Photoelectrocatalytic Hydrogen Generation at Photocathode Based on Silicon Nanowires Grown from Inexpensive Seeds

Paul Erik Olli[1,*], Pascale Chenevier[2]

[1]*Institute of Chemistry, University of Tartu, Ravila 14a, Tartu, 50411 Estonia*
[2] *Interdisciplinary Research Institute of Grenoble, CEA – The French Alternative Energies and Atomic Energy Commission, rue des Martyrs 17, Grenoble, 38054 France*

* *paul.erik.olli@ut.ee*

Making laboratory hydrogen photoelectrocatalysis concepts commercially feasible has long been dreamed of; however, the realisation of this concept has been hindered by inefficiency and practical difficulties. The subject of this study was photocathode, which drives the reduction of protons to hydrogen.

Silicon nanowires function as semiconductors where the energy of incident photons separate charges. This work uses a facile method of growing silicon nanowires from nanoparticle seeds (Figure 1). A selection of quantum dots based on Cu, In, Zn, Ag, and Sn were used as a novel and inexpensive alternative instead of gold nanoparticles, which have been proven to work effectively before[1]. MoS_x photocatalyst catalyst was electrodeposited on silicon nanowires to assist hydrogen evolution[2]. The performance of photocathodes was assessed based on generated photocurrent at different potentials in simulated sunlight conditions.

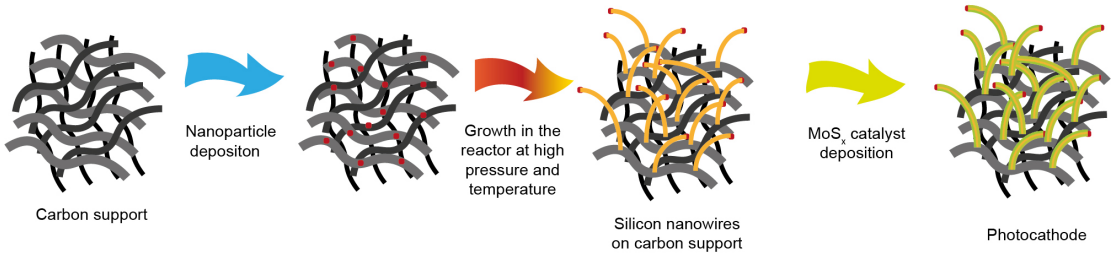

Figure 1: The process of creating a photocathode sample.

The photocurrent of the photocathodes based on silicon nanowires grown from inexpensive seeds is comparable to that of the photocathodes based on gold nanoparticles (Figure 2). The work provided novel insight into the synthesis of silicon nanowires from alternative nanoparticles and their diverse characteristics compared nanowires grown from gold nanoparticles.

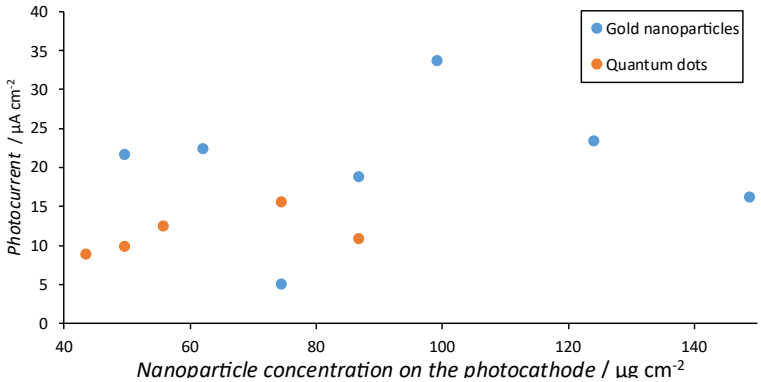

Figure 2: Dependence of the photocurrents of photocathode sample synthesised using gold nanoparticles and quantum dots on nanoparticle concentrations.

Acknowledgements
Sincere thanks to Jaak Nerut, Adina Morozan, Peter Reiss and Celine Rivaux. This work was financially supported by European Horizon 2020's Project Sun-to-X under agreement no. 883264, University of Tartu (Experimental Development Grant *Novel Catalysts for Alkaline Electrolyser Electrodes Based on Nickel Foam*) and the Estonian Ministry of Education and Research (Center of Excellence TK210).

References

1 J. Wang, C. Keller, M. Dietrich, P. E. Olli, P. Gentile, S. Pouget, H. Okuno, M. Boutghatin, Y. Pennec, V. Reita, D. N. Nguyen, H. Johnson, A. Morozan, V. Artero and P. Chenevier, *Sustainable Energy Fuels*, 2023, **7**, 4864–4876.
2 C. G. Morales-Guio and X. Hu, *Acc. Chem. Res.*, 2014, **47**, 2671–2681.