PLASMANODE

Plasma-modified active powders for Li-ion battery anodes processable by water-based techniques

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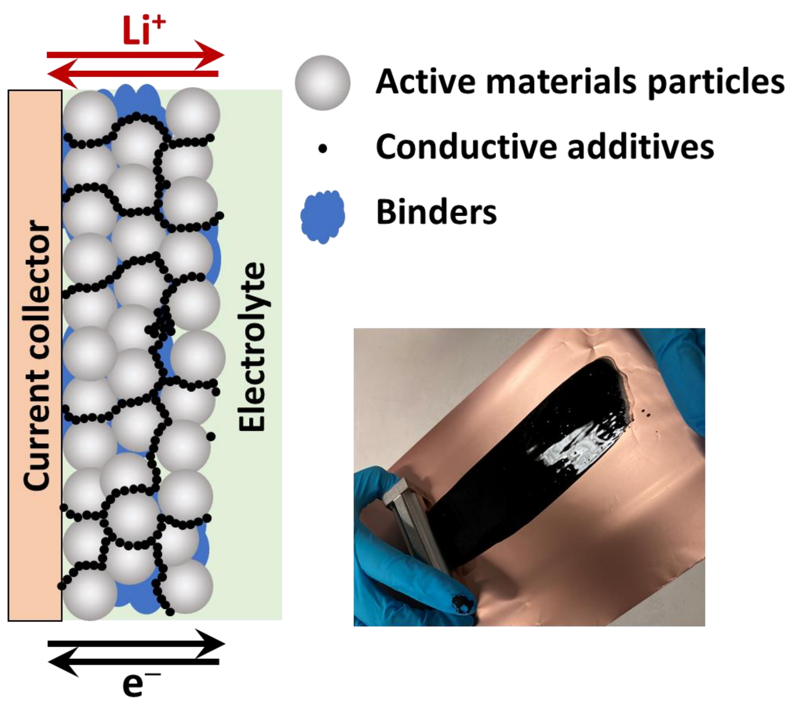
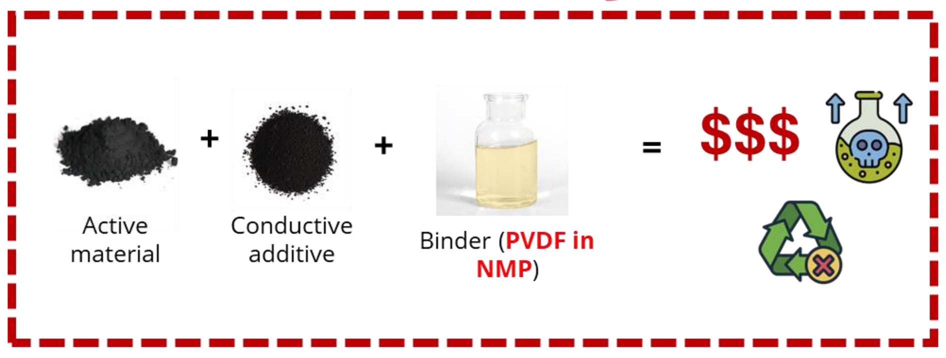
Context

Global battery market growing significantly, will exceed 130 G€ in 2025.
⇒ **Strong need of sustainable systems to not become another environmental issue.**

Develop eco-friendly anodes for Li-ion batteries by using **water-based formulation** (*remove the use of PVDF/NMP*).
⇒ **Make active materials and conductive additives powders water-compatible.**



Currently



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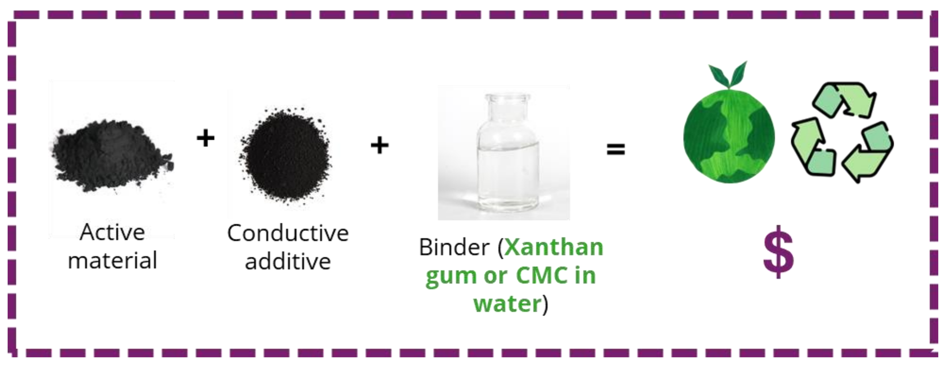


