

An Indian-Australian research partnership

Project Title: Nano-MgMn₂O₄ spinel cathode and ionic liquid compatibility study for Magnesium ion battery development

Project Number IMURA0747

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Department of Energy Science and Engineering

Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?

(Feel free to nominate more than one. For more information, see www.iitbmonash.org)

1. Advanced computational engineering, simulation and manufacture
2. Infrastructure Engineering
3. **Clean Energy**
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

The research problem

Increasing demand of energy storage devices based on lithium ion chemistry is being created by greater use of these batteries in renewable energy storage and electric vehicles. It is a challenging task to meet this demand with the limited resources of lithium, copper and cobalt and lithium salts. Many other storage chemistries can be developed and among them magnesium based chemistry has attracted attention due to its natural abundance, high specific and volumetric capacity compared to mono-valent cations like Li or Na.

Project aims

In this project, we will work on a new nano structured cathode based on magnesium manganese spinel oxide (MgMn_2O_4). This will involve constructing small test batteries based on this material. A fundamental study will be conducted to study the feasibility of magnesium ion intercalation into this material. Later on we will use in-situ and ex-situ methods (including synchrotron experiments) to understand the phase transition during the Mg-ion intercalation process. We will also study the use of our ionic liquid based electrolytes to control the stability of this material. Successes in this work will provide a critical step toward understanding the intrinsic structure and control of the electrochemical properties of spinel MgMn_2O_4 in Mg-ion batteries.

Expected outcomes

The outcomes will include:

- *A deeper understanding of the intercalation mechanisms in MgMn_2O_4*
- *An understanding of the charging limits of MgMn_2O_4 in regard to phase stability*
- *Development of ionic liquid based electrolytes for Mg batteries*
- *Mg batteries based on these materials ready for scale up to pouch cells.*

How will the project address the Goals of the above Themes?

Clean Energy: The project will address the global need for inexpensive energy storage technology.

Capabilities and Degrees Required

- *Chemistry as major with sound knowledge in inorganic material synthesis, electrochemistry and solid-state chemistry*
- *Chemical Engineering with relevant experience in materials synthesis and characterization are must*
- *Materials Science with relevant experience in materials synthesis and characterization are must*

Potential Collaborators

Monash – UCSD cooperation partners.

Please provide a few key words relating to this project to make it easier for the students to apply.

Nanotechnology, Energy Storage