Ricerca, Trasferimento Tecnologico e Recruiting al distretto Navile: dipartimenti di Chimica, di Chimica Industriale e di Farmacia e Biotecnologie

The definition of innovative industrial processes for the dry manufacturing of lithium-ion battery electrodes

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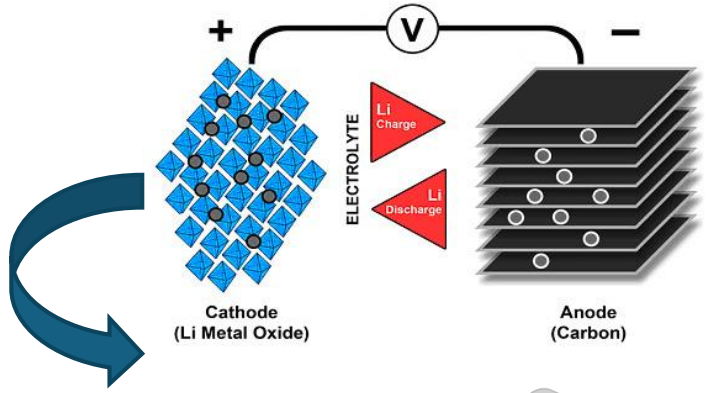
National PhD Program in Sustainable Materials, Processes and Systems for Energy Transition

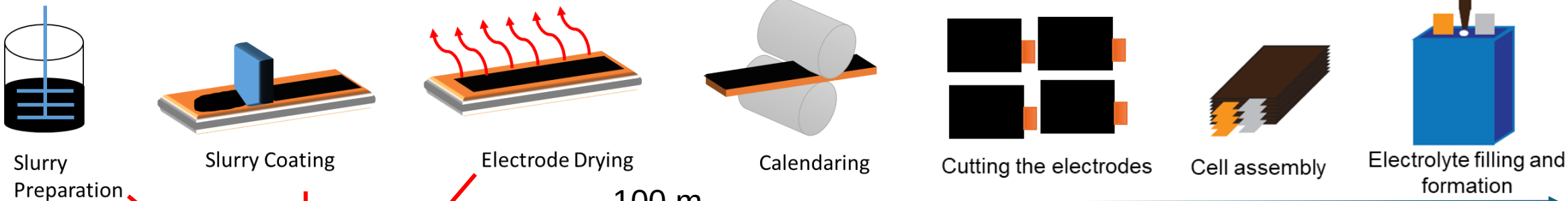
38th Cycle – Polito–UNIBO
Supervisor: Prof. Francesca Soavi

