

PhD in Materials for Sustainable Development
Teaching Activity 2023/24

MATERIALS FOR ENERGY CONVERSION AND STORAGE DEVICES: ELECTROCHEMICAL CHARACTERIZATION TECHNIQUES

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Location:

Seminar Room Department of Chemical Science and Technologies

Calendar:

11th, 17th and 25th and 31st October

Time: 14:30-16:30

Syllabus

Electrocatalytic technologies such as fuel cells (FCs), water electrolyzers (WEs), and redox flow batteries (RFBs) play a vital role in the advancement of the hydrogen economy, as well as the implementation of other renewable green energy sources. Developing efficient electrocatalytic materials and ion exchange membranes for rate-determining reactions in FCs and WEs are the major issues that must be addressed before effective implementation. The successful synthesis and optimization of materials require insights into the relationship between atomic-scale structure and their activity. The electrochemical characterization methods in a half-cell configuration combined with spectroscopical analysis are crucial to screening the materials' properties according to their structural and chemical-surface functionalization.

This series of lectures will focus on providing insights into developing and studying electrocatalytic materials for application in polymer electrolyte FCs and WEs and into the common electrochemical characterization methods to elucidate their activity. The discussed characterization approaches will be supported by the current and high-quality literature and by established protocols.

Content

11th October: *Introduction* – Role of the electrochemical systems in the energy transition scenario towards the renewable sources utilization; low-temperature fuel cells and water-electrolyzers: classification, work principle, and state-of-the-art components, reactions at the electrodes and mechanisms.

17th October: Electrode/solution interface structure (electric double-layer); electrochemical kinetics and overvoltage at polarized electrodes: the Butler-Volmer equation. Actual polarization curve: kinetic, ohmic, and mass transport limitations.

25th October: Alternative materials for oxygen electrocatalysis, acidic and alkaline environments, in polymer electrolyte fuel cells and electrolyzers.

31st October: Voltametric techniques for characterizing oxygen reduction and evolution reaction electrocatalysts: cyclic voltammetry and linear scanning voltammetry with rotating electrode (hydrodynamic conditions).