

Conference Report

Conference on Artificial Photosynthesis and Green Catalysis

Jing Gao^{*a}, Lukas Pfeifer^{*a}, Paula Dias^b, Adélio Mendes^b, and Michael Graetzel^a

^{*}Correspondence: Dr. J. Gao, E-mail: jing.gao@epfl.ch; Dr. L. Pfeifer, E-mail: lukas.pfeifer@epfl.ch

^aLaboratory of Photonics and Interfaces, Institute of Chemical Sciences and Engineering, École Polytechnique Fédérale de Lausanne (EPFL), 1015 Lausanne, Switzerland; ^bLEPABE – Faculdade de Engenharia, Universidade do Porto, rua Dr. Roberto Frias, 4200-465 Porto, Portugal

The International Conference on Artificial Photosynthesis and Green Catalysis (CAPGC) took place at the École Polytechnique Fédérale de Lausanne (EPFL), Switzerland, from July 17th to 19th, 2023. It was organized jointly by **Michael Graetzel** from EPFL and **Adélio Mendes** from the University of Porto, with the aim to provide a platform for researchers, academics, and industry experts to discuss recent advancements, challenges, and opportunities in the fields of artificial photosynthesis and green catalysis. It gathered 85 participants from 15 countries and 43 different organizations with expertise in multiple areas (Fig. 1). Sponsorships by the Swiss Chemical Society, Pixel Voltaic, Capwatt, Snam, ChemSusChem, and several RSC and Wiley journals greatly contributed to the success of the CAPGC 23 event. The event featured a diverse program of invited and contributed talks, poster presentations, as well as a lab tour and a panel discussion, all of which hugely promoted the exchange of knowledge and ideas within the cutting-edge disciplines of solar-assisted water splitting and CO₂ reduction, catalyst materials for energy applications, circular carbon, hydrogen economy, and methane decomposition.



Fig. 1. Participants of the CAPGC conference at EPFL held from July 17th–19th, 2023.

The first day of the conference commenced with an opening ceremony that welcomed attendees from around the world. Michael Graetzel, a pioneer in photovoltaics and the field of artificial photosynthesis, delivered the opening keynote lecture, highlighting the advances and significance of harnessing sunlight for the sustainable production of valuable chemicals and fuels by means of solar-assisted water splitting and CO₂ electroreduction. In the subsequent sessions on the first day, renowned researchers such as **Roel van de Krol** (Helmholtz-Zentrum Berlin), **Kevin Sivula** (EPFL), **Jae Sung Lee** (UNIST), and **Jinlong Gong** (Tianjin University) focused on their scientific and technological progress in these fields and potential strategies for large-scale

implementations. Specifically, new mechanistic insights into the improved performance of the (photo)electrodes emerged as a hot topic among the speakers. **James Durrant** (ICL) discussed his group's results from *operando* optical spectroscopy to assay the reaction kinetics in metal oxide (photo)anodes. **Sam Stranks** (University of Cambridge) discussed his recent studies on understanding carrier recombination in photoelectrode systems using photophysical characterization. In addition, advances in efficient energy conservation also attracted much attention. **Sophia Haussener** (EPFL) reviewed solar-to-hydrogen applications at high current density and at a large scale based on thermally integrated photo-electrochemical approaches. **Ted Sargent** (Northwestern University) discussed the catalyst development and reactor engineering for the ambient-temperature and -pressure electrochemical reduction of CO₂ and CO. **Yimin Xuan** (NUAA) reported the high solar-to-fuel conversion efficiency in solar-powered thermochemical CO₂ reduction systems, which can simultaneously achieve solar energy capture and conversion, CO₂ capture, fuel production, and thermochemical energy storage.

After the oral presentation sessions, the first day of CAPGC continued with an interactive poster session giving the chance for young researchers to disseminate their work (Fig. 2). This part sparked engaging conversations among participants, enabling the exchange of innovative ideas and the fostering of potential collaborations.

The second day of the conference delved deeper into the catalyst materials used for energy applications. **Jose Ramon Galan-Mascaros** (ICIQ) summarized the advantages and disadvantages of prussian-blue derivatives for solar water splitting. **Gonzalo Prieto** (ITQ) presented how tandem catalysis could be leveraged to produce a range of commodity chemicals and synthetic fuels from e-/bio-syngas in a single step. **Adélio Mendes'** talk disclosed the critical technologies that make methanol and DME promising energy vectors for the swift decarbonization of the energy sector and beyond. **Alberto Abánades** (Universidad Politécnica de Madrid) proposed that methane pyrolysis is a promising technology with a full potential for circularization, where hydrogen (a critical energetic molecule) and carbon (a critical raw material for the clean economy) could be generated. **Patricia Benito** (Università di Bologna) introduced the development of Fe-based catalysts and structured reactors to convert CH₄ into CO₂-free H₂ and highly valuable carbon nanomaterials for battery applications.

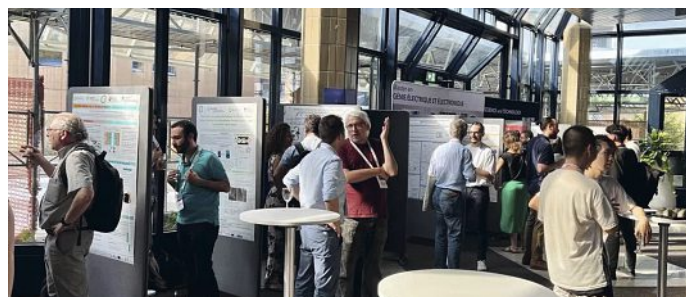


Fig. 2. Interactive poster session that sparked engaging conversations among participants on July 17th.

