Royal Academy of Engineering

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PROFILE
Distinguished International Associate

Thematic area: Heterogeneous catalysis

Project title: NECatS – Novel Empowered Catalyst Supports

Strategic goals: To collaboratively further the development of a novel oxidic support material, to store renewable energy in chemical molecules.

Background: Since the beginning of my academic career, UK researchers and collaborators have played a significant role in my work. In 2015, I had the honour of being awarded a Newton Advanced Fellowship by the Royal Society for a collaborative project with the Cardiff Catalysis Institute. I helped organise the first-ever Faraday Discussion event in Africa in 2017, and I am the secretary of the Catalysis Society of South Africa, having previously been media officer and chairperson.

My chemical engineering studies were undertaken at the Karlsruhe Institute of Technology in Germany, and my PhD was completed at the University of Cape Town, where I now work.

Previous Academy involvement: In 2018, I secured Industry–Academia Partnership funding to run free training workshops for African emerging faculty researchers, on the analysis of experimental data collected at synchrotron and neutron facilities.

About my project

Objectives: South Africa is recognised as a country with outstanding potential for renewable energy generation, but its is widely underused. Wind and photovoltaic farms are slowly making inroads, but regions of high renewable energy production capacity lack infrastructure for energy distribution. There is a need to develop storage media.

The family of Power-to-X (PtX) processes in combination with green hydrogen generation is generally regarded as the main pathway to store renewable energy in chemical molecules such as ammonia, methanol or hydrocarbons. The processes at the heart of PtX often require a redesign of the catalyst. The NECatS project proposes to further the development and understanding of a new class of material that can be employed as catalyst supports, providing physical separation of the active phases while providing electronic-promoting functionality through impregnation or deposition of alkali/transition metals in an oxidised form on the catalyst.

Specific objectives include the conclusive analysis of synchrotron X-ray absorption data on the speciation of the potassium promoter, as well as the development of a density functional theory-based model. The choice of catalyst systems will be guided by the results of the experiments testing the introduction of the novel support materials.

On the UK side... The expertise of my partners has been invaluable, with four collaborators in the UK including Simon Kondrat, a lecturer at the University of Loughborough. The opportunity to strengthen the informal collaboration with the University of Loughborough was the main driver behind applying for the DIA programme. We are currently planning a visit by our UK partners to South Africa, probably in May 2022.

Project output: We will develop further understanding of the working principles of new catalyst support materials. This will be achieved through a combination of kinetic measurements, theoretical modelling, and advanced laboratory and synchrotron-based characterisation techniques.

A special focus will be on the characterisation of the catalytic materials under realistic working conditions.

The project will not only provide key information on a novel material but also strengthen the collaboration between the South African and UK teams, providing exposure and learning opportunities for young researchers' cutting-edge techniques.

Anticipated outcomes and impact: The project has really accelerated over the last months, and I believe there are many research questions directly related to our current work. The project team's focus recently has been concluding data analysis of the X-ray absorption spectroscopy experiments, allowing us to draft a manuscript for submission in a high-impact peer-reviewed journal.

The NECatS design concept has been submitted as a patent application to the UK Intellectual Property Office, and I plan to engage media outlets upon the successful publication of the prepared manuscript. Subsequent work is expected to yield two to three journal articles, with publication dates in 2022 and early 2023.

Catalyst manufacturing companies that will be approached include BASF, Shell, Haldor Topsoe, Sasol, and PetroSA, plus Johnson Matthey in the UK.

Final thoughts on the Distinguished International Associates programme: The DIA programme has allowed me to strengthen collaborations and present work at national and future international conferences. Paired with a UK network, we have been able to generate crucial material characterisation data more quickly, including an in-depth evaluation hardly possible for the South African team alone.

About the Distinguished International Associates Programme

The Distinguished International Associates Programme is an award scheme for international engineers working across all sectors, who are at the cutting edge of engineering research or innovation.

Awardees are offered a grant to amplify the impact of an existing collaboration with the UK in an area that aligns with the Academy's new strategic priority themes.

The programme aims to develop a broad international network of excellent diverse engineers across countries and disciplines, with research and innovation links to the UK, to work alongside the Academy to enhance progress towards achieving its goals for an inclusive economy and sustainable society.