Lithium-ion Battery production

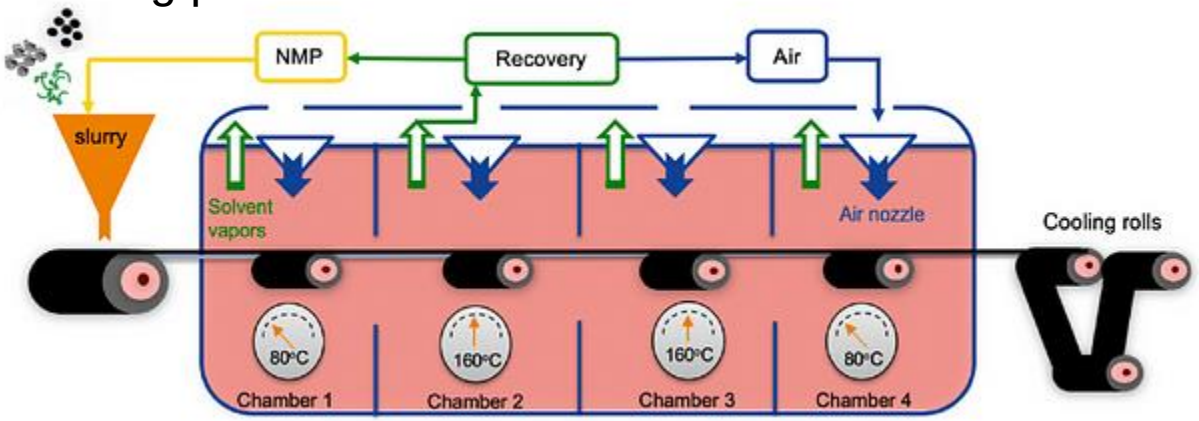


Lithium-ion battery working principle

Production line



Wet Coating process

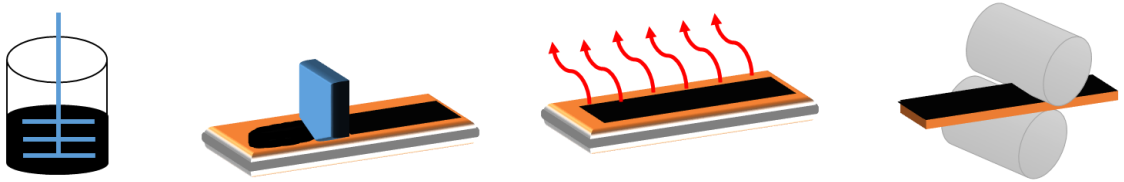


Challenges

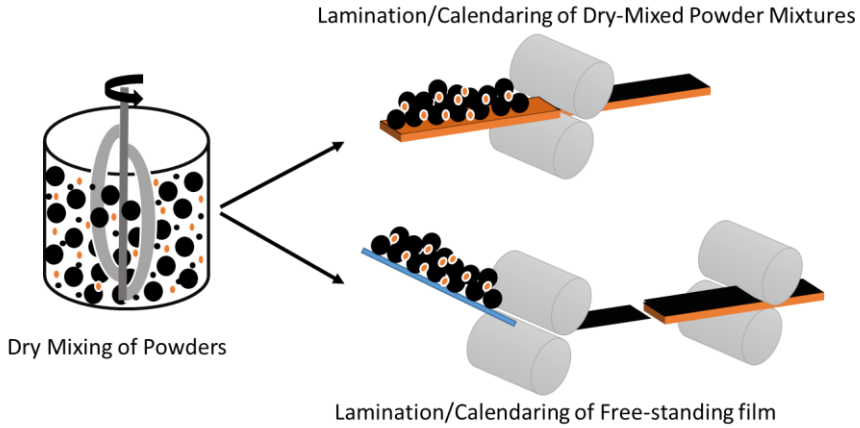
- Environmental impact
- Energy consumption
- Cost
- Zero CO_2 Emissions by 2050

