PhD Advert Template

Project title: Understanding the changing nature of electrolyser catalysts

Accept all year-round applications

Funding information: Self-funded students only

Project description:

Proton exchange membrane wate electrolysers (PEWEs) will play a critical role in the net-zero economy by enably the storage of excess renewable energy in the form of a chemical fuel, such as hydrogen. The hydrogen could then be used either to produce heat in industrial applications or in hydrogen fuel cell electric vehicles (FCEVs). PEWEs have demonstrated excellent performance and durability; however, their use of scarce and expensive precious metal catalysts, such as iridium, make their cost excessive. Prof. Secanell’s research group has demonstrated the loading of iridium can be substantially reduced to less than 0.1 mg/cm2; however, this also reduces the durability of the device as iridium is oxidised and also dissolved during operation. Therefore, it is critical to understand how to predict the changing nature of the iridium catalsyst in order to reduce its degradation and develop PEWEs that achieve a trade-off between the amount of catalyst used and degradataion. Prof. Secanell’s research team has been developing an open-source software for the computer-aided design of proton exchange membrane electrolysers for several years. The finite-element based framework, which is [available online](http://www.openfcst.org), simulates the transient, multi-phase mass, heat and charge transport, as well as electrochemical reactions taking place inside an electrolyser. Thus far, however, the computational models have not accounted for degradation during operation. The aim of this project is to extend the modelling capabilities to account for catalyst oxidation and degradation, in order to include end of life performance as part fo the design cycle. The PhD student involved in this project will be in charge of extending the current software capabilities by developing advanced micro-kinetic models that aim at predicting catalyst oxidation and dissolution. Funding for conference travel and internships will be provided.

The PhD student would work under the supervision of Prof. Marc Secanell, a leading researcher in the field of mathematical modeling of electrochemical energy systems, fabrication and characterization of polymer electrolyte fuel cells and electrolysers, and design and optimisation. His laboratory has experimental equipment for validating all numerical models developed. He has received over 5,000 citations, has an h-index of 41 (see <https://bit.ly/2NrH9zq>), has been invited to speak at prestigious conferences (e.g., the Electrochemical Society Meetings and the Gordon Research Conference in Fuel Cells), and was co-chair of the 2022 Gordon Research Conference in Fuel Cells. Graduates under his supervision have been able to secure industry jobs at leading companies such as Johnson Matthey (UK), Siemens (US), Ballard Power Systems (Canada), Altair Engineering (Spain/US), and Circle Cardiovascular Imaging Inc. (Canada); postdoctoral fellowships at Lawrence Berkeley National Laboratory (US) and Paul Scherrer Institute (Switzerland); and faculty positions at the Indian Institute of Technology (IIT) and University of Calgary (Canada).

Applicants are expected to have the following qualifications:

**Basic qualifications**

1. A B.Sc, M.Sc., or equivalent degree in Chemical Engineering, Mechanical Engineering, Applied Mathematics, or Applied Physics.
2. Programming experience in any language (C/C++, Python, Fortran, Matlab, or others).
3. Strong communication and teamwork skills.
4. Strong desire to learn mathematical modeling of electrochemical systems and numerical methods.

**Preferred qualifications (these qualifications are a plus)**

1. Programming experience in an object-oriented language, preferably C++ and/or Python.
2. Experience in and understanding of numerical methods, in particular, the finite element method and its implementation in libraries such as deal.ii.
3. Experience in and understanding of electrochemical systems.
4. At least one scientific journal or conference publication.

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Application enquires: Prof. Marc Secanell [marc.secanell@ncl.ac.uk](mailto:marc.secanell@ncl.ac.uk)

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financial economics

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automotive engineering

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biomedical engineering

chemical engineering

civil engineering

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control systems

cybernetics

dynamics

electrical engineering

electronic engineering

energy technologies

environmental engineering

fluid mechanics

gas engineering

geotechnical engineering

integrated engineering

manufacturing engineering

marine engineering

mechanical engineering

mechanics

mechatronics

nanotechnology

offshore engineering

petroleum engineering

robotics

solid mechanics

structural engineering

structural mechanics

systems engineering

thermodynamics

other

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meteorology

pollution

soil science

other

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investment

taxation

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social geography

transport geography

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world history

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german

italian

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swedish

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contract law

property law

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celtic studies

classics

latin

linguistics

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ceramics

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polymers

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probability

pure mathematics

statistics

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cardiology

complementary medicine

dentistry

endocrinology

epidemiology

neural engineering

neurology

nutrition

ophthalmology

optometry

pathology

pharmacology

pharmacy

physiology

physiotherapy

podiatry

radiology

speech science

tissue engineering

toxicology

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health informatics

medical nursing

mental health nursing

midwifery

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occupational therapy

paediatric nursing

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surgical nursing

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ethics

metaphysics

philosophy of science

other

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acoustics

astronomy

astrophysics

chemical physics

computational physics

electromagnetism

environmental physics

experimental physics

medical physics

nuclear physics

optical physics

particle physics

quantum mechanics

solid state physics

space science

theoretical physics

other

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international relations

politics

public policy

other

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clinical psychology

community psychology

counselling psychology

developmental psychology

educational psychology

forensic psychology

health psychology

neuropsychology

occupational psychology

organisational psychology

psychotherapy

sport psychology

other

Sociology

criminology

disability studies

gender studies

socio economics

social work

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sport development

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veterinary pathology

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