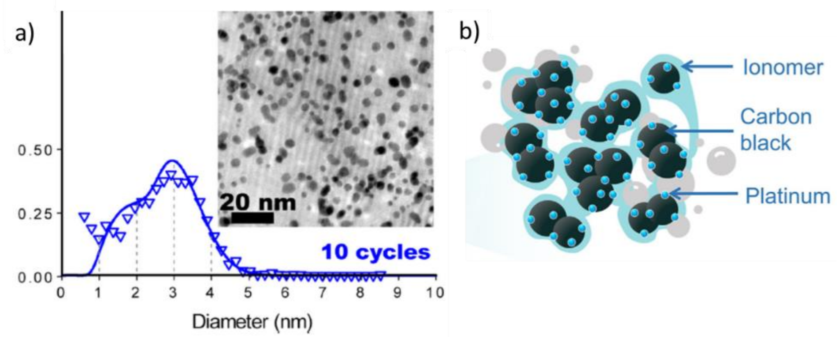
# M.Sc. Thesis Opportunity: Date: May/2023

# Optimized Use of Noble Metal Catalysts for the Energy Transition

## Background & Motivation

A key issue of the ongoing energy transition is usage and/or storage of excess electricity from fluctuating renewable sources. At the same time, many substances that today are derived from petrochemical sources must soon be replaced in order to achieve net zero carbon dioxide emission. Power-2-X technology addresses both of these issues. A prime example is electrochemical water splitting through, e.g., PEM electrolysis, now being rolled out commercially on the 100 MW scale. However, a major obstacle for the steep growth in electrolyser manufacturing output may soon be the cost and limited supply of Platinum (Pt) catalysts and other Platinum group metal (PGM). Hence, Pt is used sparsely in the form of finely dispersed particles on a host material, e.g. Pt-loaded carbon (Pt/C, figure a)[1], which is then embedded in a Pt/C in an ionomer matrix (figure b[3]).




## The Project

Commercially available Pt/C is fabricated is with rather crude methods.[2] Our approach, in contrast, is based on atomic layer deposition (ALD), which allows for precise tuning of the Pt load and particle size distribution due to the bottom-up nature of the process.[1] In order to make good use of these parameters, the following tasks and questions shall be elaborated in an M.Sc. thesis project:

- Literature review on the performance of particle-based catalysts in relation to loading, morphology and size distribution of Pt particles.
- Develop a model to quantitative link Pt loading and performance for our specific material.
- How far the Pt loading can be reduced without compromising the performance of the Pt/C catalyst?

Though these tasks are focussed on modelling, the larger, overall project includes experimental parts and aims to demonstrate the use of ALD-fabricated Pt/C catalyst in real-world applications. We are looking for students with an interest in catalysts, modelling and the energy transition from Chemical Engineering and Physics alike.

## Interested?

Contact us at p.m.piechulla@tudelft.nl for more information! The project will be supervised by dr. Peter Piechulla and prof. dr. Ruud van Ommen (PPE/ChemE/TNW and e-refinery).

## References

(1) Grillo, F.; Van Bui, H.; Moulijn, J. A.; Kreutzer, M. T.; van Ommen, J. R. Understanding and Controlling the Aggregative Growth of Platinum Nanoparticles in Atomic Layer Deposition: An Avenue to Size Selection. *J. Phys. Chem. Lett.* **2017**, *8* (5), 975–983. https://doi.org/10.1021/acs.jpclett.6b02978.

(2) Taylor, S.; Fabbri, E.; Levecque, P.; Schmidt, T. J.; Conrad, O. The Effect of Platinum Loading and Surface Morphology on Oxygen Reduction Activity. *Electrocatalysis* **2016**, *7* (4), 287–296. https://doi.org/10.1007/s12678-016-0304-3.

(3) Bapat, S.; Giehl, C.; Kohsakowski, S.; Peinecke, V.; Schäffler, M.; Segets, D. On the State and Stability of Fuel Cell Catalyst Inks. *Advanced Powder Technology* **2021**, *32* (10), 3845–3859. https://doi.org/10.1016/j.apt.2021.08.030.