After the talks on the second day had concluded, a lab tour allowed participants to gain firsthand insights into the experimental setups and methodologies that underpin the advancements discussed during the conference sessions. With the great support from Sophia Haussener and Michael Graetzel, the event offered attendees a unique opportunity to visit the high-flux solar simulator (presenter: **Franky Esteban Bedoya Lora** and **Mahendra Patel**), as well as the large-scale solar dish for concentrated photoelectrochemical systems (presenter: **Isaac Thomas Holmes-Gentle**, Fig. 3), and also to observe demonstrations on photoelectrochemical water splitting and CO₂ reduction (presenter: **Jinhyun Kim**). Afterward, the conference dinner provided a congenial atmosphere for attendees to connect, share experiences, and establish lasting relationships within the scientific community.



Fig. 3. A lab tour to visit the large-scale solar dish for concentrated photoelectrochemical systems established by Prof. Sophia Haussener's group (presenters: Prof. Sophia Haussener and Dr. Isaac Thomas Holmes-Gentle).

The last day aimed at addressing the role of methane decomposition in enabling a swifter energy decarbonization. **Maximilian Kuhn**, from Hydrogen Europe, discussed the importance of system efficiency in maximizing the benefits of hydrogen integration and methane pyrolysis for circular carbon cycles. This talk opened the room for more technical discussions within the field, namely through the participation of **Samuli Rasanen** from Hycamite TCD Technologies, Lda, **Gérard Gatt** from Sakowin Green Energy, **Jens Hanke** from Graforce GmbH, and **Tiago Lagarteira** from Pixel Voltaic. Then a 'Round Table' was moderated by Adélio Mendes to discuss in detail the topic of Hydrogen Production from Methane Pyrolysis (Fig. 4). **Jorge Matos** from Capwatt, one of the panel speakers, demonstrated how methane decomposition could be beneficial for his business involving biogas plants. **Panayotis Eggenschwiler**, a group leader for Vehicle Energy Technologies at Empa, mentioned that it is necessary to develop economically sustainable processes for hydrogen production. **Pietro Santori** presented the Snam HyAccelerator programme supporting start-ups in the hydrogen ecosystem and a perspective on biomethane reforming and applications for carbon by-products. More importantly, several names such as Methane Splitting, Methane Decomposition, Methane Pyrolysis, Methane Cracking and Methane Cleavage were proposed to represent the reaction of $\text{CH}_4 \rightarrow \text{C} + 2 \text{H}_2$. After a heated discussion among all of the participants, METHANE SPLITTING was selected to be the standard name for this reaction with ca. 60 % of the votes. The event ended with an award ceremony chaired by Michael



Fig. 4. Round Table discussion on Hydrogen Production during the CAPGC conference at EPFL on July 19th, 2023.

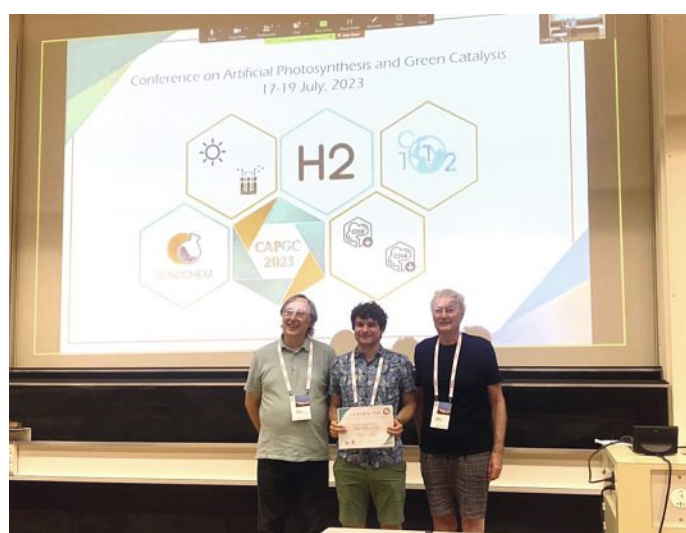


Fig. 5. Best oral presentation was awarded to Isaac Thomas Holmes-Gentle from the Laboratory of Renewable Energy Science and Engineering at EPFL.

Graetzel and Adélio Mendes, the best speaker was awarded to Isaac Thomas Holmes-Gentle from the Laboratory of Renewable Energy Science and Engineering at EPFL (Fig. 5).

In summary, the CAPGC event offered a dynamic platform for cross-disciplinary knowledge exchange. The insights shared by experts from both academic institutes as well as companies shed light on the potential of artificial photosynthesis and green catalysis to drive sustainable energy solutions and overcome environmental challenges. The conference underscored the importance of continued research, collaboration, and innovation in these fields, fostering a sense of shared responsibility toward a greener future.

The diverse topics covered throughout the conference echoed the immense promise of sustainable energy technologies. Moving forward, the knowledge exchanged, and connections forged during this event will undoubtedly fuel further advancements and drive the transformation toward a more sustainable energy landscape. Photo credits: Conference organisers.