Project: Ecofriendly ARchitectured materials for photo-assisted TecHnology (EARTH)

Post-doctoral position:
ZnO nanowire-based photo-assisted Li-ion batteries

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The EARTH project aims at developing a new efficient and industrially scalable concept for the harvest, conversion, and storage of the energy in photons. One task of this large project is dedicated to photo-assisted battery.

The development of rechargeable batteries is of considerable importance due to the increasing energy consumption of mobile devices and to the development of both renewable energies and electric vehicles. Over the past 20 years, Lithium-ion batteries have been under intense research due to their advantages, such as high energy density (250 $Wh.kg^{-1}$), high operating voltage, and low self-discharge rate. However, the cost per kWh of this technology remains still prohibitive for extended applications. This project proposes to develop a new concept of Lithium-ion battery, where light is directly used to enable charging the battery at a lower potential than that of discharge potential, inducing a significant increase of energy efficiency, and indeed a significant reduction of the kWh cost in operating condition. This innovative concept is based on the use of a photo-electro-catalytic process by adding the conventional operation of a Lithium-ion battery.

The project is centered on this electro-photo-catalytic strategy with a large innovating purpose: i) the use of the common storage system to reach high efficiency charge/discharge process due to the gain obtained by the light absorption, ii) the extension of the purpose to other electrochemical storage materials thank to chemistry, which allows to tune the redox potential of the photosensitizer.

In order to form transparent electrodes exhibiting large specific surface area, ZnO nanowires with appropriate morphology (i.e. diameter, length, density) and properties will be grown by the low-cost, low-temperature chemical bath deposition in LMGP. To assess the applicability of this concept, the chemical modification of ZnO thin film electrodes formed by chemical deposition techniques in LMGP will first be investigated using Ru(II) photosensitisers. Ru(II) complexes will be grafted onto the surface of the electrode using common procedures (diazonium and/or vinyl electrochemical reduction), allowing to tune the amount of deposited material.

The photochemical and electrochemical properties of this innovative concept will be largely characterized. The photochemical measurements of the modified electrode will be done in classical electrolyte (carbonate-based electrolyte) in order to check the influence of the nature of the ligand, the grafting density toward the photochemical characteristics (i.e. τ,

ϕ). This study will be completed by the influence of the $LiFePO_4$ ink deposited onto the modified electrode towards the photochemical properties of the photosensitizer. Finally, the ability of the $LiFePO_4$/Ru(II)/ZnO nanowire electrode to be charged under light at relative low potential will be examined by varying the morphology of the ZnO nanowire electrodes as well as their physical properties.

This project will be conducted under the Labex CEMAM between two research laboratories LEPMI and LMGP in Grenoble.

Applicant background:

The applicant should have a PhD in physical-chemistry or materials chemistry, with a proven experience in electrochemistry and/or photochemistry. The applicant should be able to work independently, have a very good English level and exhibit human skills to work within a motivated team of technicians and researchers between two labs.

Application:

Please send a resume + motivation letter + references to the e-mail addresses below.

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