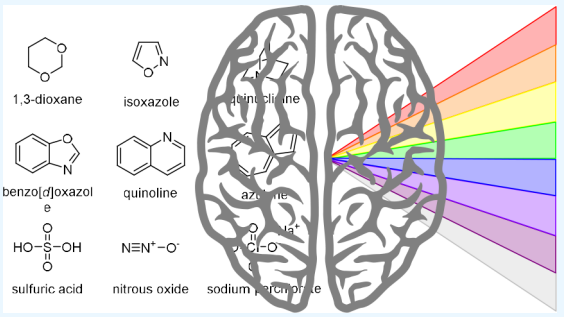
ABSTRACT: Science, including mathematics, physics, and, of course, chemistry, has its own language and symbols and names we learn in school. However, to teach it, communicate it, and use it, we use our own native languages. Most of the scientific literature, including this article, is in English, as are the texts published by the various scientific unions, including the International Union of Pure and Applied Chemistry (IUPAC), to define scientific nomenclature, terminology, and presentation. However, it is essential that these fundamental texts are available in as many languages as possible to facilitate their teaching, learning, and use throughout the world. It should be noted, however, that the translation of these texts into different languages is a complex task that requires some choices due to the lack of obvious alternatives or the cacophony of some terms. In this paper, we provide some details on the challenges, compromises, and difficult decisions involved in translating the IUPAC Nomenclature Brief Guides into Spanish.



1. INTRODUCTION

Throughout history, the spread of knowledge has taken many paths. For thousands of years, knowledge was transmitted orally from one generation to the next. With the advent of writing, a rapid expansion of, among other things, scientific knowledge became possible.[1] This transmission of ideas and experiences was associated with a language, depending on the geographical space. For example, most of the scientific literature has been published in French, German, and, more recently, English.[2] English is also the language used by the International Union of Pure and Applied Chemistry (IUPAC) to define scientific nomenclature, concepts, and terminology; thanks to this organization, we have a common, uniform, readable, and systematic chemical language, which is periodically adapted to new discoveries. For example, the latest nomenclature recommendations in inorganic chemistry are from 2005,[3] those in organic chemistry from 2013,[4] and the revision of the SI, the latter with direct consequences in the chemical community with the redefinition of the mole.[5]

The translation of these and other texts into different languages is critically important, especially at the educational and general society levels.[6] Moreover, it should be noted that chemistry is rich in metaphors, and a precise translation of chemistry text is required.[7] In the case of the IUPAC books, there are several scientists who, encouraged by the institution itself, translate the texts into different languages.

Another action supported by this institution is the translation of the Brief Guides to Nomenclature,[8] which summarize the rules and preferred names recommended by the IUPAC found in the IUPAC Color Books;[9] these documents have been translated into languages such as Basque, Catalan, Czech, Danish, Dutch, French, Galician, Slovak, and Spanish. Although it may seem a simple routine, the translation of the nomenclature requires an effort beyond the translation of the language itself, since it also requires adapting the vocabulary and concepts to the peculiarities of the language. For example, in organic chemistry nomenclature, the group C_6H_5-, which acts as a phenyl substituent (in English), is translated as *fenil* (in Spanish), which can lead to a rearrangement of the name and a renumbering of some compounds containing this substituent.[10] This and other difficulties encountered in the translation of several scientific documents produced by the IUPAC are presented herein.

