

## SPOTLIGHT ON... MEET OUR NEXT PRESIDENT

As the Symposium is coming to an end, we had the chance to speak to the next President of The Combustion Institute, Prof. **Hai Wang** (Stanford University, United States), who has been enjoying the Symposium and all of the social and post-social events. We couldn't help to ask some curiosities about the future management of some aspects of the *Proceedings of The Combustion Institute (PROCI)*. Below are his replies. We wish the best of luck to Prof. Wang in his presidency!



### **PROCI has officially transitioned into a digital-only format; can we expect relaxed space limits for future papers?**

Good question! Indeed, with *PROCI* becoming completely digital, there is a lesser reason to impose the space limit as tight as it used to be. That said, I personally believe that *a shorter paper is always more powerful than a longer paper, especially considering the limited amount of time an author has to present the related findings and conclusions at the ISOC*. The other consideration is the *competitive nature of the ISOC paper review and acceptance* – we must have a page limit to facilitate an effective and fair review process. Whether we relax the space limit will be decided by future ISOC program co-chairs and *PROCI* co-editors. As a policy, the CI office does not interfere with editorial processes.

### **PROCI and CNF require “Novelty” statements, which is often almost a duplication of the abstract; do you believe it is a good change?**

I like and support the inclusion of a “Novelty” statement. There may be some misunderstanding here. *“Novelty” is a statement about what is new with respect to the state of knowledge, whereas the abstract is an executive summary of the paper*. Today, a novelty statement is required in many of the high impact journals, e.g., *PNAS*. I believe that the statement *can help the authors to think about what new ideas their work brings and what impact the work is expected to make*. The statement also helps the reviewers by assessing the impact of a paper with respect to the state of knowledge of the field.



## FEATURED LECTURE - A Net-Zero CO<sub>2</sub> Society

PLENARY LECTURE BY PROF. TIMOTHY LIEUWEN

Thursday's Plenary Lecture on the roles of combustion in the net zero CO<sub>2</sub> society was delivered by Prof. **Timothy Lieuwen** (Georgia Institute of Technology, United States). The Plenary emphasized the future value of *fuels as energy carrier or storage medium* rather than a direct energy source for a decarbonized world at lower cost. Some drivers that will control the role of combustion relative to competing technologies will be *efficiency, operational flexibility, pollutant emissions, and fuel flexibility*. Lastly, it was argued that the traditional lean premixed combustion strategies alone won't be sufficient, and new strategies will be required to utilize e.g., nitrogen containing fuel, such as ammonia.



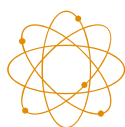
During the coffee break, we got Prof. Lieuwen's thoughts on a few questions:

### **How do you think decarbonization in combustion can be achieved?**

We are at the state-of-the-art in terms of efficiency in combustors designed for specific fuels. The main challenge, however, is that we need to have systems with a good level of fuel flexibility, and can therefore burn low carbon fuels but yet still meet all the operational constraints that combustion systems have to attempt to meet. Making a system that is still low cost and simple that can handle that whole range of fuels - that's a big challenge.

### **Do you think the energy transition systems (e.g., gas turbine) using carbon-free combustion will be the same as the current ones?**

This relates to the topic of fuel flexibility that I mentioned before, so no, systems won't be the same; we will probably shift to systems that are intrinsically flexible to accommodate renewable fuels. That's going to be a huge driver. For instance, one challenge is that if you're burning anything that doesn't have a nitrogen atom, the basic architecture is going to be a lean premix architecture. As soon as you start going to ammonia, you have to do more of a rich staged concept. An interesting challenge will be, if ammonia does indeed move ahead as a major energy carrier, designing combustion systems with low NO<sub>x</sub> emissions. So, I think the community as a whole need to revisit rich stage designs.



## SCIENTIFIC HIGHLIGHTS - TOPICAL REVIEW

SOOTING EXPLAINED BY PROF. LISA D. PFEFFERLE

Prof. **Lisa D. Pfefferle**, (Yale University, United States) gave an Invited Topical Review on "Sooting tendencies: combustion science for designing sustainable fuels." Based on the work with her long-time research partner, Dr. **Charles McEnally**, whom she referred to as the "father" of the Yield Sooting Index (YSI), she reviewed the field. She encouraged researchers worldwide to submit their fuel samples for testing and collaboration. Dr. Pfefferle was greeted by a line of attendees with questions and photos after her talk. Afterward, she answered a couple questions from us.



