

## INTERVIEW



# A Model Professor Committed to Science and the Motivation of Young Researchers

Érico Marlon de Moraes Flores  

Full Professor

Department of Chemistry, Federal University of Santa Maria  
Santa Maria, RS, Brazil

Prof. Dr. Érico Marlon de Moraes Flores has a degree in Industrial Chemistry from the Federal University of Santa Maria (UFSM), Santa Maria, RS, Brazil, a master's degree in Chemistry from the same institution, and a doctorate in Metallurgical, Mining, and Materials Engineering from the Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil. He is currently Full Professor of the Department of Chemistry at UFSM and has been Director of the International Support Secretariat as Advisor to the UFSM Rector since 2018. He has been a Fellow of the Royal Society of Chemistry since 2016 and full member of the National Council of Brazilian Pharmacopeia (Brazilian Health Regulatory Agency, ANVISA) since 2002. He works mainly in research and technological development involving atomic spectrometry and the use of alternative energies, such as ultrasounds and microwaves for sample preparation, with applications in several laboratories and in the intensification of industrial processes. He has also worked in the quality control of pharmaceutical products, food, and nanomaterials and in extraction and analytical development for the determination of rare earth elements.

Prof. Érico Flores was Director of the Analytical Chemistry Division of the Brazilian Chemical Society (DQA-SBQ) from 2010 to 2012, its Deputy Director for two periods, from 2000 to 2002 and 2008 to 2010, and Secretary of the SBQ Regional of Rio Grande do Sul, Brazil. He was also Scientific Director of the Research Support Foundation of the State of Rio Grande do Sul (FAPERGS) from 2014 to 2019 and elected Vice-President of the IUPAC for the 2018–2019 biennium. He is a Full Member of the Brazilian Academy of Pharmaceutical Sciences, and since 2018 he has been Deputy Topic Leader of the Expert Working Group/EWG-Q3D, Elemental Impurities, appointed by ANVISA at the International Conference of Harmonization. He has received several awards at national and international scientific events, has given several lectures and courses in Brazil and in more than 20 countries, and has participated in the organizing and/or scientific committees of several national and international events.

Prof. Flores has more than 340 scientific articles published in international journals, with more than 6700 citations and an H-index of 40, in addition to several chapters of international books and a book published by Elsevier. He has national and international technological innovation patents and one in Germany, with the product sold in several countries. He has supervised more than 50 master's and 30 doctoral students. In the editorial field, Prof. Flores contributes as a reviewer to more than 40 scientific journals and is currently Executive Editor of *Ultrasonics Sonochemistry* (since 2018) and a member of the Editorial Board of the *Journal Analytical Atomic Spectrometry* (since 2012), *Atomic Spectroscopy* (2020), and the *Brazilian Journal of Analytical Chemistry* (2020).

**Would you tell us where you were born and how your childhood was?**

I was born in Caxias do Sul, RS, Brazil, in 1966, as the second of three brothers. When I was a little over a year old, my father, who was a military man, was transferred to Santana do Livramento, RS, where we lived for 4 years, and shortly before I turned 6 years old, we came to the city of Santa Maria, RS, where I have lived since now. Despite the financial difficulties, I can say that I had a relatively peaceful childhood, which was due to the great sacrifice of my parents so that my brothers and I could have a good education. Today, I can clearly see the importance of parents encouraging their children to study with pleasure and to gain a good understanding of life.

**What early influences encouraged you to study science? Did you have any influencers, such as a teacher?**

Shortly before completing elementary school, I already liked the exact sciences, especially mathematics; although, I was almost obsessed with history, an area that I still like a lot and that is almost a hobby in the few spare hours I have. But it was at the beginning of high school that I really identified myself with chemistry and physics, and I was lucky to have excellent teachers in those areas. It would be unfair to mention just one influencer because at that time I had several teachers who were very committed to their students' educations. However, my main motivator was certainly my mother, who literally studied mathematics, physics, and chemistry during high school with me.