Anode active materials used

TiO_2 powders from TioTech

- Custom-made for integration in Li-ion batteries
- Outcompete LTO on cost, capacity and sustainability
- Enable safer batteries, more robust towards low and high temperatures, faster charging and longer lifetime
- Suffer from poor electrical conductivity, leading to high internal resistance and poor rate capability

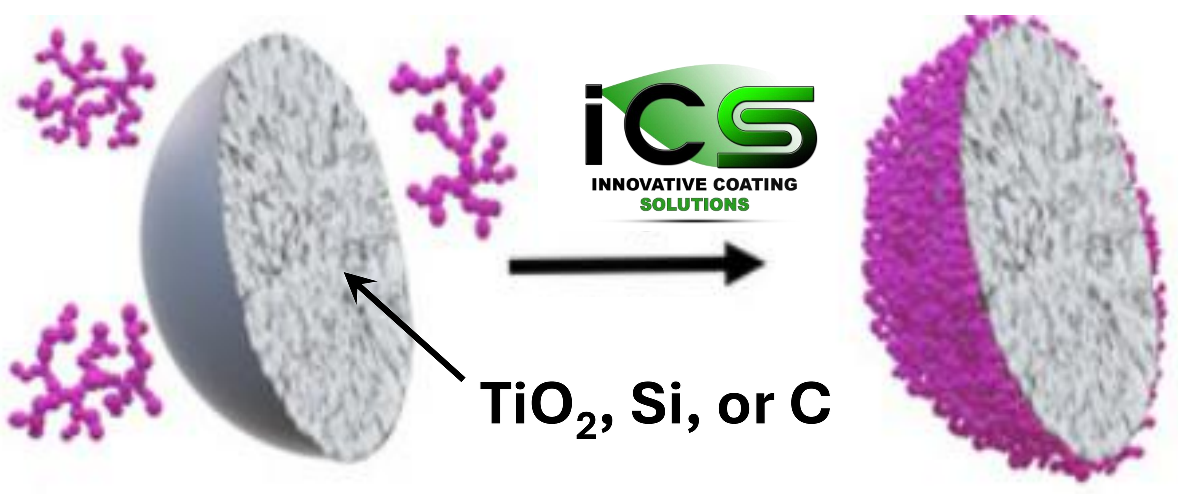
Si powders from Ferroglobe

- Exceptionally high theoretical capacity (~3579 mAh/g), nearly 10 times that of conventional graphite
- Abundant and low cost
- High potential for Next-Generation Batteries
- Suffer from poor conductivity and huge volume variation (up to 300%) during lithiation/delithiation, leading to unstable SEI layer and poor cycling stability

Carbon black from Imerys and CNTs from Nanocyl

- Aggregation issues and poor dispersion in aqueous systems

Strategy



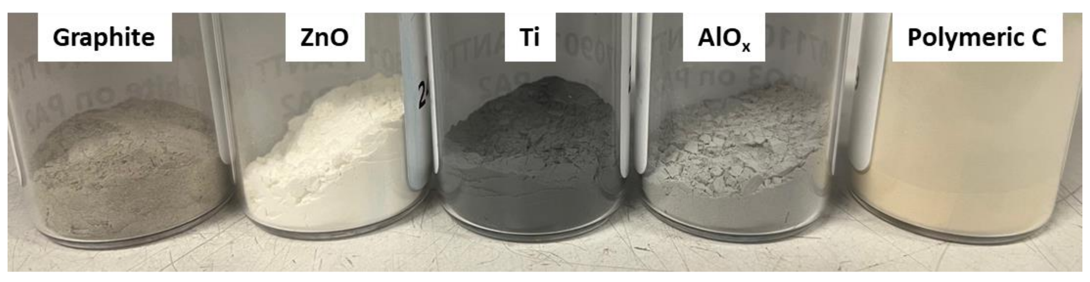
Expected benefits

- Passivation (reduced reactivity towards electrolytes and other components) (Si, TiO_2)
- Increased conductivity (Si, TiO_2)
- Improved dispersibility (All)
- Reduced moisture uptake (TiO_2)
- Limited volume expansion (Si)
- Improved homogeneity of coatings