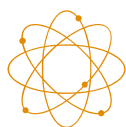
### What are the future areas of research to extend your work, as guidance for new researchers?

Most combustion researchers are experts in chemistry and transport mechanisms, so they can address a host of important problems. Some of my favorites are *nanomaterials synthesis and utilization of CO<sub>2</sub> for fuel synthesis*. Also, many new fuels are difficult to synthesize, but this is, for most, not a completely intractable problem. Novel methodologies can be developed. One of my favorites that needs more development is *atmospheric pressure plasma*.

Also, *I am very much against using large-scale models to fit rate constants in large kinetic models. It is an ill-posed problem.* Too many parameters, so MANY different sets of rate constants give identical species profiles.

### What inspired you to take on this project?

With the advent of machine learning and the *importance of structure-property relationships*, large amounts of experimental data for fuels with a wide range of structures are required. All other methods in the literature are woefully inadequate in this area. Although many people fill this void using estimated data, including different DFT strategies, this is not foolproof. Some estimation procedures entail significant errors, as a colleague at Yale, an expert in DFT analysis, has pointed out. For example, the error predicted can depend strongly on the compound addressed, and when these value differences are used in machine learning models, these errors are compounded. Thus, I believe that *much more experimental data is required using techniques where differences in error versus structure are minimized* (obviously, error cannot be eliminated). This is why our technique studies each fuel in an equivalent temperature and species background.



## SCIENTIFIC HIGHLIGHTS FROM INDUSTRY

*MORE INSIGHTS FROM ANOTHER INDUSTRY ROUNDTABLE!*

The second Industry Roundtable at the Symposium, chaired by **Stefano Campanari**, focused on clean H<sub>2</sub> production and featured several companies with competing and complementary technologies. The panelists represented different industrial processes for generating blue hydrogen. With each approach came unique feedstocks (waste plastics, natural gas), fundamental conversion processes (microwave-driven pyrolysis, gasification), and products (H<sub>2</sub>, co-products such as carbon black and aggregate for civil applications). They agreed that market demand for hydrogen was strong and that externalities stood in the way of further adoption of largely mature technologies. Some selected highlights from the session are recapped below!

**Race to the bottom:** Some industry panelists were focused on waste minimization. **Alessia Borgogna** (Maire, Italy) shared an impressive figure for reduction of waste to landfill, with less than 6% mass residue after gasification of well-suited plastic waste streams. **Murray Thompson** (Aurora Hydrogen, Canada) quoted a \$1.50-2.00/kg as an anticipated price point for their blue H<sub>2</sub>.

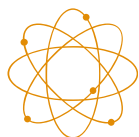
**Cost concerns:** External factors from the technological capability hinder widespread adoption, cost being the most common. **Luca Mancuso** (Wood, Italy) finds higher CAPEX and OPEX than status quo technologies a problem, and several panelists agree that governments should shoulder some costs.

**Appetite for risk:** **Aurelia Pipino** (Casale, Switzerland) compared the pros and cons of H<sub>2</sub> burners versus NH<sub>3</sub> burners, with safety issues listed from the latter but not the former. Several discussions throughout the symposium revealed varying degrees of fear about hydrogen safety concerns.

**Digestivo:** After dinner, drinks are on **Dan Murphy** (Monolith, United States), after receiving a \$1B loan from the U.S. Department of Energy! Still, his outlook that the time has never been so favorable for the implementation of blue H<sub>2</sub> was more optimistic than some in the audience.



