Green hydrogen storage: 4 PhD Scholarships

Green hydrogen will become a pivotal vector to carry and store renewable energy in a future net-zero carbon New Zealand and world. These 4 PhD scholarships (please see the details below) are focussed on the development of green hydrogen storage materials, and range from metal extraction from New Zealand minerals, to production, characterisation and hydrogen uptake measurement by the resulting materials, theoretical modelling of the hydrogen uptake, and techno-economic analysis in the New Zealand context.

Supervision and support for the projects (details on the following pages) will be provided by academic staff in **New Zealand** at the University of Otago, University of Canterbury, Victoria University of Wellington, University of Auckland and Unitec, led by Prof Sally Brooker (Otago), and by staff at the Institute of Hydrogen Technology, Helmholtz-Zentrum Hereon, in **Germany**, led by Dr Paul Jerabek (HZH). It is expected that most of the candidates will spend time at both the New Zealand and German host institutions over the course of their PhD studies. Māori and Pasifika students are particularly encouraged to apply. International students are also welcome to apply.

Novel metallurgical production of low-cost hydrogen storage alloys (1 PhD scholarship)

Hydrogen will play a key role in the future zero-carbon economy, as a fuel for transport and for use in industry. However, hydrogen is a low-density gas and hence challenging to store for use 'on-demand'. One approach is to use reversible hydrogen-storage materials such as the intermetallic alloy, Ti-Fe. This alloy absorbs hydrogen within its metal lattice at ambient temperatures, and can achieve storage densities approaching cryogenic liquid hydrogen. However, existing routes to producing Ti-Fe rely on a multi-step process that uses high purity precursor metals. As such, the cost of production is prohibitively high.

This project will explore alternative new synthetic routes to produce Ti-Fe, which can reduce production costs by employing abundant, low-cost naturally-occurring oxides as starting materials, such as titanium-bearing slags and mineral sands. The primary focus will be to pursue high-temperature metallurgical approaches to develop a proof-of-concept laboratory process suitable for scaling to industrial volumes. The student will gain familiarity with a wide range of metallurgical synthesis techniques and characterisation instruments including scanning electron microscopy (with EDS and EBSD mapping), TGA/DSC, XRD, XRF, and more. Hydrogen storage properties of sample materials produced in this work will be studied using the custom 'Sieverts apparatus' available at Helmholtz-Zentrum Hereon and the University of Otago.

Supervision and support for the project will be provided by staff at Victoria University of Wellington and University of Auckland (New Zealand), and the Institute of Hydrogen Technology, Helmholtz-Zentrum Hereon (Germany). The student will be enrolled at Victoria University of Wellington but will be expected to spend time at both New Zealand and German host institutions over the course of the PhD studies.

Eligibility

The applicant should hold a science degree equivalent to a 1st class 4-year New Zealand BSc(Honours) degree or MSc, in Materials Science/Engineering, Chemistry, Physics or equivalent. Previous laboratory experience in materials synthesis and characterisation will be advantageous. All students will be considered on merit, and Māori and Pacific students are particularly encouraged to apply. Candidates should satisfy the requirements for admission as a PhD candidate at Victoria University of Wellington.

Total value and tenure of the scholarship

The PhD scholarship will include tuition fees and a stipend of $30,000 p.a. (tax-free) for three years.

How to apply

To apply, please send your CV, academic record, and the names and contact details of two referees to: Dr Chris Bumby (chris.bumby@vuw.ac.nz) and Assoc. Prof. Peng Cao (p.cao@auckland.ac.nz) with "Hydrogen storage alloys" in the subject line.

Processing and characterisation of Ti-Fe alloys as hydrogen storage materials from New Zealand feedstocks (2 PhD scholarships)

Green hydrogen will become a pivotal vector to carry and store renewable energy in a future net-zero carbon New Zealand. Ti-Fe alloys demonstrate high hydrogen uptake at ambient conditions and are an attractive candidate material for stationary bulk hydrogen storage applications. Nevertheless, several key issues require further investigation, such as surface activation, cycle stability, impurity tolerance, and supply volume of the metallic feedstocks.

