10th International Symposium on Radiative Transfer, RAD-23 Thessaloniki, Greece, 12–16 June 2023

Invited lecture

RADIATIVE TRANSFER IN SOLAR ENERGY CONVERSION

Sophia Haussener

Laboratory of Renewable Energy Science and Engineering, Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland

sophia.haussener@epfl.ch

Solar energy is the most abundant renewable energy carrier and its efficient conversion into useful energy and chemical commodities such as electricity, heat (at different temperature levels), fuels or platform chemicals is essential for a transition of our energy economy towards a sustainable future. The understanding, characterization and accurate modeling of radiative transfer in such energy conversion systems is essential for their optimization and large-scale developments.

I will review select processes and highlight how radiative transfer has been investigated and described in order to understand and optimize these processes. Specific applications include: *i*) design, modeling and characterization of high-flux optical systems for thermal, thermochemical and concentrated photoelectrochemical approaches [1], *ii*) modeling and demonstration of solar thermochemical [2] and photoelectrochemical [3] reaction systems, and *iii*) modeling and demonstration of high-temperature energy systems. I will spend time on describing how porous media at multiple scales (Figure 1) play an essential role in these processes and how tomography-based approaches, machine learning and additive manufacturing have been used to improve understanding and optimization.

a) b)

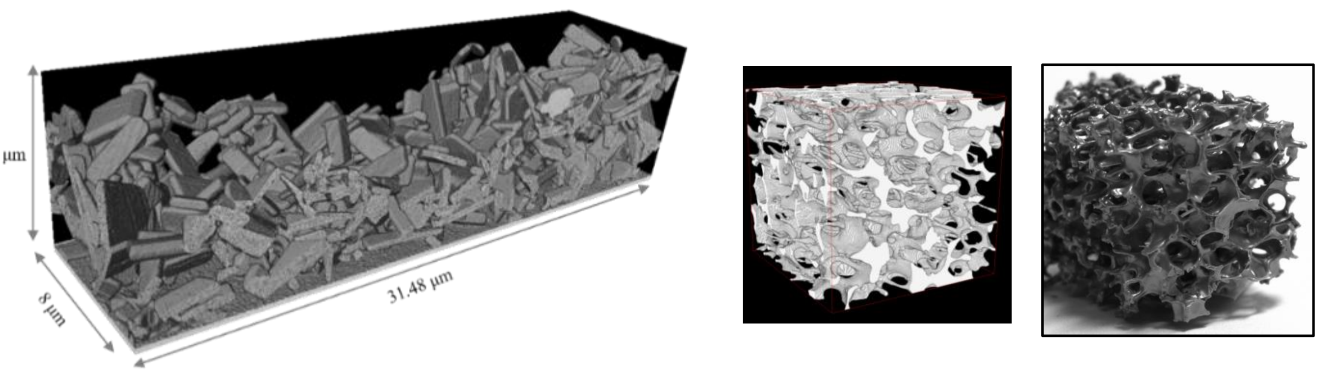

Figure 1. a) Nano-tomography of nanoporous $LaTiO_2$ photoanode for solar-driven water splitting [4], and b) computational representation and physical macroporous ceria sample (18 mm edge length) for solar thermochemical water splitting [5].

[1] G. Leveque, R. Bader, W. Lipinski, S. Haussener, High-flux optical systems for solar thermochemistry, *Solar Energy*, 156: 133-148, 2017.
[2] V. Wheeler, R. Bader, P. Kreider, M. Hangi, S. Haussener, W. Lipinski, Modelling of Solar Thermochemical Reaction Systems, *Solar Energy*, 156: 149-168, 2017.
[3] C. Xiang, A.Z. Weber*, S. Ardo, A. Berger, Y.K. Chen, R. Coridan, K.T. Fountaine, S. Haussener, S. Hu, R. Liu, N.S. Lewis, M.A. Modestino, M.M. Shaner, M.R. Singh, J.C. Stevens, K. Sun, K. Walczak, Modeling, Simulation, and Implementation of Solar-Driven Water-Splitting Devices, *Angewandte Chemie*, 55: 12974-12988, 2016.
[4] S. Suter, M. Cantoni, Y.K. Gaudy, S. Pokrant, S. Haussener, Linking Morphology and Multi-Physical Transport in Structured Photoelectrodes, *Sustainable Energy & Fuels*, doi: 10.1039/C8SE00215K, 2018.
[5] S. Suter, A. Steinfeld, S. Haussener, Pore-level engineering of macroporous media for increased performance of solar-driven thermochemical fuel processing, *International Journal of Heat and Mass Transfer*, 78: 688–698, 2014.