*From L to R: Francesco Baratto (Casale), Aurelia Pipino, Luca Mancuso, Dan Murphy, Alessia Borgogna, Murray Thompson*



## SCIENTIFIC HIGHLIGHTS

### SPECIAL SESSION - THE FUTURE OF COMBUSTION

A special panel session, organized by the CI's Early Career Advisory Committee (ECAC) members, was held to discuss the Future of Combustion Research, featuring six early career researchers on the panel. This was held Thursday in the Silver Room, and was moderated by Prof. **Clayton Mulvihill** (Baylor). The selected early career professors were **Sili Deng** (Massachusetts Institute of Technology), **Marco Lubrano Lavadera** (Université Libre de Brussels), **Xiaocheng Mi** (Eindhoven University of Technology), **Rachel Schwind** (University of Edinburgh), **Xian Shi** (University of California, Irvine), and **Huangwei Zhang** (National University of Singapore).

The panel presented their ideas on alternative fuels (H<sub>2</sub>, NH<sub>3</sub>, biofuels, e-fuels), metal-based fuels, drivers of combustion research, materials synthesis, and novel concepts (plasma-assisted, pressure-gain, and low-temperature combustion). The panel addressed these topics in light of advances in existing experimental, theoretical and computational tools, followed by questions from the audience. One takeaway was that there is much room for extending combustion into new applications -such as aerospace, as highlighted by Rachel. Concerning AI tools, Prof. Deng suggested to exploit it as a mathematical tool to be integrated with physical approaches, rather than viewing it as a black box tool.

The panelists encouraged the community to maintain its vitality through interdisciplinary research, by inspiring the next generations of students, and by seeking support of more experienced faculty members, such as in seeking funding. Prof. Mi advised young researchers to make an impact by trusting their capabilities and considering start-ups, in addition to more "traditional" careers.

A final hot topic of discussion was funding: Can we afford building a career through 3-5 year increments (this is how long funding typically lasts)? But at the same time, would longer lasting funding really encourage early career researchers to investigate innovative fields that still need fundamental studies? Panelists discussed the need for both more applied visions (i.e., startups) and at the same time the need to be able to take risks also in more fundamental science. Some food for thought, indeed!



From L to R: Profs. Clayton Mulvihill (Moderator), Xiaocheng Mi, Huangwei Zhang, Sili Deng, Xian Shi, Rachel Schwind, Marco Lubrano Lavadera



## COFFEE TALKS

### AI FOR SENIOR CAREER RESEARCHERS?

The second day of the Symposium was kicked off by a Plenary Lecture on the use of AI, attended by a packed audience of combustion scientists keen to explore the implications of AI in their field. As with any groundbreaking technology, AI's integration brings some excitement, as well as questions, about its implementation. Prof. **Terese Løvås** (NTNU, Norway), couldn't help wondering about a potential generational gap: younger researchers are entering the field with AI expertise that their more experienced supervisors may lack. "How can I ensure that the results obtained by using a method I don't entirely master are correct, unbiased, and not oversimplified?" she asks. "Who supervises whom?". Despite the uncertainties, Løvås suggested that *instead of shying away from AI, the field should embrace it as an opportunity*. This new tool could also attract talented students to a discipline often portrayed negatively by the media and, sometimes, the funding bodies. There were more coffee questions than coffee talk!



## COFFEE TALKS

### ATTENDEES: AS THE SYMPOSIUM PROCEEDS, HOW IS YOUR EXPERIENCE?

**Yongseok Choi** and **Gyeonghyun Han** (PhD students, Korea Advanced Institute of Science and Technology, South Korea):

These days, the combustion sector, including both academic and industrial fields, is undergoing a significant turning point in terms of sustainable energy, net-zero emissions, and clean combustion technologies—reflecting the theme of this symposium. While attending the series of lectures and events, we can discover many interesting and inspiring subjects that enhance our understanding of renewable trends. I can confidently say that it is worth joining this symposium.

**Shaorun Lin** (Post-Doc, University of California Berkeley, United States):

I had a fantastic time on the conference Excursion to Lake Como. The networking opportunities with fellow attendees during the trip were invaluable. It was a well-organized and enriching experience that added great value to the overall conference.

*What is the Symposium Tribune? It's a daily bulletin that will keep you updated on all the key highlights and events happening at the Symposium, including interesting scientific talks and interviews to speakers, organizers, awardees. You will also find opinions from participants, and insights into social events in case you can't make it!*

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**Feedback is always welcome, and can be submitted via Telegram: <https://t.me/CombustionSymposium2024/2>**