THE PLASMA CONNECTION

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Meet a Few Plasma Scientists

In this issue of the Plasma Connection find out how plasma science researchers first got into the field and what their recent research work is about. Briefly, eight well established researchers (listed alphabetically) tell us their stories and what are the scientific pursuits that motivate them.

Scott Baalrud
University of Michigan
Ann Arbor, MI, USA
baalrud@umich.edu

Q1: What brought you to plasma science?

SB: I was a second-year nuclear engineering student at the University of Wisconsin-Madison when Professor Noah Hershkowitz offered me an opportunity to do experiments in his laboratory. These experiments were so fun that I haven't looked back.

Q2: Which topic or topics have been the focus of your research in recent years and why (i.e., impact)?

SB: I'm motivated to explore the boundaries of our knowledge of fundamental plasma physics and to find ways to extend theory to new regimes. Lately we have explored three exotic regimes: strongly coupled plasmas (e.g., very dense, or cold plasmas), strongly magnetized plasmas, and plasma that are driven unstable by internal microinstabilities. Each of these regimes connects with interesting applications in low temperature plasmas and high energy density plasmas.

Annemie Bogaerts
University of Antwerp
Antwerp, Belgium
Annemie.bogaerts@uantwerpen.be

Q1: What brought you to plasma science?

AB: I studied chemistry, and was inspired by my professor in analytical/physical chemistry (prof. Renaat Gijbels), who asked me to study a glow discharge plasma used as ion source in analytical chemistry. So I developed models for this plasma during my master thesis and PhD. I was the first in our university to study plasmas, and I realized that plasmas are used for so many other interesting applications. Hence, after my PhD and the retirement of my supervisor, I started a new plasma research group, PLASMANT, focusing on modeling (and later also experiments) of plasmas for various applications.

Q2: Which topic or topics have been the focus of your research in recent years and why (i.e., impact)?

AB: I now mainly focus on two major plasma applications: green chemistry and plasma medicine. For green chemistry, we study plasma-based CO_2, CH_4 and N_2 conversion into value-added compounds, by plasma and plasma catalysis. This is an emerging field, because of the need for electrification of the chemical industry. As plasma operates by electricity, and is quickly switched on/off, it is suitable for combination with renewable electricity. In plasma medicine, we mainly focus on cancer treatment, where we want to develop combination therapies, e.g., with immunotherapy. We do experiments, but also develop models for plasma chemistry, reactor design and plasma-surface interactions.

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David B. Go
University of Notre Dame
Notre Dame, Indiana, USA
dgo@nd.edu

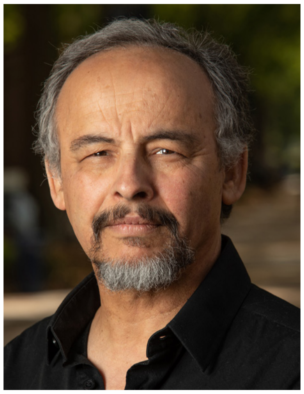
Q1: What brought you to plasma science?

DG: I came to plasma science incidentally. I was a graduate student at Purdue University, interested in heat transfer as broadly applied to energy. At the end of my first year, I was approached by my advisor Tim Fisher and my (to become) co-advisor Suresh Garimella about an electronics cooling project using ionic winds and field emission, which ultimately became my dissertation. When I started my independent career, I really began to focus on plasma science and engineering rather than heat transfer (though I still dabble), and most fulfilling, my current projects have come full circle by exploring energy applications.

Q2: Which topic or topics have been the focus of your research in recent years and why (i.e., impact)?

DG: Most of my current research is in three areas. Two of these are non-thermal plasmas applied to catalysis and electrochemistry (also known as plasma-liquid interactions), with a focus on achieving carbon-neutral chemical processing. The third is energy conversion plasmas, exploring using materials such as piezoelectrics and pyroelectrics and motion or heat to create plasmas without needing a high-voltage power supply, helping take plasma devices out of the lab and into the field. Most recently, I have started to study the intersection of plasmas and additive manufacturing, which is an exciting new direction for my group.

Mounir Laroussi
Old Dominion University
Norfolk, VA, USA
mlarouss@odu.edu



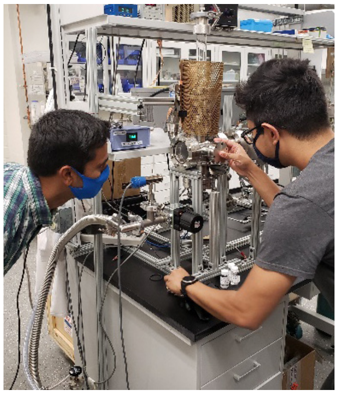
Q1: What brought you to plasma science?

ML: I was starting my graduate studies at the University of Tennessee at Knoxville when I attended a lecture given by plasma physicist, Prof. Igor Alexeff, and I immediately realized that this was the field of research that I wanted to pursue.

Q2: Which topic or topics have been the focus of your research in recent years and why (i.e., impact)?

ML: For the past two decades I have been developing low temperature plasma sources and studying the effects of LTP on biological cells. In the mid-1990s I wanted to know what the effects of cold plasma on living cells would be. I was surprised that there were no scientific studies made on this subject, so I decided to start my own investigations. Today, thanks to the work of various research groups from around the world, we understand quite a bit the mechanisms whereby plasma interacts with biological cells and tissues. The applications range from decontamination (inactivation of harmful bacteria and viruses), to wound healing, to cancer treatment.