Dry vs. Wet Electrode Manufacturing
A solution for sustainability

Wet Coating Electrode Manufacturing



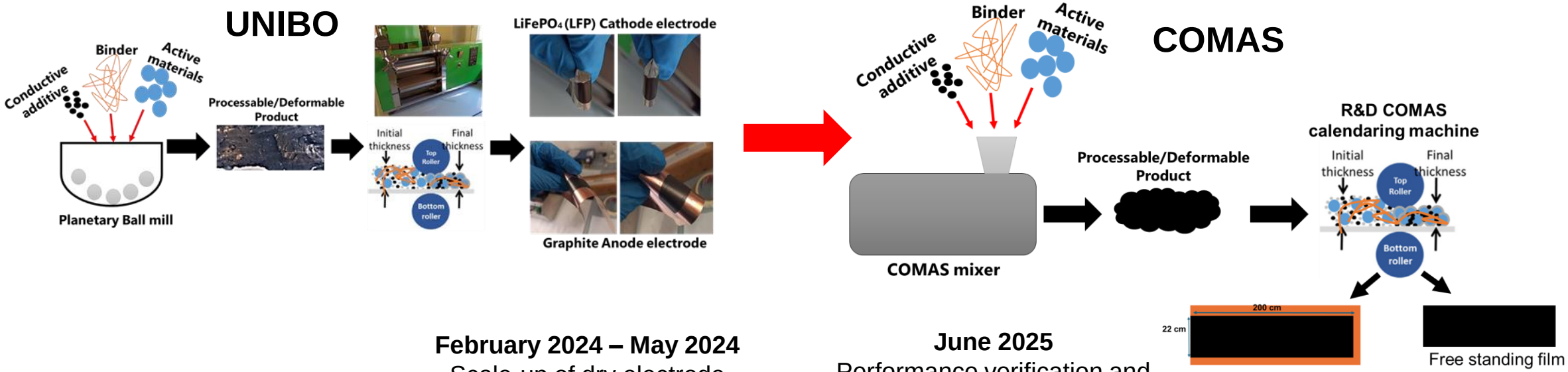
Dry Coating Electrode Manufacturing



Comparison of Wet and Dry Electrode Manufacturing

Aspect	Wet Electrode Manufacturing	Dry Electrode Manufacturing
Environmental Impact	Uses solvents like NMP, which require recovery but are recyclable.	Solvent-free process, eliminating VOC emissions and reducing environmental impact.
Energy Efficiency	Moderate; energy required for drying and solvent recovery.	High; bypasses drying and recovery steps, reducing overall energy consumption.
Cost	Lower initial capital investment; Higher total cost.	Lower operational costs due to reduced processing steps and energy use.
Scalability	Well-established; widely implemented in commercial battery production.	Emerging technology; shows strong potential for high-volume scalability.
Material Uniformity	Excellent, due to homogeneous slurry mixing.	Good, with improved control over porosity and coating thickness.

Transferring knowledge from lab activity up to production upscaling



November 2022
Start of PhD course

January 2024
Completed lab-scale setup for dry electrode manufacturing

February 2024 – May 2024
Scale-up of dry electrode manufacturing at COMAS R&D pilot line

June 2024
Patent submission

June 2025
Performance verification and optimization of industrialized Dry manufactured electrodes

