Energy storage

Lithium Ion Battery (LIB)

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Co-deposition of two materials that are insoluble to each other causes self-assembly, resulting in a large interface area. This may bring about the reduction of the interface resistance for the pairs of electrode and solid electrolyte materials of batteries. We co-deposited $LiCoO_2$ and $Li_{0.33}La_{0.56}TiO_3$ (LLTO) on Al_2O_3 (0001) substrates by the dual-PLD technique. The XRD profile of the co-deposited film shows two diffraction peaks that could be assigned to $LiCoO_2$ (003) and LLTO (112) planes, implying occurrence of self-assembly.

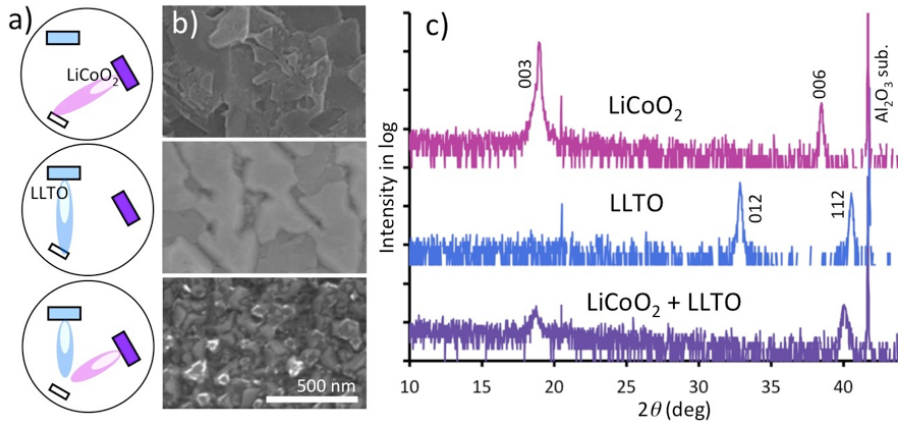

Fig. 1: Schematics of the configuration of deposition (a), SEM images (b), and XRD 2 profiles (c) of three films deposited on Al_2O_3 (0001) substrates : $LiCoO_2$ (above), LLTO (center), and $LiCoO_2$ + LLTO (below).

3D microbattery

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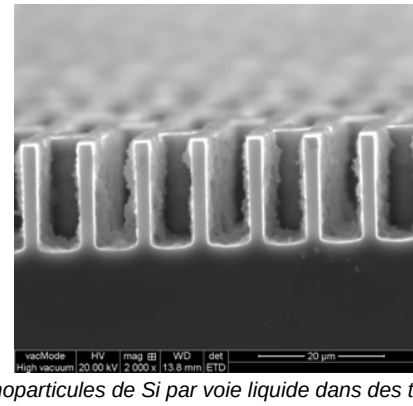
With the increasing need of **miroenergy storage devices** in regards to the miniaturization of biomedical implants, sensors or integrated circuits, **small size integrated batteries** are required. Planar all-solid state **Li-ion microbatteries** appear as possible candidate.

To increase the volumetric energy density of these microbatteries, new advanced concepts are proposed, based on **3D batteries**. By enlarging the active surface area, these batteries ensure a relatively high current and power capacity. In GREMAN laboratory, by achieving 3D structure by **Deep Reactive Ionic Etching** (DRIE) to enlarge the active surface of the microbatteries, **Silicon nanoparticles** (SiNPs) are coated using a liquid route method to investigate the performance-related improvements that these created **3D silicon structure** (versus planar) can impart. Such preparation method, very simple, fast and low-cost, compared with vacuum deposition techniques used as CVD, PVD is found to provide a conformal coating all over the wall of the 3D trenches.

The effect of these structures on the electrochemical properties is studied using cyclic voltammetry (CV). The results obtained from other characterizations as SEM and EDX post-mortem analysis confirm that only SiNPs layers are involved in lithiation/delithiation process. These SiNPs layers onto 3D structure have an impact on the electrochemical performances and its preparation and deposition improvement is a key component to maximize performances in Li-ion microbatteries.



Images MEB : dépôts de nanoparticules de Si par voie liquide dans des tranchées (facteur de forme 7).

Supercapacitors

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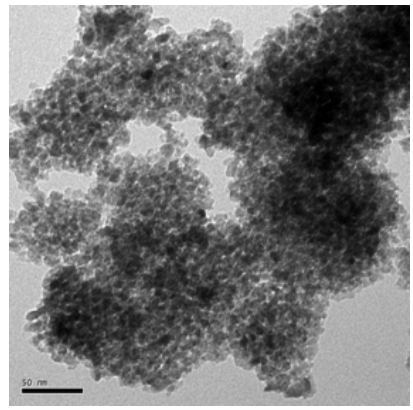
Supercapacitor (SC) is considered to be highly desirable which combines the advantage of **lithium ion batteries** (LiBs) and **dielectric capacitors** (DiCs) with high power density, excellent cycling stability and improved behavior in extreme temperatures. From the material point of view, metal oxides have been most intensively investigated due to their versatile applications

In laboratory, we synthesize the low cost sol-gel synthesis strategy for the preparation of **TiO_2 nanoparticles** by example in aqueous media without surfactants addition or the need for high temperature calcination. Another oxides are studied to improve the energy and power densities, keeping the aim of safety and scalability.



MET image : nanoparticles of TiO_2