Two PhD candidates will explore the production and processing of Ti-Fe alloys from New Zealand-sourced feedstocks using metallurgical and mechanochemical methods as part of collaborative research within the German-New Zealand Green Hydrogen alliance. The alloys prepared will be characterised by a range of methods (XRD, SEM/EDS, ICP-MS, XRF, DSC), and their hydrogen storage capacity and kinetics studied using custom 'Sieverts apparatus'. Furthermore, the presence of common impurities within the Ti-Fe alloys will be systematically studied to better understand how locally-sourced feedstocks are likely to perform as hydrogen storage materials, including the effect of surface impurities on reactivity/diffusion characteristics.

Supervision and support for the project will be provided by staff at the University of Otago and University of Canterbury, New Zealand, and the Institute of Hydrogen Technology, Helmholtz-Zentrum Hereon, Germany. The students will be enrolled at the University of Otago, but it is expected that the candidates will spend time at both the New Zealand and German host institutions over the course of the PhD studies.

Eligibility

The applicant needs a degree equivalent to the 4-year BSc(Honours) degree in New Zealand, with 1st class Honours, or an MSc or Postgraduate Diploma in Chemistry, Materials Science, Engineering, or equivalent. Practical experience with hydrogen materials, metallurgy, mechanochemistry and/or the characterisation techniques listed above will be advantageous. Māori and Pasifika students are particularly encouraged to apply. Candidates should satisfy the requirements for admission as a Ph.D. candidate at the University of Otago.

Total value and tenure of scholarship

Each PhD scholarship will include tuition fees and a stipend of $30,000 p.a. (tax-free) for three years.

How to apply

To apply, please send your full CV, including academic record, research experience, and the names and contact details of two referees, to: Associate Professor Nigel Lucas (nigel.lucas@otago.ac.nz) and Associate Professor Alex Yip (alex.yip@canterbury.ac.nz) with "Hydrogen storage materials PhD" in the subject line.

New Zealand National Energy System Modelling – Role of Hydrogen (1 PhD scholarship)

To meet Net-Zero carbon targets requires a fundamental change in New Zealand's energy system. National energy system models that include all types of energy demand and supply enable us to explore scenarios to Net Zero that encompass the scale of the changes required and include interactions across sectors, e.g. Transport and Electricity.

UniSyD is an economic model of New Zealand's energy system coded in STELLA software and based on process flows. It has been used for a variety of New Zealand applications and adapted to several other countries, including Japan and Iceland.

This Ph.D. project will use UniSyD to explore some important questions for the New Zealand energy system, including

- The optimum role of hydrogen in the NZ energy system, including storage options
- The optimum role of biomass in the NZ energy system
- The optimum evolution of hydrogen infrastructure

Supervision and support for the project will be provided by staff at the University of Otago and Unitec in New Zealand and the Institute of Hydrogen Technology, Helmholtz-Zentrum Hereon, Germany. The student will be enrolled at the University of Otago, but it is expected that the candidate will spend time at both the New Zealand and German host institutions over the course of the PhD studies.

Eligibility

The applicant needs a science degree equivalent to the 4-year BSc (Honours) degree in New Zealand, with 1st class Honours, or an MSc or postgraduate Diploma in Applied Mathematics, Engineering, Physics, or equivalent. Experience with process modelling using Matlab Simulink, Stella or Vensim will be advantageous. Māori and Pasifika students are particularly encouraged to apply. Candidates should satisfy the requirements for admission as a PhD candidate at University of Otago.

Total value and tenure of the scholarship

The PhD scholarship will include tuition fees and a stipend of $30,000 p.a. for 3 years.

How to apply

To apply, please send your CV, academic record, and the names and contact details of two referees to: Associate Professor Michael Jack (michael.jack@otago.ac.nz) and Associate Professor Jonathan Lever (jleaver@unitec.ac.nz) with "National Energy System Modelling" in the subject line.