Entrevistamos a ...

Hoy tenemos el placer de entrevistar al profesor Semih Eser. Muchos de vosotros lo conoceréis, además de por su trayectoria científica y su carácter bondadoso y colaborativo, porque es un “fan” del GEC.

Semih Eser is a Professor of Energy and Geo-Environmental Engineering at Penn State. He obtained his Ph.D. (1986) in Fuel Science from this University. After a brief period at the Department of Chemical Engineering at Auburn University, he returned to Penn State (1988) and he has been there since then. Over his career, he has held several key positions, such as Acting Head of Department of Energy and Geo-Environmental Engineering and Director of the Laboratory for Hydrocarbon Process Chemistry at the EMS Energy Institute. He currently teaches at the John and Willie Leone Family Department of Energy and Mineral Engineering and direct the Carbon Materials Program at the EMS Energy Institute.

Professor Eser is also actively involved in academic publishing, serving on the editorial boards of the Journal of Oil, Gas and Coal Technology, Journal of New Carbon Materials, and as section editor of Energy Sustainability in the Journal Sustainability. Eser's research interests include the reactivity and microscopic characterization of cokes and carbons, coke/carbon formation and deposition mechanisms, inhibition of undesired carbon deposition, molecular analysis and processing of petroleum feedstocks.

Muchas gracias Professor Eser por aceptar nuestra invitación.

Nos consta que su relación con científicos españoles comenzó hace muchos años y que se ha mantenido durante su trayectoria profesional. Remember your first interaction with a Spanish scientist? What stands out from your professional collaboration with Spanish researchers? Any interesting anecdotes?

Thank you for your kind invitation. It is an honor to be invited, as I consider GEC the premier organization of carbon scientists and researchers in recent decades.

As you mentioned, I have had the pleasure of meeting and collaborating with several Spanish scientists. My first interaction was with Juan Jose Rodriguez at a carbon conference in Granada. Our initial conversation led to a wonderful friendship and collaboration in research. Quite a few years later, I had a great sabbatical year with Juan at UAM, where I met a remarkable group of faculty members and students. I must also mention my collaboration with Ana Garcia at INCAR and my visit with Pepe and Tomas in Malaga, all in the same year.

I also had the pleasure of hosting several Spanish researchers at Penn State over the years, exchanging ideas and sharing experimental facilities. In this context, I would like to mention the terrific work Noelia did during her stay here.

What stands out in all my collaborations with Spanish researchers is their friendliness and modesty, along with their command of their area of research. An elegant sense of humor and great camaraderie also struck me as common traits of the Spanish researchers I have met. At international meetings, you will always find me with the Spanish group, the liveliest group in every meeting. Outsiders often think that I am from Spain.

I don't have a good memory for recalling anecdotes, but there are many happenings that I will never forget. For example, sitting on a hill with Juan and conversing while gazing at the lights of Alhambra, and joyful interactions with Pepe and Tomas along with their students at Chiringuitos in Malaga.

Professor Eser, you have participated in several GEC Meetings, what was your experience at these conferences?

While my Spanish comprehension is not yet at the level to fully understand the presentations and discussions, I enjoy observing the lively interactions among the colleagues. Such immersion in Spanish language and culture at these meetings and their venues gives me great pleasure.

I should note that these meetings are very well organized and provide excellent opportunities for all participants to engage in focused learning and networking.

Tell us a little about your career in carbon science. How did you start doing research in carbon and how has it evolved over the years? What are your main topics of expertise? Do you anticipate a bright future for carbon research?

My research journey started at the Middle East Technical University, where I conducted a master’s thesis study on the pyrolysis of coals and related materials. The primary objective of that work was to develop liquid products rather than solid carbons, because at the time the world was seeking alternatives to petroleum following the 1973 and 1979 petroleum supply crises.

In 1981, I received a scholarship to pursue a PhD degree at Penn State University to study making solid carbons by carbonization of petroleum feedstocks. While my lab colleagues explored liquefaction or gasification of coal, the purpose my research was to identify suitable feedstocks and carbonization conditions for producing high-quality sponge coke. Sponge coke is used to manufacture carbon anodes for aluminum smelting. This research provided insight into the formation of shot coke, a troublesome byproduct, formed during the delayed coking process. Developing the means of preventing shot coke formation has been of significant interest for some petroleum companies.

I also need to mention another product of delayed

coking, needle coke, which has played a central role in my research career. My research on needle coke focused on understanding the relationships between the chemical constitution of petroleum feedstocks and the development of an intermediate carbonaceous mesophase, a crucial liquid crystalline phase that hardens into graphitizable needle coke. Needle coke is used in manufacturing graphite electrodes in electric-arc furnaces. The research challenge in this area involved unraveling the exceedingly complex chemistry of carbonaceous mesophase formation. The procedures developed in our laboratory associated the chemical constitution of feeds with needle coke quality. These procedures have been adopted by three major petroleum/coke companies, enabling them to manufacture better needle cokes for graphite electrodes to afford more efficient recycling of iron and steel, resulting in significant energy and materials savings.

In the area of amorphous carbons, Katia Gergova and I adapted one-step pyrolysis activation techniques to produce activated carbons from anthracite and agricultural byproducts, such as fruit stones. The conventional activated carbon preparation technique involves separate carbonization and activation (with steam) steps. Carrying out pyrolysis in the presence of water vapor (one-step pyrolysis/activation) has proved to be a useful method for tailor-making activated carbon materials. These carbons have unique properties with respect to porosity and surface functional groups. Achieving this conversion with lower energy inputs helps optimize the activated carbon manufacturing processes for the desired end uses. I must note that Spanish researchers have been very successful in the development of activated carbons from different sources, including agricultural byproducts.

