Seminar announcement

Tuesday, December 6, 2022
1:30 pm
WSI Seminar room S 101

“Nanoporous semiconductors and electrocatalysts for solar energy conversion”

Efficient conversion and storage of solar energy are crucial steps in the establishment of a renewable and carbon neutral energy supply. Photocatalysis and photoelectrochemistry are considered promising to make use of the large amounts of sunlight that reach the surface of earth. They render the direct conversion of light into chemical energy possible, circumventing the problem of expensive energy storage using batteries that comes with the use of photovoltaics. Moreover, since the first reports on periodically ordered mesoporous silica materials by the Kresge group and some earlier works, scientist all over the world have been fascinated by crystalline (periodic) pore ordering. Since then, long-range periodically ordered mesopores with a number of geometries have been reported, including two-dimensional (2D) hexagonal, three-dimensional (3D) cubic, 3D continuous gyroidal and others, for a range of different materials including a vast number of (crystalline) oxides and hybrid materialsHowever, no systematic study has been reported on how periodic pore order in mesoporous materials affects hydrogen generation in photocatalysis.[1] The most probable reason for the lack of such studies is that it is experimentally challenging to vary solely the degree of periodic pore order, e.g. of a mesoporous semiconductor, without changing other important material parameters, like the crystallite size, pore wall thickness, surface area, pore diameter or pore wall surface chemistry, the latter being easily affected by using different types of templates (e.g. using polymer or silica spheres as templates). Motivated by this challenge, several examples of mesoporous semiconductors for photocatalytic and photoelectrochemical hydrogen generation or water splitting will be presented, including the first 3D co-continuous periodically ordered mesoporous quaternary semiconductor for photocatalytic hydrogen generation.[2] Well-ordered mesoporous $ZnFe_2O_4$ and $NiFe_2O_4$ materials will be presented, fabricated by sol-gel synthesis and utilised in (photo)electrochemical water oxidation.[3,4] Recently, we presented a low temperature synthesis of a p-type earth-abundant iron oxide photocathode, hierarchical porous thin films of fully crystalline and phase-pure $CaFe_2O_4$ were prepared and applied in photoelectrochemical hydrogen generation.[5] For the first time, this material can be prepared at temperatures as low as 700 °C. A novel synthesis for macroporous $CaFe_2O_4$ foams will also be presented.[6]

[1] A. S. Cherevan, L. Deilmann, T. Weller, D. Eder, R. Marschall, ACS Appl. Energy Mater. 1 (2018) 5787
[2] T. Weller, J. Sann, R. Marschall, Adv. Energy Mater. 6 (2016) 1600208; T. Weller, L. Deilmann, J. Timm, T. S. Doerr, P. A. Beaucage, A. S. Cherevan, U. B. Wiesner, D. Eder, R. Marschall, Nanoscale 10 (2018) 3225
[3] K. Kirchberg, S. Wang, L. Wang, R. Marschall, Chem. Phys. Chem. 19 (2018) 2313
[4] C. Simon, J. Timm, D. Tetzlaff, J. Jungmann, U.-P. Apfel, R. Marschall, ChemElectroChem 8 (2021) 227
[5] K. Kirchberg, R. Marschall, Sustainable Energy Fuels 3 (2019) 1150
[6] A. Bloesser et al., Solar RRL 4 (2020) 1900570

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