2. TRANSLATION OF AN IUPAC COLOR BOOK

Translating one language into another presents some challenges, difficulties, and inevitably some compromises. We will use our experience in translating several texts related to the IUPAC nomenclature from English to Spanish. The first example was the Nomenclature of Inorganic Chemistry (The Red Book). In November 2005, IUPAC published the Nomenclature of

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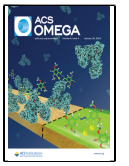

Inorganic Chemistry in collaboration with RSC (Royal Society of Chemistry) Publishing.[3] The original project was submitted to the Inorganic Chemistry Division (II) and the Chemical Nomenclature and Structure Representation Division (VIII) of IUPAC on January 2, 1999, by coordinator Neil G. Connelly with the title Nomenclature of Inorganic Chemistry—Revised "Red Book"—Part I. This work, which took almost seven years to publish, was translated into Spanish in less than two years by Miguel Ángel Ciriano and Pascual Román Polo with the same title: *Nomenclatura de Química Inorgánica. Recommendaciones de la IUPAC de 2005* (ISBN 978-84-7733-905-2). Figure 1 shows the covers of the Spanish textbook published by Prensas Universitarias de Zaragoza (PUZ).[11]

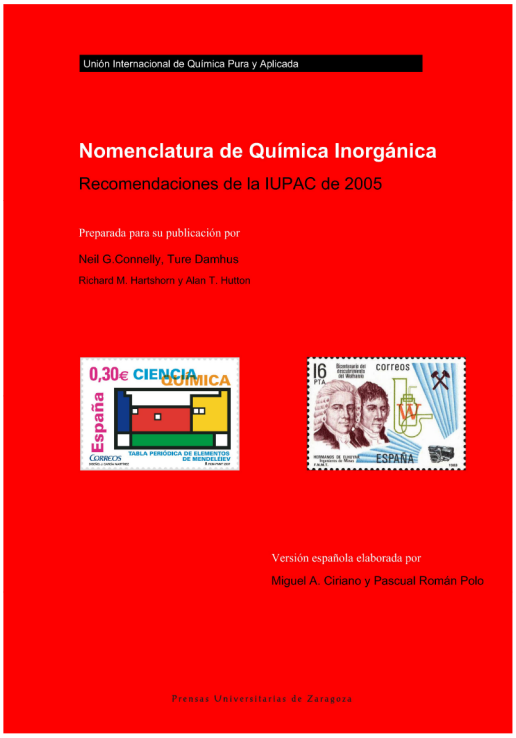

Figure 1. Front cover of the *Libro Rojo* of Nomenclature of Inorganic Chemistry (*reproduced with permission given by Prensas Universitarias de Zaragoza*).

The motivation for this translation was to facilitate communication among the community of Spanish-speaking chemists and to provide a coherent and consistent use of inorganic chemistry terms in Spanish. Some of them did not exist in Spanish at the time of their translation and had to be included for the first time. This translation was proposed and commissioned by Professor Luis A. Oro, Professor of Inorganic Chemistry at the University of Zaragoza, President of the Spanish Committee of IUPAC and, at the time, President of the Royal Spanish Society of Chemistry (RSEQ).

After the translation was completed, it was sent for review to renowned Spanish chemists and researchers in the field of inorganic chemistry, as well as to the Chemical Societies of Argentina, Chile, Spain, and Puerto Rico. After receiving feedback from these communities and incorporating their changes and suggestions, the IUPAC Red Book, translated into Spanish, was presented on October 16, 2007, at the *Residencia de Estudiantes* of the Spanish National Research Council (*Consejo Superior de Investigaciones Científicas*, CSIC) in Madrid. It is worth mentioning that on July 17, 2008, the Union of University Publishers of Spain (*Unión de Editoriales Universitarias Españolas*, UNE) awarded PUZ (*Prensas Universitarias de Zaragoza*) the Prize for Best Translation within the XI National University Publishing Awards (*XI Premios Nacionales de Edición Universitaria*).[12]

For the translation of the Red Book (2005), the authors used the dictionary of the Real Academia Española (RAE) in its 23rd edition (*Diccionario de la Lengua Española*, DLE),[11,13] the Scientific and Technical Vocabularies II and III (*Vocabularios Científicos y Técnicos II y III*),[14,15] and the Essential Dictionary of the Sciences II (*Diccionario Esencial de las Ciencias II*)[16] of the Royal Academy of Exact, Physical and Natural Sciences (*Real Academia de Ciencias Exactas, Físicas y Naturales*, RAC) were also used. The Spanish version of the Nomenclature of Inorganic Chemistry Recommendations of 1990,[17] translated by Luis F. Bertello and Carlos Pico Marín,[18] was also used to maintain linguistic consistency with that earlier work.