As well known, solid carbons possess impressively diverse structures and properties. Consequently, they find many diverse applications in the materials industry. One weakness of carbon materials in some applications is their low resistance to oxidation. Understanding oxidation reactivity of carbon materials in different environments is, therefore, critical. My research in this area has focused on studying the relationships between microstructure and reactivity of carbon materials using in-situ techniques. These techniques include environmental SEM, and in-situ x-ray diffraction (in collaboration with Isabel Fonseca from NOVA in Portugal) coupled with the use of microscopic characterization and Temperature-Program Oxidation. The applications from this research program have ranged from understanding the failure of C-C composite aircraft breaks in the presence of de-icing fluids on airport runways, to clarifying the mechanism of carbon deposit formation on metal surfaces, and quantifying the extent of graphitization in carbon materials.

Not all carbons are good! I have also done research on undesirable formation of solid carbon deposits that accumulate on metal surfaces from decomposition of jet fuel, diesel fuel, and gasoline, as well as lubricating oils. This problem has become more pressing since combustion engines are being operated at higher temperatures and pressures for increased performance and efficiency. A particular concern with solid deposition relates to the operation of advanced aircraft. Our research program has identified different mechanisms of solid carbon deposition on metal surfaces that led to the development of strategies for inhibiting the deposit formation. This can be accomplished through judicious selection of metal alloys for manufacturing the fuel system components and by pre-oxidation or by coating of metal surfaces to produce protective thin films.

The future of carbon materials looks very promising, considering the unique diversity in allotropy with 0-, 1-, 2-, and 3-dimensional geometry spanning a wide range of materials, including fullerenes, nanotubes, graphenes, graphite, and diamond, and all with just one element of wonder. I believe that innovative applications of carbon materials will bring forth new revolutions, in corollary to charcoal and metallurgical coke that ushered in the 2nd Industrial Revolution. A summer school organized by Raul Arenal and Wolfgang Maser of the University of Zaragoza this year has helped me envision the new frontiers of carbon nanomaterials in energy conversion and storage, environmental remediation, biomedical engineering, and functional material applications. Graphite has the distinction of being the only material that gets stronger with increasing temperature; new architectures of carbon nanomaterials, possibly their hybrids, will continue to surprise us, as Professor Philip L. Walker, Jr. had foreseen half a century ago in “Carbon: An Old But New Material.”

During your extensive career in carbon science and application, you have frequently collaborated with companies and industry partners. Can you offer advice to young scientists on fostering scientific collaboration?

I can share some insights that I have gained throughout my career.

It is important to remember that industry primarily focuses on the R&D question of know-how to gain a competitive advantage. As a scientist, your focus must also encompass scientific inquiry (know-what) and the social and environmental relevance of your research (know-why). Establishing a good balance between these interests, which usually should not clash, can play a crucial role in securing and maintaining support for your research program.

You have been honored with multiple awards from the American Chemical Society, most recently from the Division of Energy and Fuels in 2023. How have these accolades impacted your career?

It is undoubtedly gratifying to be recognized by one’s peers. Moreover, receiving an award increases your chances of being considered for subsequent recognition. I believe, for example, that having

received a Fulbright Scholarship had a positive impact on my selection as an ACS Fellow. Further, the nomination process for an award gives an opportunity for self-reflection and self-evaluation. Correspondence with your referees and peers during a nomination process also affords means of closer acquiantances that can be mutually beneficial.

We believe there are significant differences in conducting research in Spain and the USA. Could you outline the main contrasts?

My response to this question is based solely on my personal observations and is not supported by formal inquiry. The main contrasts I have noticed lie in two areas: How research is funded, and how it is conducted.

In Spain, there is a stronger public funding structure from both central and local governments compared to the United States. These funding opportunities are distributed more equitably, with fewer instances of unfair practices interfering with the process. In contrast, private enterprises in the United States play a larger role in funding research than governmental organizations. This leads to research programs that are more biased toward the agendas of the funding companies rather than focusing on pressing social, environmental, and public health issues.

Regarding university research, the main contrast lies in how individuals are involved in the research organization. In the United States, tenure-line assistant professors are given a start-up fund that may include support for graduate students. They are expected to establish their own laboratories and generate data for publications to meet the tenure review requirements typically within six years. Often, they need to establish internal or external collaborations themselves.

In Spain, young researchers are incorporated into multi-faculty research groups mentored by senior faculty members. This provides a built-in mentoring structure and a natural environment for research collaboration within the group. I perceive this as a less stressful entry into academic research and advancement into higher ranks than the lone wolf approach that prevails in US universities.

One must note that both systems have their advantages and disadvantages, and different approaches have serious implications for teaching, research, and service tasks of faculty members, as well as the quality of graduate and undergraduate education in academia.

What are your thoughts on the increasing number of manuscripts being submitted to scientific journals? Do you think this has impacted the quality of publications? Additionally, what is your take on the growing number of scientific journals?

I have not given much thought to these trends, although they clearly relate to the classic dichotomy of quality versus quantity in terms of the number of publications. Scientific review of submitted publications is a voluntary activity. Hence, increasing numbers of submitted manuscripts put pressure on journal editors to find qualified reviewers. This, in turn, increases the pressure on reviewers for timely completion. Further, the limited number of papers that can be accommodated in a journal issue leads to a higher rejection rate from journals with high impact factors.

In the publications market, the increasing demand to publish has led to a growing number of scientific journals. One factor contributing to this demand may be the requirement by academic departments for students to publish in peer-reviewed journals as a condition for earning their PhD degrees. I am confident that journal editors and journal owners are working on addressing these issues, but the challenge lies in bringing all the involved parties (academic departments and journal editors) together to find a solution.