Mohan Sankaran
University of Illinois
Urbana-Champaign, IL, USA
rmohan@illinois.edu



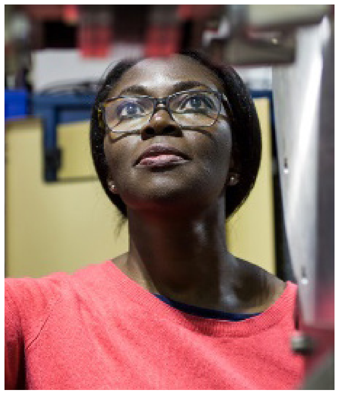
Q1: What brought you to plasma science?

MS: When I was in the final year of college at UCLA, I was looking for an elective course to take and there was a new course that caught my eye taught by Robert Hicks and Francis Chen, two very prominent plasma scientists. There, I learned that plasmas played a critical role in semiconductor manufacturing and that fascinated me both for the fundamental science and technological impact. Later, when I joined graduate school, I started working with plasmas. The first time I ignited my own plasma, it captured my own childlike fascination – it was so bright and colorful, it felt like someone starting their own fire. At that point, I wasn't just interested, I was hooked.

Q2: Which topic or topics have been the focus of your research in recent years and why (i.e., impact)?

MS: As a chemical engineer, I am always interested in applications of plasmas in a chemical process. In the beginning of my career, I was mostly interested in how plasmas could grow materials. While I still work on plasmas for material synthesis, recently I have also become interested in using plasmas for synthesizing chemicals. Current methods for chemical manufacturing are a problem for our environment because they rely on fossil fuels. Plasma-based chemical processes have the potential to address this issue because they can operate near room temperature and use electricity which in future years could come from renewable sources.

Sedina Tsikata
Centre National de la Recherche Scientifique (CNRS), ICARE
Orleans, France
Sedina.tsikata@cnrs-orleans.fr



Q1: What brought you to plasma science?

ST: Complex flows and turbulence, in general, have always been interesting to me. As a graduate student, I was fortunate to integrate a research group at the Ecole Polytechnique in France with very broad expertise in plasma fusion. This provided an ideal environment for me to learn about plasmas, their complexity, and many open questions. Thanks to my PhD advisor, I became involved in the French electric propulsion community, which was looking into understanding aspects of Hall thruster physics akin to those plaguing fusion devices.

Q2: Which topic or topics have been the focus of your research in recent years and why (i.e., impact)?

ST: My research has focused on developing and applying laser diagnostics to study plasmas, with the goal of answering questions around waves and self-organization, and providing missing information on particle properties and dynamics. We can now take advantage of advanced experimental methods, combined with theory and simulations, to make significant progress in understanding the features of plasmas. I'm interested in plasmas with diverse applications, relevant to areas such as space propulsion, materials processing, and nuclear physics.

Achim von Keudell
Ruhr University Bochum
Bochum, Germany
Achim.vonkeudell@rub.de

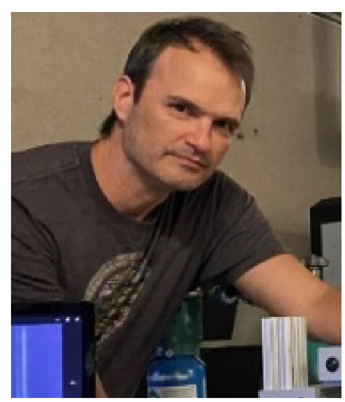
Q1: What brought you to plasma science?

A v K: After my physics study, I was interested in very many topics. Plasma science seemed to me most attractive, because it combines very many disciplines from atomic and molecular physics, to plasma physics, to solid state physics, to biology etc. For a curious person this is a great playing ground, which keeps being intriguing ever since.

Q2: Which topic or topics have been the focus of your research in recent years and why (i.e., impact)?

A v K: I am trying to change the focus of my work every 7 years to follow my interests. More recently, we worked on plasma dynamics in magnetized plasmas, on extreme plasmas in liquids and now more on plasma chemistry and plasma catalysis problems. In all these cases a very nice application scenario such as the demand for excellent materials or the search for solutions for the use of renewable energy is combined with very intriguing and fundamental physics questions. These are the right topics to be addressed by a university group.

Richard Wirz
University of California Los Angeles
Los Angeles, CA, USA
wirz@ucla.edu



Q1: What brought you to plasma science?

RW: Early in graduate school at Caltech, a lecturer from NASA JPL introduced the concept of plasma rockets; a relatively new technology at the time. I was amazed that the behavior and performance of plasma rockets, and plasmas in general, must be understood by analyzing the behavior and interactions of ions and a fundamental particle, the electron. Understanding the world from the fundamentals was always a dream of mine and is why I returned from a career in music to go to graduate school.

Q2: Which topic or topics have been the focus of your research in recent years and why (i.e., impact)?

RW: I have continued to work in the rapidly growing area of plasma rockets and in newer space electric propulsion technologies such as electrosprays, a new a promising thruster concept for small satellites. I have also recently used my passion for plasmas to extend my work into plasma-based fusion materials in hopes to help save the planet, as well as plasma medicine to directly help people around the world.

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