Electroless Copper Metallization for Improving Li-Ion Batteries Performances

M. Spreafico[a], M. Biso[b], P. Cojocaru[b], L. Magagnin[a], F. Triulzi[b]

[a] *Politecnico di Milano, Via Mancinelli 7, Milano, Italy*
[b] *Solvay Specialty Polymers S.p.A., Viale Lombardia 20, Bollate, Italy*
Corresponding author: maurizio.biso@solvay.com

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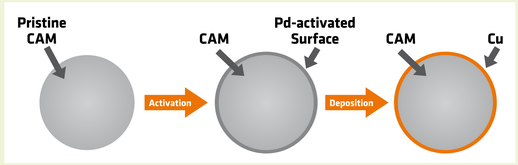
High molecular weight PVDF is widely recognized as the most performing LIB binder thanks to its excellent chemical and electrochemical resistance, ensuring active material adhesion to current collector and cohesion throughout the electrode. Another advantage of PVDF is that can be used in both organic and aqueous based processes. The use of PVDF latex in the cathodes manufacturing process is hindered by the sensitivity of Cathode Active battery Materials (CAM) to moisture and their inability to resist harsh environments. In fact, the dominant manufacturing process in Li-ion batteries industry is based on the use of polymeric binders dispersed in organic solvents during slurry preparation. The organic solvent used as standard in the industry is currently N-Methyl-2-pyrrolidone (NMP), which has recently raised concerns due to its reprotoxic, mutagenic and cancerogenic properties. In order to replace NMP-dispersed with water-based polymeric binders, it is necessary to eliminate the interaction between particles of active material and aqueous environment during electrode preparation. In this work it is developed the idea of plate a water-proof and Li-ion permeable protective coating on the surface of the CAM particles, which will preserve the integrity of the material without affecting its cycling performances. The coating is obtained by means of electroless deposition process. This work has been developed in the framework of the **LIFE+ GLEE Project (LIFE12 ENV/IT/000712)** co-funded by EC, whose goal is to demonstrate the feasibility of the scale-up of the metallization technology.

The LIFE+ GLEE Protection Process of CAM

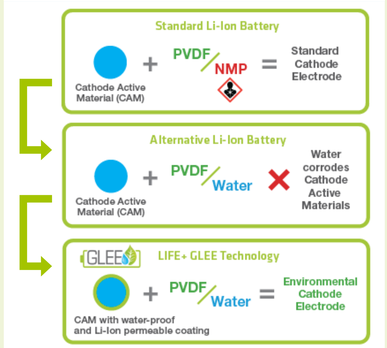
CAM powders have been metallized with copper using two steps process electroless metallization technique:

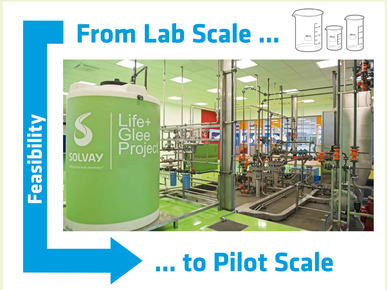
1. **Activation** is Pd-based, goal is to adsorb Pd atoms and clusters on Si particles, which will act as a catalyst during the plating step.
2. **Metallization** contains copper ions and a reducing agent. Metal ions will reduce on the surface of Si particles using electrons provided by the oxidation of the reducing agent. The redox reaction will be catalyzed from Pd present on the surface of the particles.

Coating Process

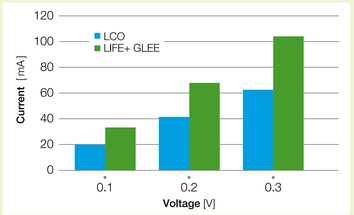


LIFE+ GLEE: the Innovative Idea

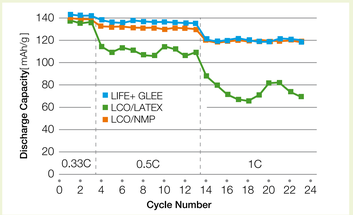




Improved Li-Ion Battery Performance



Out-of-plane conductivity analysis shows an **increse in electrical conductivity** of the electrode containing Cu-coated particles. Calculated resistance values are of 2.9 Ω and 4.81 Ω.



Copper-coated powders metallization process allows performance retention during **cyclability** when using a PVDF latex as a binder. Capacity values are comparable with a NMP-based electrode.

2015 Future Developments

- December 2015 – External evaluation of CAM in large size prototypes
- Extend the metallization treatment to different CAMs (LFP, NMC, NCA, etc.). Preliminary results are encouraging.

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