October 2025
Thesis submission and PhD completion

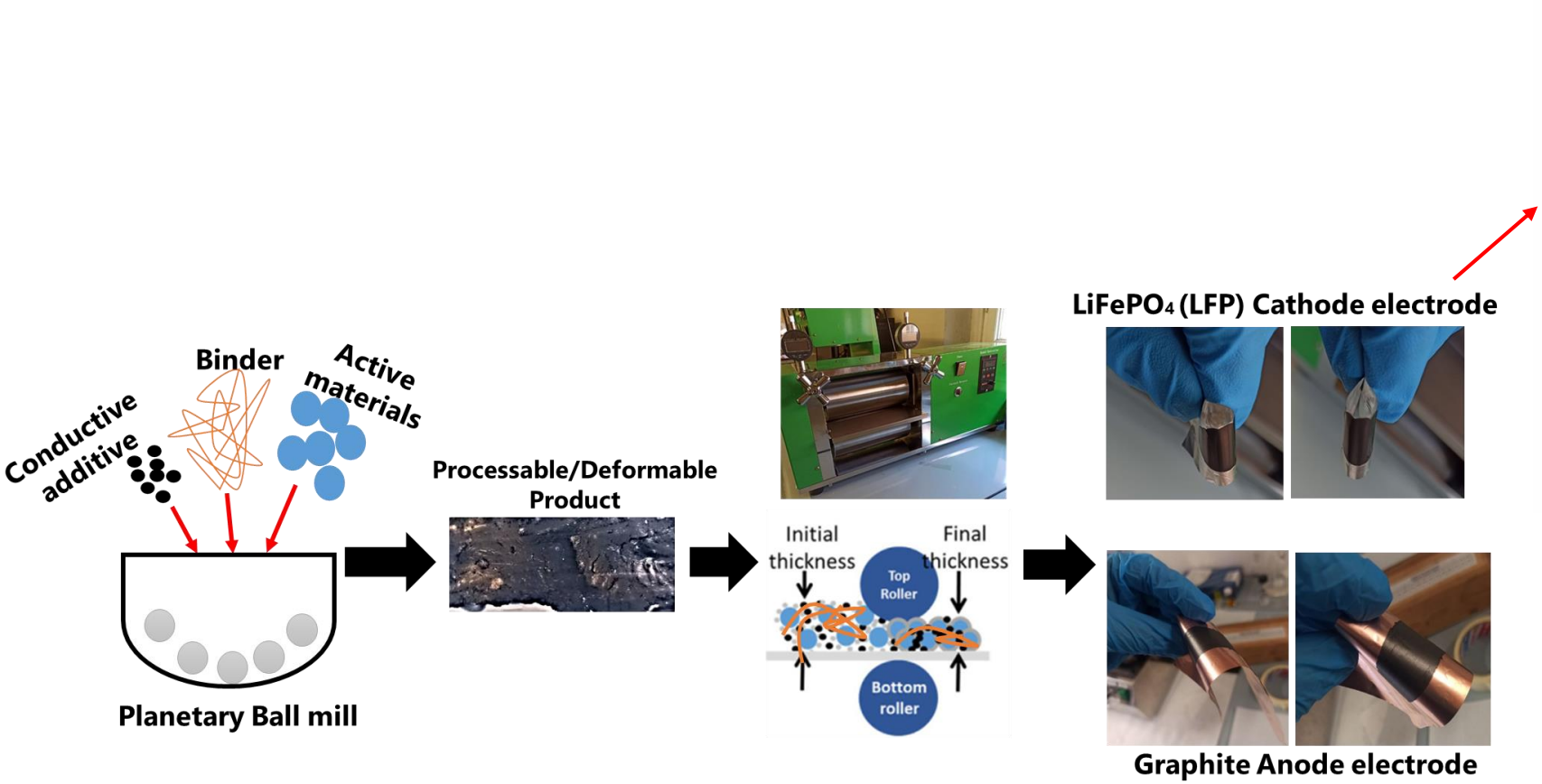
Patent: Method of manufacturing an electrode, electrode and energy storage device (n. 102024000012958).

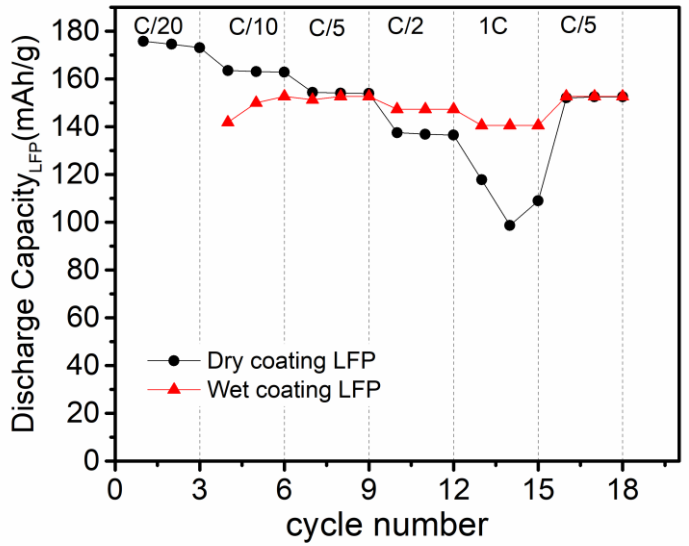
Inventors:
Prof. F. Soavi (UNIBO)
S. Mojtahedi (UNIBO)
E. Maruccia (COMAS)
M. Serafin (COMAS)

