The faculty of Engineering of the Vrije Universiteit Brussel and the faculty of Applied Engineering of the Universiteit Antwerpen invite you to attend the public defense leading to the degree of

**DOCTOR OF ENGINEERING SCIENCES (VUB)**
**DOCTOR OF APPLIED ENGINEERING (UA)**

of **Stéphane Alexander den Hartog**

The public defense will take place on **Tuesday, 21st December 2021 at 5:00pm** in room D.2.01 (Building D, Brussels, Humanities, Sciences & Engineering Campus)

If you want to attend the defense on campus, please contact Stéphane den Hartog on stephane.alexander.den.hartog@vub.be

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**CHARACTERIZATION OF NANOPARTICLE ELECTROCATALYSTS BY COMBINING ELECTROCHEMISTRY WITH ELECTRON PARAMAGNETIC RESONANCE**

**BOARD OF EXAMINERS**

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Abstract of the PhD research

In order to transition to an ecologically and economically sustainable society, we need to reconsider our current consumption habits, production processes and waste generation. The chemical industry especially plays a crucial role – the mining, refining and processing of our resources all rely on chemical reactions. We need to increase the efficiency of these processes, eliminate toxic reaction components and reduce the production of chemical waste. Electrochemistry is recognized as a key player in this sustainable transformation: many processes to make materials more durable involve electrochemical steps, and efficient conversion of chemical to electrical energy requires knowledge of electrochemistry. Some electrochemical processes can be made more efficient by using the right electrocatalyst – a material that speeds up a reaction while not participating in the reaction itself. An example is the use of platinum nanoparticles in protonexchange membrane (PEM) fuel cells that are used to power electric buses and trucks. The reaction of hydrogen and oxygen to water and electricity in the fuel cell proceeds much faster on a platinum surface (the electrocatalyst) than on carbon under the same conditions. This reaction (or any other electrocatalytic reaction) proceeds through one or multiple series of sub steps from one reaction intermediate to another. Understanding this series of sub steps, also called the reaction pathway, allows us to improve existing electrocatalysts or design new ones. In fuel cells, the reaction intermediates are suspected to detach from the platinum surface and cause the degradation of the platinum electrocatalyst and the supporting material. This in turn reduces the efficiency and lifetime of the fuel cell. To prevent or slow down the degradation, we need to identify and quantify the responsible reaction intermediates. In this work, we use a technique called electron paramagnetic resonance (EPR) spectroscopy to study the intermediates produced during the electrochemical reaction of oxygen to water on platinum nanoparticle electrocatalysts. The aim of this research is not only to gain a better understanding of this reaction, but to show that EPR spectroscopy can be used for the study of other electrocatalytic reactions as well.