

**Accelerating Higher Education Expansion and Development (AHEAD)
Development Oriented Research (DOR) Funded by the World Bank**

Development of Novel Electrolyte and Electrode Materials for Secondary Sodium-Ion and Magnesium-Ion Batteries

**Department of Physics & Department of Chemistry - University of Jaffna
National Institute of Fundamental Studies (NIFS) - Kandy**

**Progress Made in the First Three Years
(June 2019 - June 2022)**

Team members: Prof. K. Vignarooban (Principal Investigator)
Prof. K. Velauthamurthy
Prof. G. Sashikesh
Dr. H.W.M.A.C. Wijayasinghe (NIFS, Kandy)
Mr. S. Senthuran

Collaborators: Prof. A.M. Kannan (Arizona State University, USA)
Prof. Aleksandar Matic (Chalmers University of Technology, Sweden)

Total funding: 40 Million LKR for 3 and a 1/2 years (June 2019 – December 2022)

Amount spent in the first three years: 27,592,232.11 LKR (about 28 Million LKR)
(another 8 Million LKR committed for the ongoing building work - Extension of laboratory space at the Department of Physics)

Full-time Research Assistants: Mr. J.H.T.B. Jayamaha and Mr. V. Jathushan

MSc students

- Mr. A. Thabesan (Graduated in June 2021, MSc thesis title is ‘*Novel electrolytes based on Azadirachta indica natural resin for rechargeable sodium-ion batteries*’)
- Mrs. M. Rajathevy (MSc thesis title is ‘*Solid-polymer electrolytes based on Azadirachta indica natural resin for rechargeable magnesium-ion batteries*’)

Major instruments purchased in the first three years

	Instrument	Made	Cost (LKR)	Present Location	Co-ordinating Staff
1.	Differential Scanning Calorimeter (DSC)	Perkin-Elmer, USA	9,980,000.00	Laboratory for Energy Conversion and Storage, Department of Physics	Prof. K. Vignarooban & Mr. S. Senthuran
2.	Fourier Transform Infrared Spectrometer (FTIR)	Bruker, USA	4,925,000.00	Chemistry Research Laboratory, Department of Chemistry	Prof. K. Velauthamurthy & Prof. G. Sashikesh
3.	High temperature furnace	Carbolite, UK	2,499,984.00	Laboratory for Energy Conversion and Storage, Department of Physics	Prof. K. Vignarooban & Mr. S. Senthuran
4.	Super-dry box (with electrical humidity control system)	Totech, China	1,337,450.40		

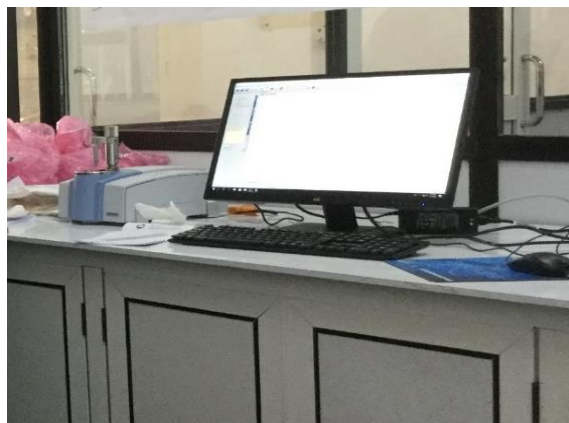
5.	Ultrasonic cleaner	J.P.Selecta, Spain	317,174.40		
6.	Analytical scale	Sartorius, Germany	160,000.00		

* Those who wants to collaboratively carry out their projects by using these instruments can do so by contacting and discussing with the Principal Investigator and the corresponding co-ordinating staff.

Differential Scanning Calorimeter (DSC)



Fourier Transform Infrared (FTIR) Spectrometer



Super-Dry Box



High Temperature Furnace



Other completed purchases / activities

	Item	Model	Department	Cost (LKR)
1.	Renovation works of laboratories	---	Physics and Chemistry	1,678,099.00
2.	Air-conditioners (03)	LG	Physics - 01 Chemistry - 02	566,970.00
3.	Desktop PCs with UPSs (02 sets)	Dell	Physics - 01 Chemistry - 01	401,280.00
4.	Chemical resistant laboratory stools (16)	Zeba	Physics - 08 Chemistry - 08	381,024.00
5.	Multifunctional printing device (01)	Toshiba	Physics	219,240.00
6.	Conference table (01) and chairs (06)	Damro	Chemistry	127,822.50