On the occasion of the publication of Red Book (2005), IUPAC decided to modify the nomenclature of several inorganic compounds that provoke a revision of the previous version of the Red Book. The most important changes incorporated by IUPAC are

(1) The compounds of halogens with oxygen are not called oxides but are oxygen halides.
(2) The systematic nomenclature of oxoacids and oxosalts is modified.
(3) The names phosphine, arsine, and stibine are replaced by phosphane, arsane, and stibane.
(4) The nomenclature of the ions is modified.
(5) Some abbreviations are unified and their use is limited: for example, the abbreviation for 2,2′-bipyridine is *bpy* and not *bipy*; the abbreviation C_p represents the cyclopentadienyl group C_5H_5, and it is recommended not to use C_p* to designate C_5Me_5, due to the frequent use of the asterisk with other meanings (excited states, optical activity, presence of a chiral stereocenter, etc.).

However, as mentioned above, when translating the textbook into Spanish, several decisions should be taken related to vocabulary, terms, and expressions; in addition, several words should be adapted to the cacophony of the language. The most important difficulties faced and decisions adopted by the authors are

(6) Difficulties with important nuances without an obvious translation in Spanish.
(7) English words created "ad hoc" but not recognized by English dictionaries at the time (locant, location, ligating, bicapped...).
(8) Words widely spread in Spanish not included in DLE (*ligando*, *oligonuclear*, *borano*, *clúster*...).
(9) Words that required inventing a simple name, such as seesaw: which was translated as *balancín* (rocker).
(10) Single word used for translating several concepts or words: for example, all anions in English end in *-ide*, *-ate*, or *-ite*, and when they are ligands in metal complexes in *-ido*, *-ato*, or *-ito* (e.g., chloride and chlorido), but the Spanish translation of both anions corresponds to a single name (e.g., *cloruro*).
(11) It was decided to maintain the English abbreviations of the ligands, the symbols of the polyhedra, the Bravais networks, and the allotropic varieties as their own to

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provide greater uniformity with the scientific literature and for avoiding errors of interpretation.

(12) The endings of organometallic ligands, radicals, or substituent groups that form part of a multiple bond or with several unsaturated valences have been written directly with the "o" final vowel. For example, methylidene, azanylidene, propane-1,3-diyl, were translated to *metilideno*, *azanilideno*, *propano-1,3-diilo*, respectively.

(13) The names of organometallic radicals and ligands have been written with the ending *-il* for direct use as prefixes in the names, although the proper name of the radical or ligand ends in *-ilo*. For example, allyl, methyl, and aminyl are translated as *alil* or *alilo*, *metil* or *metilo*, *aminil* or *aminilo*.

(14) Some names of the elements included in the DLE do not coincide with the usual ones in Spanish: *astato*, *tantalio*, and *telurio* (*astato*, *tántalo* and *teluro*, according to RAC). For this reason, the vocabularies of the RAE have been used.

(15) The letter "z" has been preserved in nitrogenous derivatives (*hidrazina*, *azida*, *aziridina*, etc.), to highlight the origin or presence of nitrogen (*azoe*) although DLE used the letter "c" for some of this compounds.

(16) The rules of accentuation have been respected, with the exception of the word *hidrógeno* in hydrogen nomenclature, while accents have been omitted in the written names of the ligands to form the addition name (unless the name of the ligand is separated by inclusion signs).

