Carbon-neutral fuels via CO_2 conversion. Current Status and Perspectives

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Keynote Speaker

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Short Biography

Dr. Nikolay Dimov obtained his M.Sc. degree at the department of inorganic chemistry at Sofia University, Bulgaria in 1998. He received his Ph.D. in 2003 at the department of applied chemistry, Saga University, Japan. He worked as a post-doctoral research fellow at the department of applied chemistry at Saga University, Japan until 2011. His work at Saga University was focused on developing high capacity Si anodes for lithium-ion batteries in collaboration with industrial partners. Lithium-ion batteries with Si at the anode are now commercially available.
In 2011 he joined the Institute for Materials Chemistry and Engineering at Kyushu University, Japan. His research focus there was studying fluoride hosts as cathode materials for lithium-ion and sodium-ion batteries.
Currently, Dr. Dimov is working at the International Institute for Carbon-Neutral Energy Research (WPI-I^{2}CNER) focusing on electrochemical CO_2 reduction as a means of renewable energy storage, alternative to batteries. His research interest is modelling and optimization of electrochemical CO_2 reduction to either CO and H_2 (syngas), or to various C1-C3 products such as CH_3OH, CO, C_2H_5OH, etc. His background in battery-related research and insights of conversion of CO_2 into synthetic fuels allows him to perform comprehensive analysis and compare batteries with CO_2 conversion as two complementary routes to carbon-neutral future.

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Abstract

Despite the intense research and investments in renewable energy sources, fossil fuels are still expected to contribute around 80% of the global energy demands by 2040. IPCC predicts that such scenario could result in catastrophic increase of the Earth atmosphere temperature, with 2016 being the hottest year on record, setting a new high for the third year in a row. Therefore, CO_2 conversion to liquid fuels have recently being considered as a possible route for storing renewable energy, complementary to the traditional electrochemical energy storage solutions with even greater potential to curb CO_2-emissions. However, building a device that could mimic photosynthesis and store renewable energy in the chemical bonds of

a fuel using only CO_2 and water as starting materials remains one of the greatest challenges in chemistry. Aim of the talk will be to provide fair comparison between traditional electrochemical energy storage solutions (e.g. Lithium-ion batteries, Zn-air batteries, etc.) and CO_2-derived liquid fuels by considering the intrinsic mechanism of energy storage in both cases, revealing their current development status, limitations and possible advancements. While most of the battery chemistries have matured for decades, CO_2 conversion into value-added chemicals and liquid hydrocarbon fuels is still in its infancy. While battery chemistries are highly optimized and further substantial improvements is unlikely, CO_2 conversion still has great potential for substantial improvements. Well-optimized CO_2 to liquid fuel industrial process would be of interest:

(1) For recycling of CO_2 as an energy carrier, thus reducing its concentration in the atmosphere
(2) As a convenient means of storing electrical energy in chemical form via electro reduction of CO_2 (eCO_2RR), and
(3) For the production of renewable hydrocarbon fuels from abundant renewable electricity, CO_2 and water.

The talk will summarize experimental and computational work carried out worldwide and in our group and will highlight future research efforts.