7.	Agate mortar and pestle (02 sets)	A.J. Cope & Sons	Physics	82,087.45
8.	Vacuum cleaner (01)	Karcher	Physics	63,825.00
9.	Repair of a 2 kVA UPS connected to Autolab Impedance Analyzer	Techfine	Physics	24,030.00
10.	Laser pointers (02)	Logitech	Physics - 01 Chemistry - 01	12,600.00

Laying of foundation stone for the extension of laboratory space at the Department of Physics
June 09, 2022

As part of this AHEAD-DOR project, Laboratory for Energy Conversion and Storage (LECS) at the Department of Physics is going to be extended at an estimated cost of about 8 Million LKR. The foundation stone was laid by the Vice-Chancellor Professor S. Srisatkunarajah on June 09, 2022 for the construction of two-story building for extending the laboratory space in Physics. Double 'S' Construction is starting the building work.



Opening ceremony of renovated laboratories November 25, 2020

As part of this AHEAD-DOR project, Laboratory for Energy Conversion and Storage (LECS) at the Department of Physics and Chemistry Research Laboratory (CRL) at the Department of Chemistry have been fully renovated and upgraded with necessary high-tech instruments. These two research laboratories were ceremonially opened on November 25, 2020 by the Vice-Chancellor, Professor S. Srisatkunarajah. This will be a very good addition to the research and development sector of the Faculty of Science.



Publications in the first three years

Full papers published in peer-reviewed international indexed journals

- Synthesis, electrochemical and optical studies of poly (ethylene oxide) based gel-polymer electrolytes for sodium-ion secondary batteries, M. Menisha, S.L.N. Senavirathna, K. Vignarooban, N. Iqbal, H.M.J.C. Pitawala and A.M. Kannan, *Solid State Ionics* **371** (2021) 115755.
- Novel gel-polymer electrolytes for sodium-ion secondary batteries - An electrochemical impedance spectroscopic studies, J.H.T.B. Jayamaha, V. Jathushan, K. Vignarooban, G. Sashikesh, K. Velauthamurty and M.A.K.L. Dissanayake, *Materials Science Forum* **1053** (2022) 119–124
- Gel-polymer electrolytes for sodium batteries - Raman and electrochemical impedance spectroscopic studies, G. Menisha, J.H.T.B. Jayamaha, K. Vignarooban, G. Sashikesh, K. Velauthamurty, H.W.M.A.C. Wijayasinghe and M.A.K.L. Dissanayake, *Materials Science Forum* **1023** (2021) 21–26.

Abstracts published in international / national conference proceedings

- Comparison of Li^+ and Na^+ alkali-cations on the ionic transport properties of solid-polymer electrolytes intended for secondary batteries, D.H.K.T. Dassanayake, J.H.T.B. Jayamaha, V. Jathushan and K. Vignarooban (February 2022). Abstract presented at the Undergraduate Research Symposium (URS), Physics Society, University of Jaffna, Jaffna, Sri Lanka.
- Synthesis and characterization of poly (vinyl alcohol) based aluminum-ion conducting solid-polymer electrolytes, M.H. Viduranga, M. Kajani, J.H.T.B. Jayamaha, V. Jathushan and K. Vignarooban (February 2022). Abstract presented at the Undergraduate Research Symposium (URS), Physics Society, University of Jaffna, Jaffna, Sri Lanka.

