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SEMINAR SERIES

HIGHLIGHTS IN ENERGY RESEARCH

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Renewable synthetic fuels by electro- or thermo-catalysis?

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State-of-the-art production of renewable hydrocarbons may be divided into three steps: light harvesting and conversion to electricity (photovoltaics), water electrolysis, and conversion of the hydrogen to hydrocarbons by catalytic reaction with CO_2. Electrolysis is an electro-chemical process taking place at two spatially separated electrodes. The Faraday efficiency for water electrolysis is near one; the voltage–current relation is thus sufficient to characterize the water-splitting reaction and defines the overall efficiency, which reaches more than 80% in modern electrolyzers. The efficiency of the subsequent step, the catalytic reaction of hydrogen with CO_2 to produce hydrocarbons, depends on thermodynamic factors (Gibbs free energy) and kinetic constraints requiring elaborated temperature/pressure and additional separation and/or cycling procedures. The effort of the required various technically different devices may be lowered, if CO_2 reduction takes place simultaneously with water splitting in the very same device. However, in contrast to water splitting, the Faraday efficiency of electro-chemical CO_2 reduction towards the sought end product, e.g., methanol, is much smaller than one. In this talk, I will review some renown facts most importantly the one that almost all "*electro-chemical*" CO_2 reduction reactions in aqueous media are strictly speaking *catalytic* reactions taking place in parallel to electro-chemical water splitting. Based on this we arrive at a new interpretation of the observed voltage-current relations. I will present some fundamental experiments corroborating this interpretation and its consequences for new materials design for both catalytic as well as electro-chemical CO_2 reduction.

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