FACES OF MASS SPECTROMETRY / Leonard Nyadong

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Fuel for Inspiration

Leonard Nyadong is a senior scientist at Phillips 66 in the Energy Research and Innovation organization. Having grown up in Cameroon, Leonard moved to the United States to study organic synthesis. However, he soon discovered his passion for the field of analytical chemistry. Leonard earned his PhD from Georgia Institute of Technology, where his research focused on development and applications for ambient ionization techniques. From there, he accepted a postdoc with the National High Magnetic Field Laboratory at Florida State University. It was during this time that he began working closely with petroleum characterization and learning about the unique challenges in this field.

Following his postdoc, Leonard accepted a position with Phillips 66. He enjoys this job for a variety of reasons, some of which include the wide array of research projects, the frequent opportunities for collaboration, and the chance to continue pursuing scholarly activities. Furthermore, as the organizer of an internal mass spectrometry excellence team, Leonard is committed to improving and expanding the role that mass spec plays within the organization.

Sharing his expertise with colleagues and younger scientists is something that Leonard finds very rewarding. During his PhD and postdoc, Leonard frequently hosted summer internships, and he continues to do this at Phillips 66. Leonard is also very grateful for the support he has received from his family and mentors, and the example they set. Two of Leonard's chief role models have been his father and PhD advisor, both of whom he credits for instilling the work ethic and persistence that are crucial qualities for a successful researcher.

Can you tell us about when you realized you'd like to become a scientist?

I realized I wanted to become a scientist as soon as I started my secondary school education and began taking subjects like chemistry, physics, biology, and math. I had a natural inclination toward those subjects, because they could explain a lot of things in the natural environment. I was particularly drawn to chemistry after learning about the various pieces of equipment such as test tubes, burettes, and Bunsen burners. I also saw pictures of chemists in their lab coats, and I started dreaming of someday becoming one of those chemists. In those formative years, one individual who really helped to drive my interest in science was my chemistry teacher, Mr. Tata Augustine. He was perhaps one of the greatest teachers I have encountered throughout my education. He was gifted with the ability to bring chemistry to live in a classroom. I got really excited learning about concepts like the atomic structure and the discovery of subatomic particles—the proton, neutron, and electron. I used to sleep and dream about the subatomic particles and always thought, "There has to be something beyond the proton, neutron, and electron!" My goal was to someday become a scientist and get the opportunity to discover those subatomic particles.

How did you get your start in mass spec? How did you come to your current position at Phillips 66?

My start in mass spec happened when I moved to the United States for graduate school at the University of Toledo. My intention was to study organic chemistry, and specifically organic synthesis. But it was during seminars there that I realized my real interest was not organic chemistry but analytical chemistry. But I couldn't do analytical chemistry research at the time because there were no openings in the labs of professors who did research in analytical chemistry. So, that's how I ended up pursuing research in biochemistry, specifically enzymology. I later decided to pursue my real interest, graduating with a master's degree and moving to Georgia Tech for my PhD, where I could do analytical chemistry research. After speaking to various professors, I was inclined to join a lab that was mostly focused on spectroscopy. In the meantime, there was a student poster session to showcase research in the various groups to incoming graduate students.

> *My career is a summed-up total of everything that has impacted my life, including all of the great advice from family, friends, colleagues, professors, and mentors.*

Leonard Nyadong investigating a sample by use of ambient MS with lab colleagues: left Melissa Patrick; right Amber Crow. (Photo courtesy of Leonard Nyadong.)

There, I came across a poster that showed a mass spectrum that had a single peak—that poster session was my first time ever seeing a mass spectrum with just one peak. The presenter explained the spectrum was generated by a soft ionization technique in which the ions don't fragment after being generated, which I found to be quite powerful.

That encounter motivated me to get into mass spec to learn about how to make ions. I later arranged another meeting with the professor whose student presented the poster: Facundo Fernandez, who became by PhD advisor, and who also had a project waiting for me. It was much like a match made in heaven! My PhD was mostly spent learning and developing ways of making ions, which were tailored for forensic applications, with simple systems containing a few analytes. Following my PhD, I accepted a postdoc at the National High Magnetic Field Laboratory (MagLab) at Florida State University, working with the Alan Marshall teams. At MagLab, I was able to learn a lot about petroleum and some of the challenges in the field. Following my postdoc, I was open to a career in either industry or academia. It was kind of a natural transition for me to join Phillips 66 R&D, which provided an opportunity to do applied research and work across teams for problem solving. This has made for an exciting career so far.

When, and how, did you decide to focus specifically on analytical method development and ionization techniques?

My inspiration to focus on mass spectrometry ionization stems, as I mentioned, from my first encounter of seeing a mass spectrum that contained just one peak as opposed to the multiple fragment peaks seen in organic mass spectrometry. That is what got me hooked on learning and understanding different ways of making ions by mass spectrometry during my PhD. In my opinion, ion generation is probably the most critical step in being able to characterize materials by mass spectrometry. Understanding various ways of making ions facilitates the ability to develop a method for characterizing any material of interest. That is why I focused my work on development and applications of various mass spectrometry ionization techniques.

How did you decide to make the shift from academia to industry? What are some of the advantages, disadvantages, and differences to both areas of the mass spec field that you have encountered?