- Palmyrah kernel shell derived hard carbon as an anode material for secondary sodium-ion batteries, J. Sankhani, K. Velauthamurty, K. Vignarooban and G. Sashikesh (February 2022). Abstract presented at the Undergraduate Research Symposium (URS), Physics Society, University of Jaffna, Jaffna, Sri Lanka.
- Solid state biopolymer electrolytes based on *Azadirachta indica* derived natural resin for sodium-ion secondary batteries, A. Thabesan, J.H.T.B. Jayamaha, V. Jathushan, K. Vignarooban, G. Sashikesh and K. Veluathamurty (July 2021). Abstract presented at the Technological Advances in Science, Medicine and Engineering Conference, SickKids, Toronto, Canada.
- Optical vibrational excitations, electrochemical and structural properties of poly (ethylene oxide) based gel-polymer electrolytes for sodium batteries, M. Menisha, K. Vignarooban, S. Senthuran, H.M.J.C. Pitawala and A.M. Kannan (July 2021). Abstract presented at the Technological Advances in Science, Medicine and Engineering Conference, SickKids, Toronto, Canada.
- Gel-polymer electrolytes based on poly (methyl methacrylate) host polymer for sodium-ion rechargeable batteries, J.H.T.B. Jayamaha, V. Jathushan, R.P.P.D. Rajakaruna, K. Vignarooban, G. Sashikesh and K. Veluathamurty (February 2021). Abstract presented at the 8th Ruhuna International Science and Technology Conference, University of Ruhuna, Matara, Sri Lanka.
- *Commiphora mukul* derived natural resin-based biopolymer electrolytes for rechargeable sodium-ion batteries, C.N.B. Tennakoon, J.H.T.B. Jayamaha, V. Jathushan, K.G.H.S. Keppetiyawa, K. Vignarooban, G. Sashikesh and K. Veluathamurty (January 2021). Abstract presented at the Undergraduate Research Symposium (URS), Physics Society, University of Jaffna, Jaffna, Sri Lanka.
- Poly (methyl methacrylate) based gel-polymer electrolytes for sodium-ion secondary batteries - A comparative study with different ionic salts, J.H.T.B. Jayamaha, G. Menisha, K.G.H.S. Keppetiyawa, S.L.N. Senavirathna, K. Vignarooban, G. Sashikesh, K. Veluathamurty, H.W.M.A.C. Wijayasinghe and M.A.K.L. Dissanayake (January 2022). Abstract presented at the 7th Ruhuna International Science and Technology Conference, University of Ruhuna, Matara, Sri Lanka.

Gold Medal won by Mr. T.M.C. Nuwan Bandara Tennakoon April 2021

Mr.T.M.C. Nuwan Bandara Tennakoon became first in Sri Lanka in an undergraduate research competition.



He won Gold Medal from the Royal Society of Chemistry - Sri Lanka branch for the best undergraduate Chemistry research project in Sri Lanka carried out in Physics and Chemistry laboratories as part of this AHEAD-DOR project.



**Second place award received by the MSc student Mr. A. Thabesan
July 2021**

Mr. A. Thabesan (MSc student) got second place award for his oral presentation titled ‘*Novel electrolytes based on Azadirachta indica natural resin for rechargeable sodium-ion batteries*’ at the Technological Advances in Science, Medicine and Engineering (TASME 2021, July 2021) Conference, SickKids, Toronto, Canada.

Usage of instruments for other research projects

Several academic staff members and students are interested to collaborate with us and to carry out their project works by using the state-of-the-art instruments purchased under this AHEAD-DOR project. The following three staff members and their students have already started using our FTIR facility for collaborative research works.

- Dr. N. Kannan (Dept. of Agricultural Engineering, Faculty of Agriculture, Kilinochchi)
- Mrs. S. Sivakanthan (Dept. of Agricultural Chemistry, Faculty of Agriculture, Kilinochchi)
- Eng. (Ms) T. Thinojah (Dept. of Engineering Technology, Faculty of Technology, Kilinochchi)

Assignments to Prof. K. Vignarooban (Principal Investigator) in international conferences as part of the progress of this AHEAD-DOR project

- International Organizing Committee member representing Sri Lanka for the 11th International Conference on Material Science and Engineering Technology (ICMSET 2022) to be held in Tokyo, Japan on November 26-28, 2022
- Chaired a session at the International Conference on Nanomaterials (ICN 2021) organized by the Mahatma Gandhi University, Kerala, India on April 9-11, 2021
- Co-chair for the ‘*Engineering 3 - Innovation, Design and Energy*’ track of the Technological Advances in Science, Medicine and Engineering (TASME 2021) conference hosted by SickKids, Toronto, Canada on July 2-4, 2021
- Co-chair for the ‘*Battery Materials and Technology*’ session of the Technological Advances in Science, Medicine and Engineering (TASME 2021) conference hosted by SickKids, Toronto, Canada on July 2-4, 2021
- International Organizing Committee member representing Sri Lanka for the 10th International Conference on Material Science and Engineering Technology (ICMSET 2021) held in Kyoto, Japan on October 14-17, 2021

We are glad to report to the Faculty Board that the World Bank evaluated the progress made in the first three years and has given us ‘NO OBJECTION’ to extend the project period by six months until December 2022.

Sgd

Prof. K. Vignarooban, PhD (Cincinnati, USA)
Co-ordinator and the Principal Investigator / AHEAD-DOR 62 Project
June 13, 2022