School of Chemistry

Module Aims: Session 2022-2023

Module CH5715: Energy Conversion and Storage

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(*Module Convenor)

Aim: The aim of the course is to familiarise students with electrochemical processes occurring in the solid state. The basic mechanisms and principles of ionic conduction in solids and the electrochemical processes occurring at the interfaces of solid-state electrochemical systems will be discussed. The course will cover important technologies in energy conversion and storage in detail, including lithium ion batteries and fuel cells. Operating principles, materials requirements, advantages and disadvantages will be discussed. The course will be given in three parts: 1. Fundamental Electrochemistry (JTSI); 2. Fuel Cell Technology (RTB) and 3. Energy Storage and Batteries (ARA).

Objectives:

1. To understand the fundamentals of electrochemistry in the solid state.

2. To compare ionic conductivity in solids with that in molten salts and conventional liquid electrolytes.

3. Ionic conductivity in polymers -polymer electrolytes: what are they and how can we understand their unique mechanism of conduction?

4. To understand electrochemical processes and the application of Impedance Spectroscopy.

5. To be able to explain the general principles of fuel cells in detail and to be familiar with the main fuel cell types, their operation, advantages, disadvantages and potential applications.

6. To be able to describe and explain the operation of SOFC and PEMFC fuel cells in detail including the roles and requirements of the anode, cathode and electrolyte and the associated materials considerations.

7. To understand the energy and efficiency considerations and potential for alternative fuels in fuel cell systems.

8. To understand the mechanism of intercalation and the factors allowing a material to act as an intercalation host, to be familiar with intercalation compounds.

9. To understand the important parameters of batteries, the most common/important types and why novel ionic conductors and intercalation compounds are important for advanced batteries with particular relation to lithium-ion and sodium-ion batteries.

10. To understand alternative mechanisms for electrode materials including alloying and conversion and their advantages and disadvantages, to be able to compare the emerging types of battery and their strengths and weaknesses and be familiar with lithium-sulfur, lithium-air, sodium-ion and multivalent batteries and their possible application.