

CONTRATOS PREDOCTORALES 2022 SEVERO OCHOA

PROJECT TITLE / JOB POSITION TITLE:

Controlling the chemistry in aqueous zinc batteries

JOB POSITION RESEARCH LINE:

RL1.- SUSTAINABLE ENERGY CONVERSION AND STORAGE SYSTEMS

RESEARCH PROJECT / RESEARCH GROUP DESCRIPTION:

The transition to a carbon-free energy system requires a huge energy storage capacity to match renewable production with the consumer demand. The current mature electrochemical storage technologies that are technically able to satisfy such operation, such as lithium-ion batteries and vanadium redox flow batteries, are based on too scarce elements to satisfy such capacity need.

Zinc batteries have emerged in the past decade as a suitable candidate for this challenge. They show high power, decent energy density and long cycling using nearly-neutral aqueous electrolytes, MnO_2 as cathode and metallic zinc as anode. They present attractive material price and availability, as well as safe and environmentally benign components.

On the other hand, zinc/air batteries could allow 3-5 times the specific energy of current Li-ion batteries at a lower cost, making an ideal choice for electric vehicles. However, their durability is often limited, and the mechanisms that lead to their failure are generally poorly understood.

For both battery chemistries, complex deposition and dissolution mechanisms are involved in the main and in side reactions. The research line lead by Dr. Dino Tonti aims to contribute to the understanding of mechanisms and improve performance by combining new materials and advanced characterization.

Dr. Dino Tonti is a chemist at ICMAB. He has worked on surface science and optical techniques, synthesis of colloidal nanoparticles, carbons and battery materials. He is currently involved in metal-air batteries within several topics: development of novel electrode architectures, study of electrolyte additives, and characterization of electrochemical processes by analysis of discharge products and in situ monitoring. The present work will be supported by the collaboration with Dr. Laura Simonelli and Dr. Andrea Sorrentino, beamline scientists for x-ray absorption and microscopy at the ALBA Synchrotron, where part of the experiments will be designed and carried out.

JOB POSITION DESCRIPTION:

Dissolution and precipitation reactions that govern zinc batteries are often sensitive to the operating conditions, the electrode architecture, cell geometry and the electrolyte composition. The overall mechanism is extraordinarily complex and leads to a wide range of performances. A key factor to understand the reaction mechanism and to control rechargeability is the composition and morphology of the products deposited on both electrodes during the discharge and charge processes. This work will study the evolution of these precipitates, and relate them to several factors such as the electrode texture, the presence of solid or soluble catalysts or other additives in the electrolyte able to control the stability of reaction intermediates. This information will help to minimize formation of side products, and produce precipitate architectures that promote the most efficient removal.

The student will participate to the development of more efficient zinc batteries using different electrodes and electrolytes, focusing on the investigation of the electrode and cell materials before, during and after operation with emphasis on imaging and spectroscopic operando techniques. In particular he/she will:

- Process electrodes, assemble cells and test their electrochemistry
- Design specific operando experiments to follow the formation of compounds during electrochemical cycling
- Analyze large data sets by high throughput tools

Required degree: MSc or equivalent in Physics, Chemistry, Nanotechnology, Chemical engineering or Materials Science.

Valuable experience: electrochemical techniques, electrodeposition, electrochemical energy storage, electron microscopy, x-ray absorption, data analysis.

GROUP LEADER:

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Research project / Research Group website <https://icmab.es/ssc/nanointerfaces>