

CONTRATOS PREDOCTORALES 2022 SEVERO OCHOA

PROJECT TITLE / JOB POSITION TITLE:

Laser wet synthesis of multicomponent hybrid electrodes for asymmetric supercapacitors

JOB POSITION RESEARCH LINE:

RL1 - Sustainable energy conversion and storage systems

RESEARCH PROJECT / RESEARCH GROUP DESCRIPTION:

Intense research and industrial efforts are being devoted to the development of high-performance supercapacitor devices exhibiting high energy storage performance and long lifetime. Thereby, hybrid composite electrodes formed by carbon nanostructures (CNS) as carbon nanotubes (CNTs) and graphene derivatives coated with transition metal oxide nanostructures (TMO) are especially suitable for supercapacitor devices due to their high surface area, capacitance and chemical stability. The objective of the project is to fabricate complex CNS-TMO hybrid electrodes for high performance supercapacitors using a fast, versatile and easily scalable to industry laser synthesis technology. By using an industrial laser system, a novel laser fabrication method will be developed to obtain advanced CNS – binary / ternary TMO nanocomposite materials. Their characterization will be carried out through a variety of microscopies, spectroscopies, and electrochemical techniques. Besides the fabrication and analysis of the nanostructured electrodes, asymmetric supercapacitor devices will be also assembled and fully characterized.

The Laser Processing Research Group at ICMAB is leading the development of hybrid carbon-based supercapacitor electrodes by laser-induced chemical transformation and deposition of a variety of graphene- and CNT-based nanocomposites, having achieved very promising results. Recent studies are focused on the fabrication of electrodes with high power density, high specific capacitance, and more stable life-cycling by laser-induced crystallization of multicomponent materials. The technology to be developed in this project is expected to be fast, cost-effective and easy to integrate at industrial processes. The work will be carried out in the frame of a research project financed by the Spanish Science and Innovation Ministry.

JOB POSITION DESCRIPTION:

The aim of the project is to fabricate binary / ternary metal oxide-coated graphene / carbon nanotubes-based electrodes by means of an innovative laser synthesis technique consisting on the irradiation of CNS (graphene derivatives and CNTs) dispersions containing reactive precursor molecules. The combination of fast laser-driven photochemical and photothermal mechanisms will lead to the crystallization of electroactive TMO nanostructures on the surface of the CNS, leading to a significant enhancement of the electrodes' performance.

The investigations will be experimental and multidisciplinary, including the synthesis and advanced characterization of nanomaterials, laser and energy physics, laboratory instrumentation and electrochemistry. The laser-induced decomposition of the precursors and the crystallization of TMO nanostructures on the CNS structures will be studied as a function of the experimental conditions. Laser-matter photothermal simulations will be also carried out for elucidating the mechanisms responsible of the materials transformations. A variety of characterization techniques (microscopies, spectroscopies) will be used for the investigation of the nanostructure and chemical composition of the obtained materials. Additionally, advanced supercapacitor electrodes will be fabricated with the synthesized materials. Besides, the electrochemical properties of the electrodes will be studied by cyclic voltammetry, galvanostatic charge-discharge and electrochemical impedance spectroscopy, and correlated to their structural-compositional nature. Finally, asymmetric supercapacitor devices will be fabricated with the optimized electrodes and their electrochemical performance will be evaluated. Therefore, candidates with academic training related to physics, chemistry or materials engineering would fit best for this position.

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