NECEM SEMINAR: "Transforming (photo)electrochemical activity using interfacial nano-layers"

Dr Matthew T. Mayer, Helmholtz Center Berlin for Materials and Energy

14:00pm-15:00pm, Wednesday 10th July 2019

Lecture Theatre 1.75, Bedson Building, Newcastle University

Refreshments available after the seminar

Abstract

Transforming (photo)electrochemical activity using interfacial nano-layers

The use of renewable electricity to drive chemical reactions provides an approach to storing the energy from intermittent sources (solar, wind) in the form of chemical bonds. In combining photoabsorber and electrocatalytic components into integrated devices, we developed various types of photocathodes for proton reduction to hydrogen, as well as carbon dioxide reduction to carbon monoxide. Precisely controlled nanometer-scale layers of metal oxides, grown by atomic layer deposition (ALD), can be used to tune interfaces for notable improvements in interfacial charge transport and corrosion passivation. These approaches enabled benchmark demonstrations of photocathodes based on copper oxide and on bulk-heterojunction organic photoabsorbers.

Looking to expand electrochemistry as an approach for the synthesis of more valuable carbon-based products, we are investigating the mechanistic origins of selectivity for electrocatalytic reduction of carbon dioxide on inorganic catalysts. Again, we show that ultra-thin films of metal oxide can significantly alter activity, discovering that ~1 nm films of SnO_2 deposited on CuO shifts the electrocatalytic selectivity to favor the production of carbon monoxide with Faradaic efficiency exceeding 90%. To uncover the origins of these effects, we use *in situ* X-ray spectroscopy techniques for element-specific information under electrochemical operating conditions.

References

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2. Steier, L.; Bellani, S.; Rojas, H. C.; Pan, L.; Laitinen, M.; Sajavaara, T.; Di Fonzo, F.; Grätzel, M.; Antognazza, M. R.; Mayer, M. T. Stabilizing organic photocathodes by low-temperature atomic layer deposition of TiO_2. Sustain. Energy Fuels 1, 1915-1920 (2017).

3. Schreier, M., Heroguel, F., Steier, L., Ahmad, S., Luterbacher, J. S., Mayer, M. T., Luo, J. & Grätzel, M. Solar conversion of CO_2 to CO with Earth-abundant electrocatalysts prepared by atomic layer modification of CuO. Nature Energy 2, 17087 (2017).
4. Schreier, M., Luo, J., Gao, P., Moehl, T., Mayer, M. T. & Grätzel, M. Covalent Immobilization of a Molecular Catalyst on Cu_2O Photocathodes for CO_2 Reduction. J. Am. Chem. Soc. 138, 1938–1946 (2016).

Biography

Dr. Matthew T. Mayer is a group leader at the Helmholtz Center Berlin for Materials and Energy (HZB) since 2017, where he leads research activities on electrocatalytic and photoelectrochemical conversion of carbon dioxide into valuable products. Dr. Mayer was born and raised in Alaska, USA.

He trained as a chemist, with emphasis on the chemistry of materials and analytical chemistry. He obtained his Ph.D. in 2013 from Boston College where he worked on nanostructures and thin films for solar energy conversion applications. For the next four years he worked as postdoctoral scientist and *Solar Fuels* sub-group leader at the École polytechnique fédérale de Lausanne (EPFL) in Switzerland in the institute of Prof. Michael Grätzel, leading the group's efforts in the European projects PECDEMO and PHOCS. In 2017 he earned a Helmholtz Young Investigators Group fellowship (1.5M EUR) to initiate his independent research program in Berlin, Germany.

Location

Lecture Theatre 1.75, Bedson Building, Newcastle University

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