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Title: Advanced Electrocatalytic Materials for the Sustainable Production of Fuels and Chemicals

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Context: Fossil fuels represent a vital part of the energy infrastructure and chemical industry. However, long-term neglection of excessive CO_2 emission and carbon reduction have become a significant destabilizing factor for the natural carbon cycle and the biggest cause of climate change. The Paris Climate Accord commits signatories the goal of achieving "a balance between anthropogenic emissions by source and removals by sinks of greenhouse gas in the second half of this century", and countries can formulate specific plans to achieve this goal according to their national conditions. In this line, there is a paradigm shift towards sustainable energy production.

In this regard, hydrogen (H_2) production from water electrolysis, CO_2 conversion into added-value chemicals and carbon-based fuels, and ammonia production from nitrogen (N_2) are some relevant examples.

Electrochemical processes hold a central role in this area. Dr. Rabah Boukherroub delivered a talk on the rational design of catalytic materials for the electrochemical production of fuels and added-value chemicals based on renewable sources. After a brief discussion of the good practices in photo- and electrocatalysis, he presented the basics of photoelectrochemical and electrochemical water splitting and CO_2 reduction reaction, and the challenges faced to reach industrial scale. The following part was focused on the results obtained by the Boukherroub's group on the cost-effective and scalable preparation of layer double hydroxide (LDH)-based electrocatalysts, by exploiting the corrosion-assisted method, and their application in overall electrochemical water splitting in alkaline media. Another example using these electrocatalysts was sea water splitting to produce H_2 combined with ethylene glycol (EG) oxidation to generate formate under alkaline conditions. In this system, EG was derived from plastic (PET: polyethylene terephthalate) waste. This example gave a good demonstration on how to realize sea water (abundant) splitting with plastic waste electroreforming. The last example was focused on the concurrent production of formate both at the cathode and anode of an electrochemical cell through CO_2 reduction and PET electroreforming, respectively.

In the last part of the presentation, Dr. Boukherroub summarized the different challenges the field of electrochemical water splitting is facing for scaling up water splitting technologies and making hydrogen production economically and technically viable on an industrial scale. Finally, the fundamental role of artificial intelligence (AI) in advancing the design and development of high-performance catalytic materials was discussed, illustrating its transformative potential in this area of research. The presentation was followed by an open discussion with the audience.