**When did you decide to study chemistry? What motivated you? How was the beginning of your career?**

As with most of my colleagues at the end of high school, I was very hesitant about which career to choose. Until the last day of registration, I could not decide between Chemical Engineering and Industrial Chemistry courses. I ended up choosing the latter, which I joined in 1983. At the time, the Industrial Chemistry course at the Federal University of Santa Maria (UFSM) was an effervescence course because it counted on the presence of professors from Germany in undergraduate classes through an agreement between UFSM and the German Technical Cooperation Agency (GTZ). It was during a General Chemistry class on the structure of the atom with the excellent professor Lademir D'Avila Cruspeire that I convinced myself that I would continue in the Industrial Chemistry course. I graduated in 1986, when I was 20 years old. During graduation, I was lucky to connect with extremely dedicated professors. I worked as a volunteer in two laboratories – one of organic chemistry and the other of inorganic chemistry – and in my second year of graduation I was selected to be a monitor in the Industrial and Environmental Chemistry Sector of the Department of Chemistry at UFSM. There, I had a fertile environment to work and learn, and I was fortunate to work with Prof. Dr. Berenice Roth and Dr. Leopoldina Keller, in addition to Prof. Dr. Ayrton F. Martins, who was a great motivator and who later would be my master's and doctoral advisor – I was his second master's student and his fourth doctoral student.

Even during my master's degree, when I was only 24 years old, I was already a substitute professor of Inorganic Chemistry at the Department of Chemistry, and the following year I was also a substitute professor in the Department of Physics. When I was 26 (1992), I passed a contest to become a permanent professor at the Department of Chemistry at the UFSM, where I have been a professor and researcher ever since.

**What has changed in the student profiles, ambitions, and performance since the beginning of your career?**

Over time, I think that the vision of science and the world has become not only broader but more profound and tolerant. However, my main ambitions remain the same. Although I have increasingly held management positions, I am still fascinated by teaching classes for undergraduate and postgraduate students. I always try to find time to talk to students and to discuss Chemistry, History, Society, and, of course, Analytical Chemistry.

### **Could you briefly comment on recent developments in analytical chemistry, considering your contributions?**

There have been substantial advances in all areas of Analytical Chemistry, making it difficult to mention a single subarea. However, in general, there is a clear trend towards the development of faster and less invasive methods, with better detectability and selectivity. This is a growing need in the industry, and, in this regard, the development of portable systems that allow analysis *in loco* or *in situ* is a reality since they facilitate decision making in a safer and faster way. Another important aspect that is increasingly present in analytical protocols refers to the use of methods that are consistent with the principles of Green Chemistry, which presupposes, among other aspects, the use of increasingly smaller volumes and concentrations of reagents and, obviously, lower generation of laboratory waste (and, consequently, less need for waste treatment for disposal or eventual reuse).

### **What are your lines of research? You have published many scientific papers. Would you highlight any?**

Despite mainly researching the development of analytical methods by atomic spectrometry, sample preparation procedures, the quality control of high purity materials, and the analysis of environmental samples, food, effluents, and various industrial matrices, in recent years I have dedicated myself to the development of systems that use alternative energies (microwaves and ultrasound) and that can be applied in the intensification of industrial processes in several areas, such as processing oil and derivatives and food and industrial waste.

Among the more than 340 scientific articles published in international journals, I could highlight my first article published in the *Journal of Analytical Atomic Spectrometry* (JAAS, 1997), resulting from my doctoral thesis. This article was written in partnership with my advisor, Prof. Dr. Ayrton F. Martins, and with my friend and also colleague at the time, Prof. Dr. Sergio R. Mortari. This was my first international article, which received much praise for the simplicity of the generation and introduction of hydrides in an atomizer, and this allowed greater visibility of our, at the time, still small, research group. After that article, many others were published, but it is worth highlighting our first article published in *Analytical Chemistry* (ACS, 2004) in partnership with professors Juliano S. Barin, Guenther Knapp, João Alfredo Medeiros, and José Neri G. Paniz. This article, the result of Prof. Juliano S. Barin's Master's thesis at UFSM, was a pioneer in demonstrating the feasibility of a combustion method involving a new principle, microwave ignition, which ended up being patented. The respective product is still commercialized in more than 20 countries and also used as reference method in pharmacopoeias and as reference method for the establishment of international certified reference materials.

... "one of the biggest challenges for scientific research in Brazil is to transform the knowledge generated into applications that impact the daily lives of different sectors of society, from the economy to social and environmental well-being."

### **Do you keep yourself informed about the progress of research in chemistry? What is your opinion about the current progress of chemistry research in Brazil? What are the recent advances and challenges in scientific research in Brazil?**

Yes, I try to keep myself updated with the news and trends in Analytical Chemistry. Analytical Chemistry, although it is an ancient scientific area, took longer to establish in Brazil. However, it is currently one of the most vigorous fields and it has researchers with great international recognition, which can be seen by the growing number of Brazilian researchers acting as editors or in editorial boards of high impact international journals. There have been substantial advances in all areas of Analytical Chemistry, largely due to advances in microelectronics and new materials with properties that allow the construction of detectors, reactors, instruments, etc., with many advantages over the instruments produced a few years ago. Despite all these advances, one of the biggest challenges for scientific research in Brazil is to transform the knowledge generated into applications that impact the daily lives of different sectors of society, from the economy to social and environmental well-being. For this, we

will have to advance even more in the popularization of science, with the convergence of many academic themes with different demands from society, linking aspects related to technological innovation and entrepreneurship. Thus, different products, processes, and services can be generated through scientific research, which can impact society at the local, regional, national, or even international level.