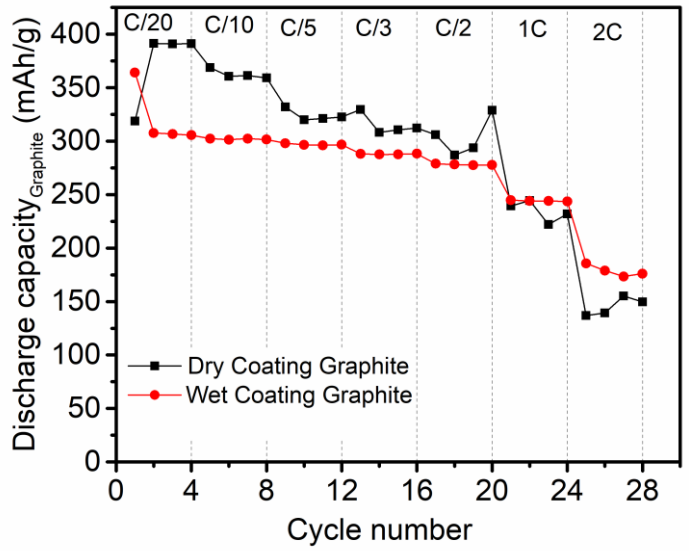
Field of the invention

- Method of manufacturing an electrode for energy storage devices by a technique which minimizes the use of solvents
- Electrode formulation in the form of a cohesive solid material and a self-supporting film.

