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Electrocatalysis for renewable energy conversion and production of sustainable fuels and chemicals

There is an urgent need to develop a sustainable economy based on renewable energy and green synthesis processes. Electrocatalysis may play an essential role in this transition towards a sustainable future. Electrochemical energy conversion devices, such as fuel cells and electrolysers, coupled to renewable sources, allow producing renewable fuels and chemicals as well as clean electricity. On the other hand, electrocatalytic methods are very appealing to achieve a sustainable valorisation of simple chemical building blocks. Switching from traditional fossil-fuel dependent methods to electrosynthesis processes may be key to transition towards a green chemical industry.

This talk will focus on our research on tailored electrocatalysts for electrochemical energy conversion and electrosynthesis of renewable fuels and chemicals. We have tailored the electrochemical interface at the atomic and molecular level in order to understand the structure-reactivity relations and tune the electrocatalytic properties. This approach has been very relevant to rationally design highly active platinum-based electrocatalysts for the oxygen reduction reaction (ORR) in fuel cells. This talk will first present some strategies aiming to understand and tailor the ORR activity, stability and selectivity by means of atomic ensemble control and electronic effects. In particular, our work on Pt-lanthanide alloys show that the trends in electrocatalytic activity and stability can be controlled by fine tuning the alloy structure. Finally, we will summarise our recent work on the electrocatalytic synthesis of value-added chemicals, with a special focus on the production of dimethyl carbonate, an industrially relevant and green chemical.