Electroless Copper-based Coating on Cathode Active Materials (CAMs) for Improved Performance

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High-performance, high-capacity Cathode Active battery Materials (CAM), including Nickel Cobalt Aluminum (NCA), Lithium Iron Phosphate (LFP), Cobalt-based lithium-ion (LCO) and Nickel Cobalt Manganese (NCM), are a critical core component of Li-Ion batteries. That's why the rush in the industry to develop the next generation's Li-Ion batteries, with even higher power and more energy densities, has normally focused on the investigation of new and higher performing CAM. These developments, however, are impeded by the sensitivity of CAM to moisture and their inability to resist harsh environments.

Therefore, the use of aqueous binders in the cathode manufacturing process is hindered. In fact, the dominant manufacturing process in the Li-Ion batteries industry is based on the use of polymeric binders dispersed in organic solvents during slurry preparation. The organic solvent used as a standard in the industry is currently N-Methyl-2-pyrrolidone (NMP), which has recently raised concerns due to its reprotoxic, mutagenic and cancerogenic properties.

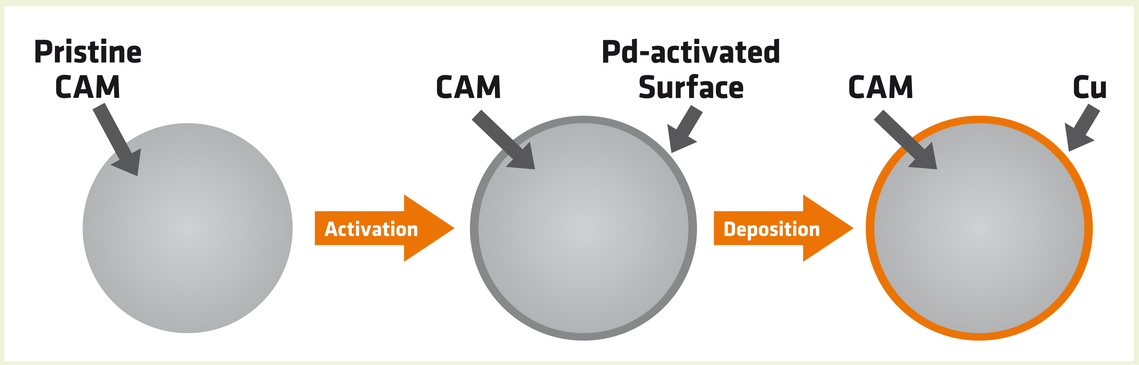
In order to replace NMP-dispersed with water-based polymeric binders, it is necessary to eliminate the interaction between particles of active material and aqueous environment during electrode preparation. In this work it is developed the idea of plate a water-proof and li-ion permeable protective coating 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**, whose goal is to demonstrate the feasibility of the scale-up of the metallization technology.