Dry Coating at Laboratory Scale: Process & Performance

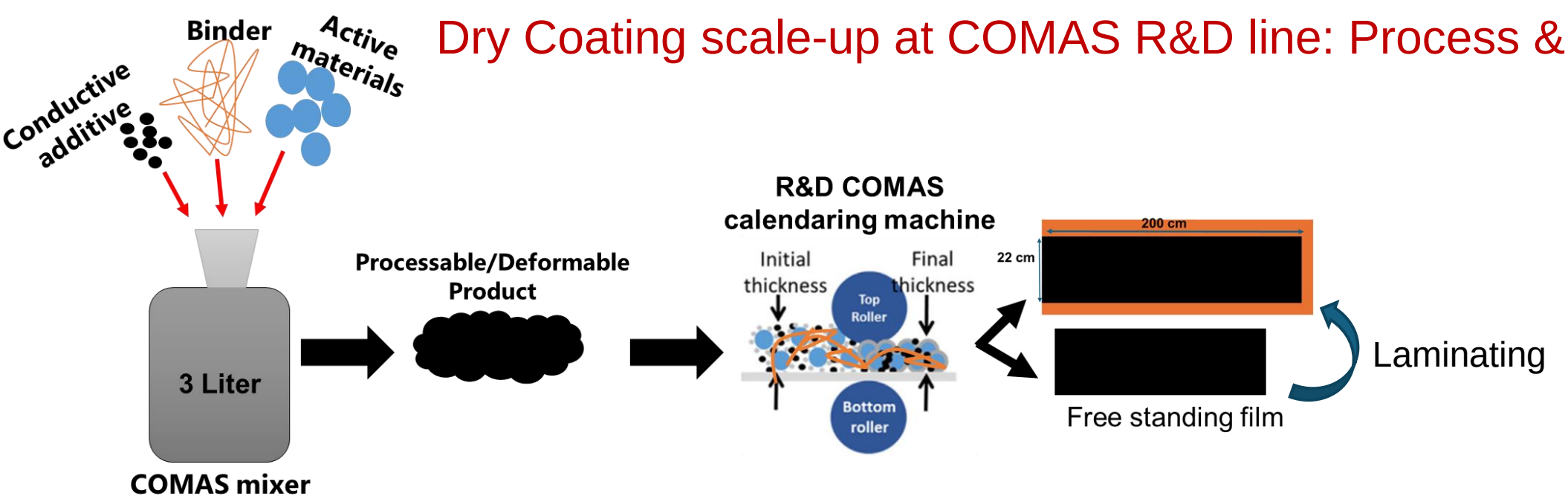


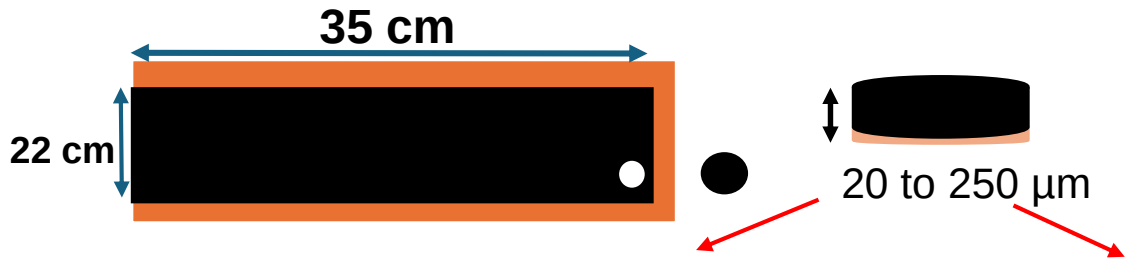


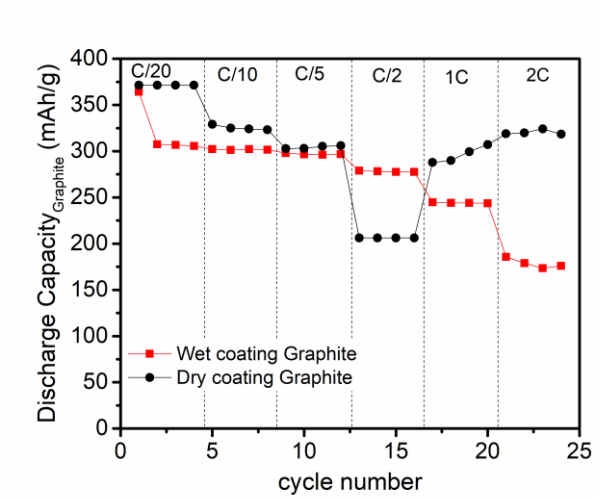


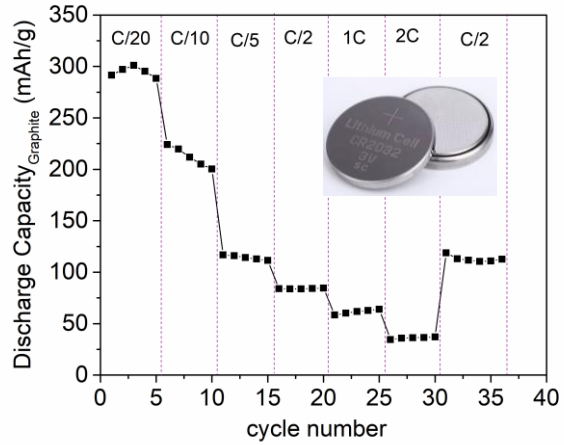
- The dry-coated electrodes exhibited performance comparable to conventional wet-coated electrodes, with even higher charge capacity observed at low C-rates.

Dry Coating scale-up at COMAS R&D line: Process & Performance



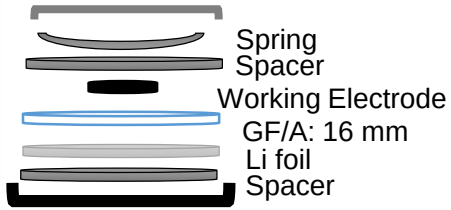






- The dry-coated electrodes with high thickness and mass loading exhibited acceptable performance.

High mass loaded electrode



Conclusion

- Dry coating represents a promising pathway toward enhancing the sustainability of lithium-ion battery electrode manufacturing.

- Its potential extends beyond batteries, offering valuable applications in other energy storage technologies such as supercapacitors and fuel cells.

- This advancement was made possible through the effective and synergistic collaboration between UNIBO and COMAS, which enabled the successful translation of laboratory-scale material innovations into the development of a pre-industrial, scalable manufacturing line.

ACKNOWLEDGMENTS

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Thank You for Your Attention

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