A special case is the translation of the name of the element $Z = 74$. In the 2005 version of the Red Book, this element is called exclusively tungsten, eliminating its alternative name *wolframio*, which had been accepted since 1949.[3] In the same year that the latest version of the Red Book was published, Pilar Goya and Pascual Román, representing the opinion of many Spanish chemists, requested that both tungsten and wolfram be used to name this element, as had been the norm for decades and as had been the clear will of the brothers Juan José and Fausto Delhuyar, the first to isolate this metal, and proposed *wolframio* (the original name of wolfram) to name this new metal.[19] The response of Ture Damhus, one of the coauthors of the Red Book, was that there could only be one name in English and that was tungsten.[20] It is important to note that IUPAC is silent on the name of this or any other element in languages other than English, leaving the translation of chemical names into local languages to experts in the various countries. In March 2006, Román published the article *The real name of the metal tungsten is wolfram*, in order to promote the use of *wolframio* among Spanish-speaking people.[21] In addition, and to make this case even more visible, a stamp depicting the Delhuyar brothers and this element with its name appeared in the Spanish translation of the Red Book (Figure 1).

The other stamp on the cover of the Spanish translation of the Red Book shows a periodic table of chemical elements with four elements highlighted in white. This was done to highlight some of the predictions made by Russian chemist Dmitri Ivanovich Mendeleev on the centenary of his death in 1907 (Figure 1). This stamp in the Science series was designed by the Spanish chemist Javier García Martínez, currently Professor of Inorganic Chemistry at the University of Alicante and President of IUPAC, and was inspired by the paintings of Dutch painter Piet Mondrian.

3. IUPAC BRIEF GUIDES IN SPANISH

In recent years, IUPAC has produced and made freely available some Brief Guides covering the main aspects of chemical nomenclature, including organic, inorganic, polymer, etc.[8] These documents are easily recognizable by their colors, which are the same to the IUPAC Color Books.[9]

They are concise summaries of the most important IUPAC standards and are therefore not only very useful but also very popular. They have been translated into several languages to help students around the world learn chemistry in their native language.[22−25]

The first Brief Guide translated into Spanish was the Brief Guide to the Nomenclature of Inorganic Chemistry (title in Spanish: *Guía Breve para la Nomenclatura de Química Inorgánica*)[22] in 2015 (last version 2022) (Figure 2). The authors took great care to maintain the format, length, and visual identity of the original text. After being revised by various Spanish-speaking experts and approved by IUPAC, it was uploaded to both the IUPAC[26] and RSEQ[27] Web sites for wider dissemination. Similarly, in 2019, the Brief Guide to the Nomenclature of Organic Chemistry (title in Spanish: *Guía Breve para la Nomenclatura de Química Orgánica*) was also translated into Spanish, corrected by experts, and made available on both the IUPAC and RSEQ Web sites (Figure 2).

The Brief Guide to Inorganic Chemistry and the Brief Guide to Organic Chemistry were translated into Spanish by Miguel Á. Ciriano, Efraím Reyes, and Pascual Román, while the rest of the short guides and other important related texts were translated by the latter two, namely, A Short Guide to Polymer Nomenclature, A Short Guide to Polymerization Terminology, A Concise Summary of Quantities, Units and Symbols in Physical Chemistry, and A Concise Summary of the International System of Units, SI. Once all these translations were completed, revised, and approved by IUPAC, they were combined into a single book so that chemistry students, teachers, and practitioners could have the most important IUPAC documents in Spanish in a single volume. The authors included a foreword by Javier García Martínez, President of IUPAC, and a short introduction by the authors. The book was titled *Nomenclatura química y normas de la IUPAC en español* (Chemical Nomenclature and IUPAC Standards in Spanish) and published by the University of La Rioja (UR) in November 2022 (Figure 3).[28]

This book also contains the IUPAC Periodic Table of Chemical Elements and the IUPAC Periodic Table of Isotopes. It should be noted that the translation into Spanish of the elements with atomic numbers 113 (nihonium, Nh), 115 (moscovium, Mc), 117 (tennessine, Ts), and 118 (oganesson, Og) was not obvious and required a meeting between representatives of the RAC, RAE, RSEQ, and the FundéuRAE[29] to agree on their names in Spanish. The final decision, accepted by the parties, was that they should be called as follows: 113, *nihonio*; 115, *moscovio*; 117, *teneso;* and 118, *oganesón*. This meeting was used to review the names and spellings of all of the chemical elements in Spanish. For example, during this revision, zinc was preferably translated as *zinc* (with z) maintaining the etymology of the word; however, zirconium as *circonio* (with c) maintaining an extended used word in other sciences (such as *circonita* in Geology or Gemology). The periodic table in the book *Nomenclatura química y normas de la IUPAC en español* includes the names and symbols decided at this meeting.