The LIFE+ GLEE Protection Process of CAM

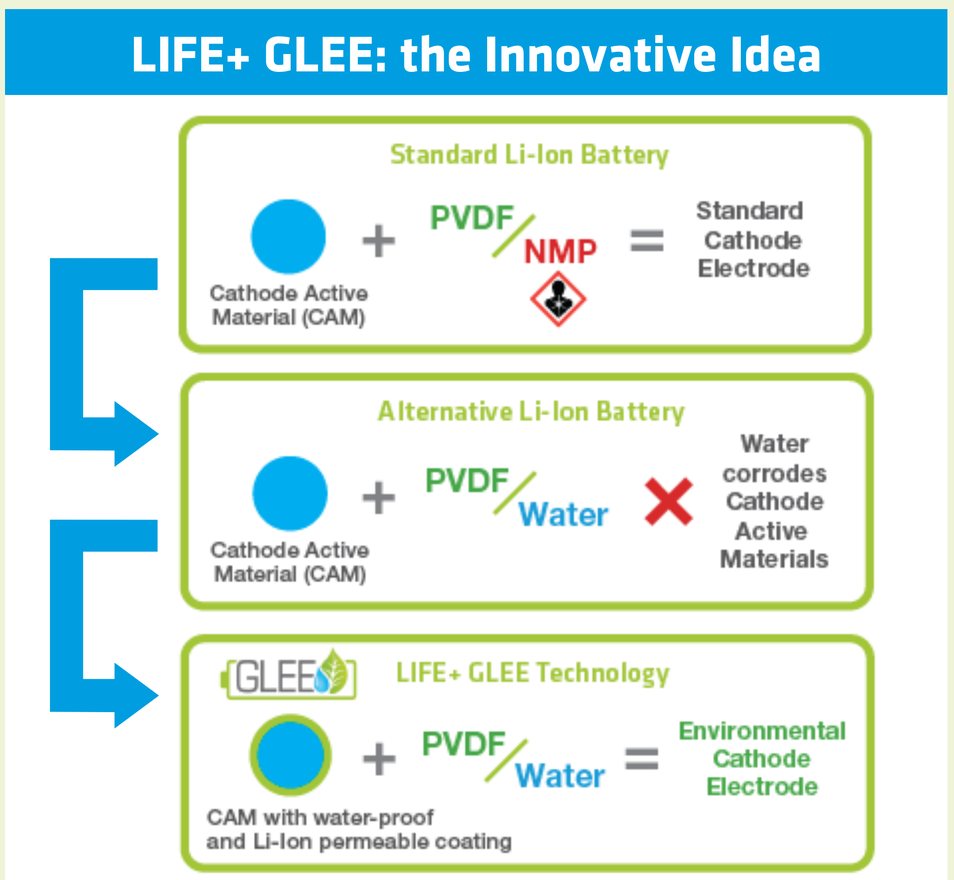
CAM powders have been metallized with copper using two steps process electroless metallization technique:

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.

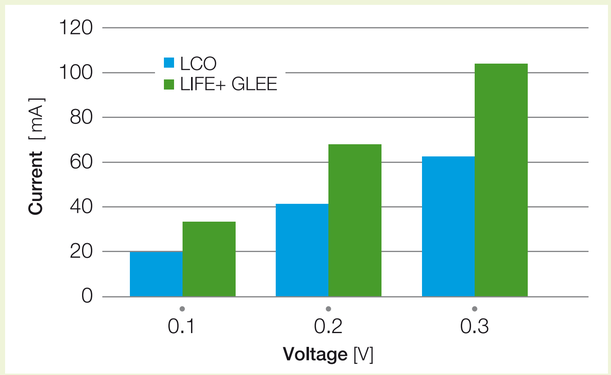
Coating Process



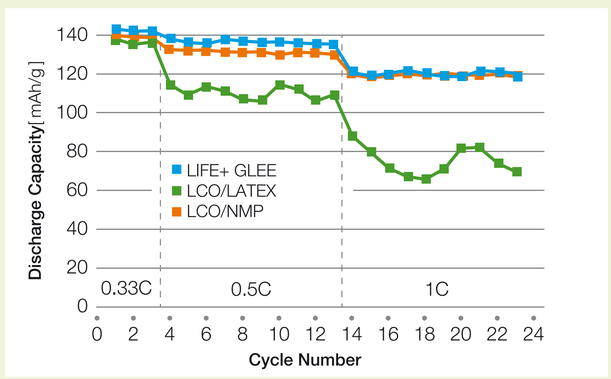
LIFE+ GLEE: the Innovative Idea



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.

From Lab Scale ... to Pilot Scale

Feasibility

2015 Project Developments

- January – Pilot plant for metallization treatment ready
- March – First treated batch sent to testing labs
- Extend the metallization treatment to different CAMs (LFP, NMC, NCA, etc.). Preliminary results are encouraging.

GLEE
Green Li-Ion Batteries through Electrode Electroless Deposition

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