**For you, what have been the most important recent achievements in analytical chemistry research? What are the landmarks?**

There have been many notable achievements, and it is impossible to select all without risking forgetting many, but I believe that recent developments in sample preparation methods with the application of systems that combine microwave and ultraviolet energies; the integration of nanomaterials with nucleic acids in biosensors; 3D printed biosensors for optical and electroanalytical applications; microstructure-based techniques for the analysis and manipulation of individual cells; infrared thermal imaging for fast and portable enthalpimetric analysis and the consequent appearance of different spectrometric methods for the generation of chemical images can be cited as interesting novelties.

**There are in Brazil, and in the world, several conferences on Chemistry. To you, how important are these meetings to the scientific community? How do you see the development of national chemistry meetings in Brazil?**

Despite the growing trend towards virtual meetings, there is a certain consensus that they are still unable to compete with all the advantages and dynamics of face-to-face meetings. In this regard, meetings of great international recognition are organized in Brazil, such as the biennial “Encontro Nacional de Química Analítica” (ENQA), which is in its 20<sup>th</sup> edition, and the Analitica Latin America Expo&Congress, which is one of the largest Analytical Chemistry meetings in the world today, with thousands of participants in all editions. Both congresses and exhibitions are events that allow the exchange and updating of information. I believe that this face-to-face model, despite recent restrictions due to the COVID-19 pandemic, should return strongly in the coming years.

**You have already received some awards. What is the importance of these awards in the development of science and new technologies?**

I think that the awards, in addition to the expected joy of those who receive them, are a motivator for students, especially the youngest. Regardless of value, the meaning of the award will always be a healthy stimulus for new generations as well as for scientists with a well-established career. This stimulus obviously has an important role in sharpening the creativity and advances of chemistry.

**For you, what is the importance of the national funding agencies for the scientific development of Brazil?**

National and state agencies are essential for scientific development. Of course, some adjustments and improvements are always welcome, and it is known that these agencies are constantly improving. However, it is amazing that, despite the obvious advantages of this type of investment, it has been increasingly necessary to clarify and convince most Brazilian managers and politicians of the need to invest in science, technology, and innovation. Such investment is always reverted in improvements for the society, and this has been demonstrated by all industrialized countries. I would like our government officials to take more account of the need to finance science and technology at levels that are at least similar to those of more developed countries.

**At the moment, the situation for scientific research in Brazil is one of decreasing investment. How do you see this situation, and what would you say to young researchers?**

This is a very difficult time for Brazilian science. The cuts in investments in science and technology have been brutal, and I don't remember so much disinvestment, at least in the last 20 years. This causes

disenchantment and discouragement in all researchers and brain drain to other countries, but it is mainly in the younger generations that this feeling is perceived. Brazil's investment in S&T is one of the lowest among developing countries, which is unacceptable for a country the size of Brazil and with a structure of highly qualified laboratories. I sincerely hope that this obscurantism in terms of understanding the importance of S&T has does not take long to pass. For now, I recommend that young people try to endure this situation and make sure that we will again have investments compatible with what is expected for Brazil.

### **What advice would you give to a young scientist who wants to pursue a career in analytical chemistry?**

I believe that I would give the same advice that I've given to those who wanted to pursue other areas of science, that is, always keep up to date and always try to read what has already been published so as not to risk trying to rediscover old news. In addition, always have a look at other areas of science that may contribute to your specialty, never give up the care in carrying out everything you do and, especially, always be in a good humor. It is not possible to develop good science without a certain dose of good humor. Difficulties always occur, but with optimism and good humor things become easier, and it is not so difficult to deal with ridiculous setbacks, such as scientific denialism and obscurantism, which, from time to time, always end up appearing.

*...“never give up the care in carrying out everything you do and, especially, always be in a good humor. It is not possible to develop good science without a certain dose of good humor.”*

### **How would you like to be remembered?**

For always trying to improve our society by generating and spreading knowledge and for motivating students to believe in their potential and to pursue an academic or entrepreneurial career, but always based on real science never in pseudo or quasi-science. In addition, for having contributed to the consolidation of the following thought: *“if with science we can have problems, without it we would probably not be here today”*.