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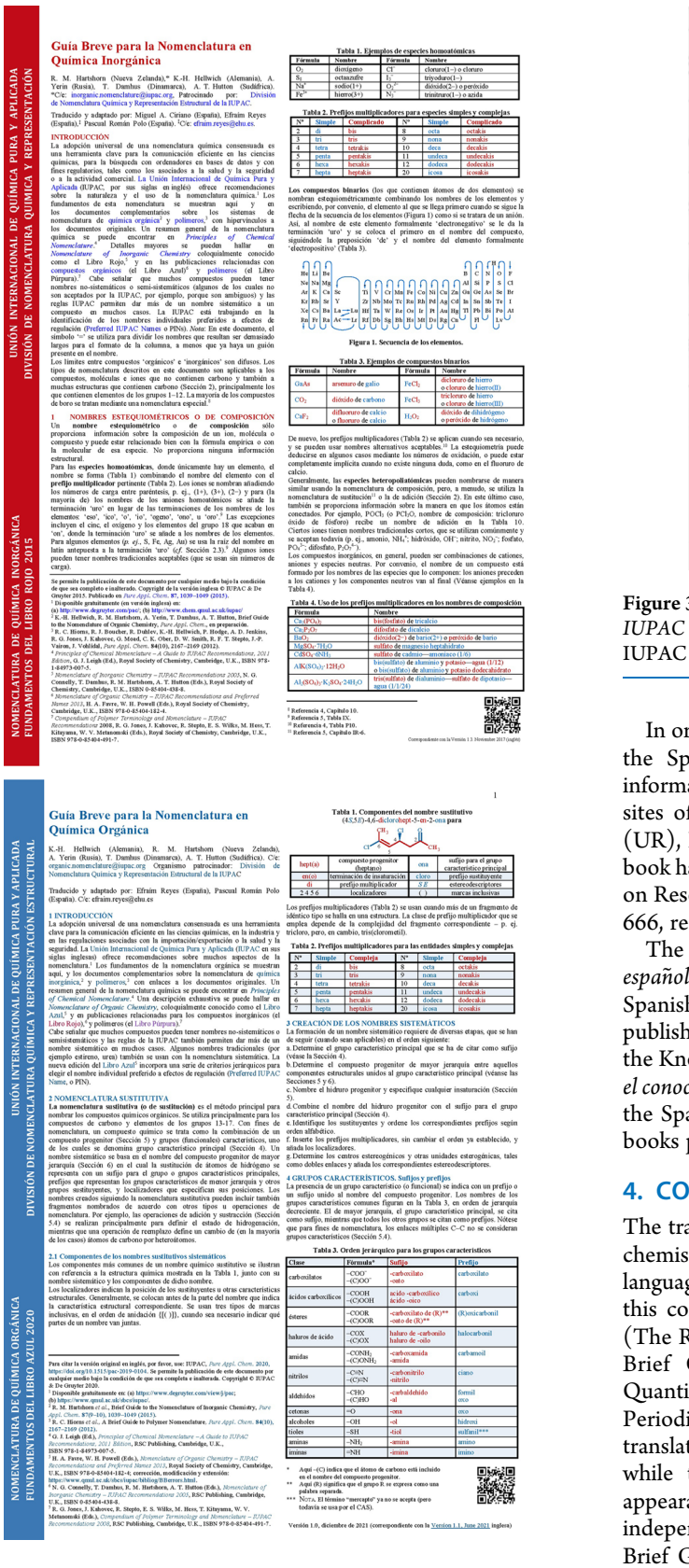

