

Position Description

Position Title: Swinburne PhD Scholarship 2020

Position Number: New

Classification: PhD Student

Faculty/PAVE Centre/Organisational Unit: FSET / Fluid and Process Dynamics (FPD) Group

Department: Mechanical and Product Design Engineering

PhD Project Title

Kinetics of Electrically-Enhanced Reactions during Recycling and Refining of End-of-Life Silicon Photovoltaic Cells

Position Purpose

A PhD scholarship is available for a suitable candidate to undertake PhD project on “Kinetics of Electrically-Enhanced Reactions during Recycling and Refining of End-of-Life Silicon Photovoltaic Cells”. The successful applicant will carry out the PhD research work closely with Swinburne Researchers, CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia) and related industry partners.

There is a genuine worldwide problem of a growing generation of WEEE (waste electrical and electronic equipment), i.e. about 40 million tonnes per year. WEEE contains of more than 40 elements including the strategic metals and hazardous elements. The concentrations of the strategic metals in the WEEE are higher compared to that of in their respective underground ores. This makes them suitable as secondary metals sources. End-of-Life (EOL) Photovoltaic (PV) cell is also considered as WEEE. Considering the average panel lifetime of 25 years, the global solar PV waste is anticipated to be between 4-14% of total generation capacity by 2030 and rise to over 80% (~78 million tonnes) by 2050. In addition to the Si, EOL PV cell contain very valuable Ag which is used as metallisation pastes/inks in the cell. There is also a problem of Si kerf (slurry) waste generated from manufacturing process of PV Cell (account for up to 45% loss of ultrapure materials), totalling to approximately 160,000 tonnes/year (and increasing if not processed).

The PhD project is part of a broader project to develop a unique pyrometallurgical process that allows high volume and high throughput recycling and processing of end-of-life (EoL) Si Photovoltaic (PV)-cells and alternative silicon source (e.g. Si kerf). The process involves the application of voltage through electrodes placed across molten silicon and slag phases during slag refining reactions. This results in the removal of impurities (such as Boron (B) and Phosphorus (P)) at much faster rates and higher amounts compared to the regular slag refining or current Si production process; and at the same time promotes maximum recovery of high value Silver (Ag) from EOL-PV, making the overall recycling process economically attractive.

This proposed PhD project will establish a reaction mechanism and develop a comprehensive kinetic model that relates applied voltage with enhanced rate during Silicon refining reactions. The project will involve both experimental and kinetic modelling studies. In particular, the project will:

- 1) Track the change in electrical potential, current and concentration (of Ag, B and P) at different reaction times to form the kinetics data.
- 2) Conduct a cyclic voltammetry measurement on equilibrated silicon-slag system.
- 3) Analyse the samples using various characterisation techniques to establish the reaction mechanism and develop a comprehensive kinetic model that relates applied electrical potential with enhanced reaction rate.

The scholarship funding is for 3 years but a 6 month extension may be possible upon application. The successful applicant will be invited to submit an application for entry into a PhD and satisfy the general requirements of entry into a PhD program at Swinburne University of Technology, please see (<https://www.swinburne.edu.au/courses/applying/how-to-apply-research-degree/>).

The scholarship offered will be consistent with the SUPRA (Swinburne University Postgraduate Research Award) scholarship at the University. The 2020 SUPRA stipend rate is \$28,092 per annum with the following make conditions

- i. Annual indexation.
- ii. A potential 6 month scholarship extension
- iii. Provisions for paid leave (maximum of 12 weeks/84 days of paid leave, plus provision for paid maternity/paternity leave)
- iv. A thesis allowance (maximum \$840 for a PhD)
- v. A relocation allowance (\$505 for each eligible adult and \$255 for each eligible child – maximum total allowance is \$1,455)
- vi. Tuition fee waiver/scholarship up to four years

Location

The research will be carried out at Swinburne University of Technology (Hawthorn, Melbourne, Australia) and CSIRO (Clayton, Melbourne, Australia). The successful applicant may spend time at both locations (30 minutes apart) to carry out the project. The successful applicant may need to travel to present research findings to the funding body, at conferences, or visit industry collaborators.

Key Responsibility Areas

Research	<p>Work towards research objectives, ensuring close liaison with Supervisors and industry partner/collaborator.</p> <p>Planning and execution of relevant research work and data analyses, including modelling, survey and experimental study relevant to the project.</p> <p>Maintain a high-quality record of regular and original research publications of high international standing including peer reviewed journal papers.</p> <p>The following general research program is proposed in carrying out the project:</p> <ul style="list-style-type: none"> i) A literature review completed to assess the current state of knowledge around processing of EoL PV Cell. ii) Development of electrochemical cells for the experiments. iii) Experimental study to collect kinetics data and samples. iv) Analyses of samples and data to establish reaction mechanism and develop kinetics model v) Writing of papers and reports. vi) Completion of PhD thesis. <p>This program of work may change as the student develops the project and these changes will be discussed with the student's supervisors and external collaborators.</p>
Swinburne Behaviours	<ul style="list-style-type: none"> • Commitment to the Swinburne Behaviours of: • Communicate – Say it – have the conversation, respect each others differences, give meaningful feedback and share honestly and openly • Listen and Learn – Hear it, learn from it – learn from one another, actively listen to each other, resolve conflict and be innovative • Collaborate – Share it – work constructively together with a common purpose to achieve the university's goals • Trust – Trust it – be open to and with others, act with fairness and respect, inspire positive expectations and communicate effectively • Act – Do it – have a strong sense of immediacy, take practical action and see it through
Other	<ul style="list-style-type: none"> • Undertake Department-wide and/or university-wide responsibilities as required.

Key Selection Criteria

Candidates are required to respond to each of the selection criteria below

Key Selection Criteria		Essential / preferable
Qualifications	Bachelor of Engineering (4 years); Bachelor of Applied Science (4 years); or Masters degree	Essential
Experience/ Knowledge/Attributes	Background in Process/Extractive Metallurgy, Chemical/Environmental Engineering, Materials Engineering or Mechanical Engineering	Essential
	Experience in conducting research; in particular in high temperature experiments and modelling	Preferable
	Proficient interpersonal and communication skills, including the ability to work within a diverse team	Essential
	Experience in electrochemistry	Preferable
	Experience in using computer software modelling (thermochemical packages, flowsheeting packages, etc)	Preferable
	Industrial experience in a process/metals industry	Preferable
	Track record of high-quality journal publications	Preferable
Other	English Language Requirement (e.g. IELTS: Overall 6.5, No individual band below 6.0) (Australian Universities English Requirement)	Essential

Further information and how to apply

Please submit expression of interest (EOI) for this PhD scholarship position to Professor Akbar Rhamdhani (ARhamdhani@swin.edu.au) by using email subject "EOI-Swinburne PhD Scholarship-Recycling of EoL PV Cell". Please include a copy of your CV, academic degrees, academic transcripts, English test results (IELTS or TOEFL) and copies of journal publications (if applicable).

The deadline for the EOI is **31 August 2020**.

For further information about the position, please contact Professor Akbar Rhamdhani at ARhamdhani@swin.edu.au.

Relevant weblinks:

Swinburne

<https://www.swinburne.edu.au/>

FPD Research Group

<http://www.swinburne.edu.au/science-engineering-technology/research/fluid-and-process-dynamics/>

Application Process

<https://www.swinburne.edu.au/courses/applying/how-to-apply-research-degree/>

CSIRO

<https://www.csiro.au/>