Following my postdoc, I was interested in continuing my career in academia but was also open to a career in industry. It seems my training was leading me to a career in industry and specifically the petroleum industry. I also wanted to pursue a career where I could have the opportunity to conduct independent research, which is what drew me to Phillips 66. So far, I think it has not disappointed me, because I'm still able to do research and get work published in peer-reviewed journals and pursue other scholarly activities such as presenting my work at conferences and organizing conference workshops etc. I think one of the main advantages of working in industry is funding to get supplies and capital items. In industry, we typically work for profit, so most of the research is applied and is tied specifically to projects demonstrated to create value for the company. This kind of limits the space within which we can explore. But one of the other advantages is that when you have a good idea that shows promise to create value for the company, it probably doesn't go through as rigorous of a process to secure funding as it would in academia.

My main advice is: Immerse yourself in the literature, because the field is moving rapidly in terms of technology and applications.

Warming up to score some big goals. (Photo courtesy of Leonard Nyadong.)

Tell us about some of your efforts to mentor younger scientists, along with URM scientists. How has being a mentor helped to shape your own career?

Throughout my PhD and postdoc, I had the pleasure to host and mentor NSF-REU and URM students during summers, guiding them through work on various projects. I have been able to do the same here at Phillips 66, hosting summer interns. In recent years, I started a mass spectrometry excellence team, which brings together colleagues with an interest in mass spectrometry within our organization. That has been very useful in guiding and mentoring team members to hone their mass spec skills. I have also provided formal and informal training to new technicians, enabling them to transition into the mass spec arena. Through mentoring, I'm able to learn about the patience and consideration that it takes to educate a novice in a new field. It's also very rewarding to see the improvement in performance it brings to our overall analytical science team. In addition, it provides me with the opportunity to be more productive, passing on responsibilities as mentees gain experience and expertise—it frees room for me to create more value for our company.

What excites you about your current work? Are there new topics or questions you hope to explore in the future?

Working within a centralized research and development organization of a global company like Phillips 66, I get the privilege to work on projects across all aspects of the business. What really excites me about my work is the diversity in terms of the projects and the extensive collaborative opportunities they provide. Working on problems from all aspects of the business allows me to connect the dots. I might be working on one problem occurring in one of our refinery units and a seemingly different problem in another unit. Being able to see both sides sometimes allows me to find and solve the root cause. My vision for our company is to establish a distinguished mass spectrometry program for a refining and midstream business. The energy transition is also coming with exciting new challenges requiring the refineries to process new types of feed stock. Ongoing and future work, for me, relates to establishing a firm role of mass spectrometry in supporting the energy transition to secure a sustainable energy future for generations to come.

Can you describe a relationship or major piece of advice that has influenced your career?

I don't think there is any one piece of advice that has had an outsized influence on my career. My career is a summed-up total of everything that has impacted my life, including all of the great advice from family, friends, colleagues, professors, and mentors. I would like to highlight two individuals who greatly influenced my work ethic, mostly based on me observing them. The first is my dad, who was a dress designer and a great provider, and who taught me the spirit of hard work. It was only after I got much older that I realized how hard he worked to provide for our family. The second impactful person was my PhD advisor, Facundo

Fernandez, who taught me the patience and persistence it takes to do research. He would often come by the lab toward the end of the workday, and some of those times, I was struggling with an experiment that wasn't working. He would sometimes stay in the lab with me until very late, and most of the time, we got a positive result. Those experiences really taught me what it takes to be successful.

Is there an advancement in mass spec analysis or instrumentation that has had an impact on your research?

Most of my research work has been based on the development of methods and approaches for characterization of complex mixtures. The most impactful developments have been recent advancements in high resolution mass spectrometry that have pushed the limits of mass resolution and mass accuracy, with technologies such as Fourier transform ion cyclotron resonance, orbitrap, and time-of-flight mass analyzers. Combining some of these tools with high resolution chromatography techniques has also been very helpful. With the multitude of ionization techniques available to mass spectrometrists today, I'm still in search for that single technique that provides universal equimolar ionization and analyzers that offer uniform transmission and detection of ions.

What are your interests outside of the lab? Do they include any kind of travel?

I like to travel, but I've never really had opportunities to do much traveling until very recently. Last summer was my first time traveling outside the United States on vacation. My family and I went to Munich, Germany for vacation and a wedding. I really enjoyed it—I think I'll have to create some more time to travel. I'm also an avid fan of the Real Madrid football club. One item on my bucket list is to travel to Madrid someday to watch a game live. My typical pastime when I get home from work is checking scores and watching highlights from the games of the day. My daughters are also growing fast—they are 12 and 14 years old, and I love spending time with them. We enjoy bike rides around the neighborhood most evenings when the temperature is right. Recently, I've also been doing a lot of other personal development by listening to audiobooks.

What advice would you give to scientists working in or entering the field of mass spec?

My main advice is: Immerse yourself in the literature because the field is moving rapidly in terms of technology and applications. There is plenty of learning to be done by beginners with mass spectrometry being such a vast field. It's also in reading the literature that gaps are found, along with areas to which to contribute. For me, at the beginning, I was always very concerned about breaking the instruments, so I also advise scientists who are just starting out to not be afraid of doing that—always be eager to try new things. Finally, take advantage of more experienced colleagues and supervisors to bounce ideas back and forth, and ask a lot of questions which helps facilitate the work.