Figure 2. First page of the (up) *Guía Breve para la Nomenclatura de Química Inorgánica* (version 2022) and (down) *Guía Breve para la Nomenclatura de Química Orgánica* (version 2022) (*reproduced with permission given by the IUPAC).*

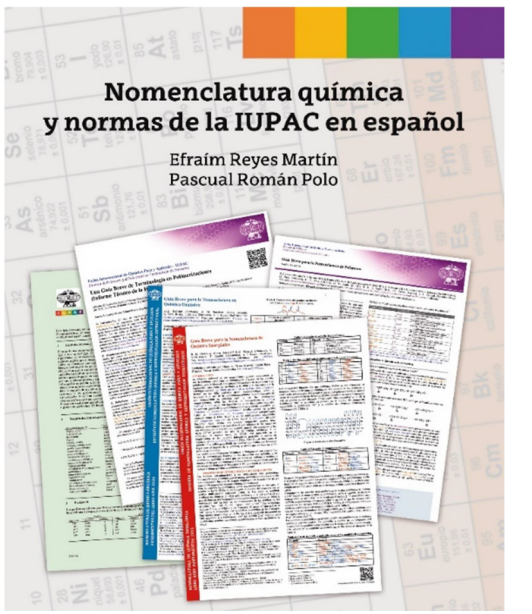

Figure 3. Front cover of the book *Nomenclatura química y normas de las IUPAC en español* published by the University of La Rioja and the IUPAC (*reproduced with permission given by the University of La Rioja).*

In order to disseminate this work, which is of great interest to the Spanish-speaking world, this book, with all the above information, has been made available free of charge on the Web sites of Dialnet,[30] associated with the University of La Rioja (UR), RSEQ, and ResearchGate. By the end of June 2023, the book had been accessed 20,083 times on Dialnet and 1816 times on ResearchGate, with the number of downloads of 12,042 and 666, respectively.

The book *Nomenclatura química y normas de la IUPAC en español* was awarded the prize for the best translation into Spanish of scientific studies or essays of relevant studies published in other languages, organized by the Foundation for the Knowledge of the Community of Madrid[31] (*Fundación para el conocimiento de la Comunidad de Madrid*), in the first edition of the Spanish Science Prizes (*Premios de Ciencia en Español*) for books published in 2022.[32]

4. CONCLUSIONS

The translation of scientific texts is a nontrivial task. Regarding chemistry, this is specifically challenging as this is a very rich language with its own vocabulary, terminology, and grammar. In this contribution, we described how one of the Color Books (The Red Book) and some of the key chemistry texts (IUPAC Brief Guides of Nomenclature, A Concise Summary of Quantities, Units and Symbols in Physical Chemistry, and the Periodic Table) were translated from English into Spanish. The translation involved some difficult decisions and compromises while trying to maintain the visual identity and even the appearance of the original texts. The translations were revised by independent experts, approved by IUPAC, and, regarding the Brief Guides, combined in a single volume, which was made available free of charge on several Web sites.

The great success of this book, which has been accessed more than 20,000 times in just one year, is a testimony of the importance and convenience of having the main scientific texts available in as many languages as possible, verified by experts, and approved by relevant international organizations. This is

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useful not only for the teaching and learning of science but also for avoiding the proliferation of terms with every new translation.

For that, the authors suggest that the various chemical societies have a working group for the consensual translation of the IUPAC main texts into their respective mother tongues. For science to be truly global, it must be spoken, read, and written in every language but that involves translation, and that requires not only technical expertise, some difficult decisions, and even compromises but also consensus to avoid the proliferation of alternative chemistry languages.

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Author Contributions

The manuscript was written with contributions from all authors.

Notes

The authors declare no competing financial interest.

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(31) The Community of Madrid (Comunidad de Madrid) is one of the seventeen autonomous communities of Spain.

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