Use of ICS plasma technology to modify the surface of powders

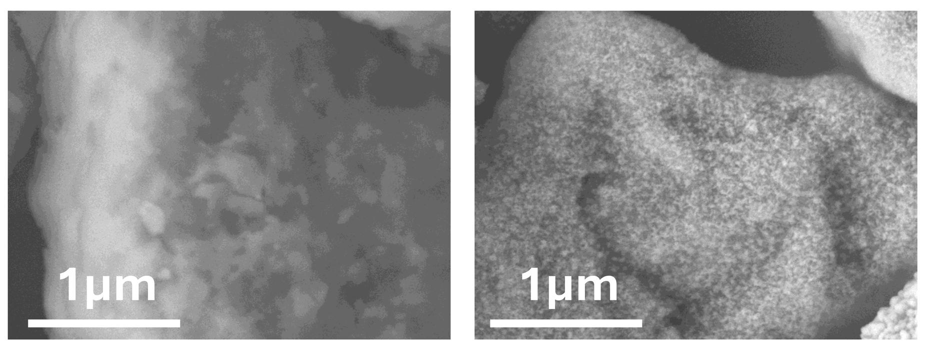
- One-step process
- No liquid by-product, little waste
- Easily scalable process

Extensive choice of coatings



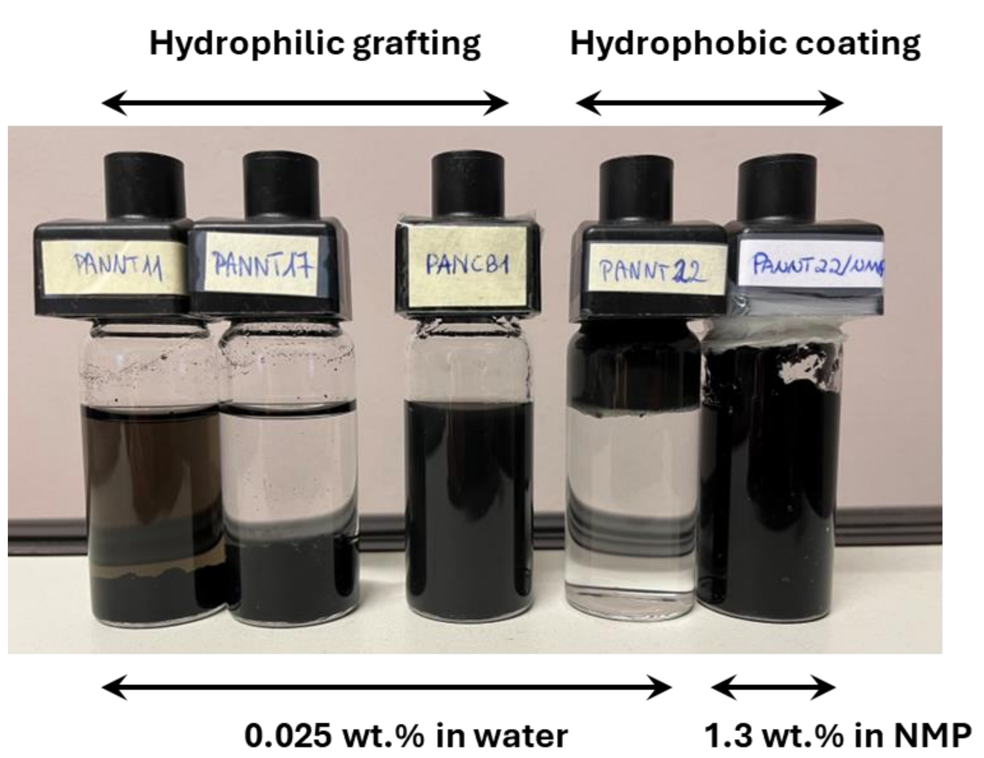
TiO_2 powders coated with different materials

Fine tuning of surface properties

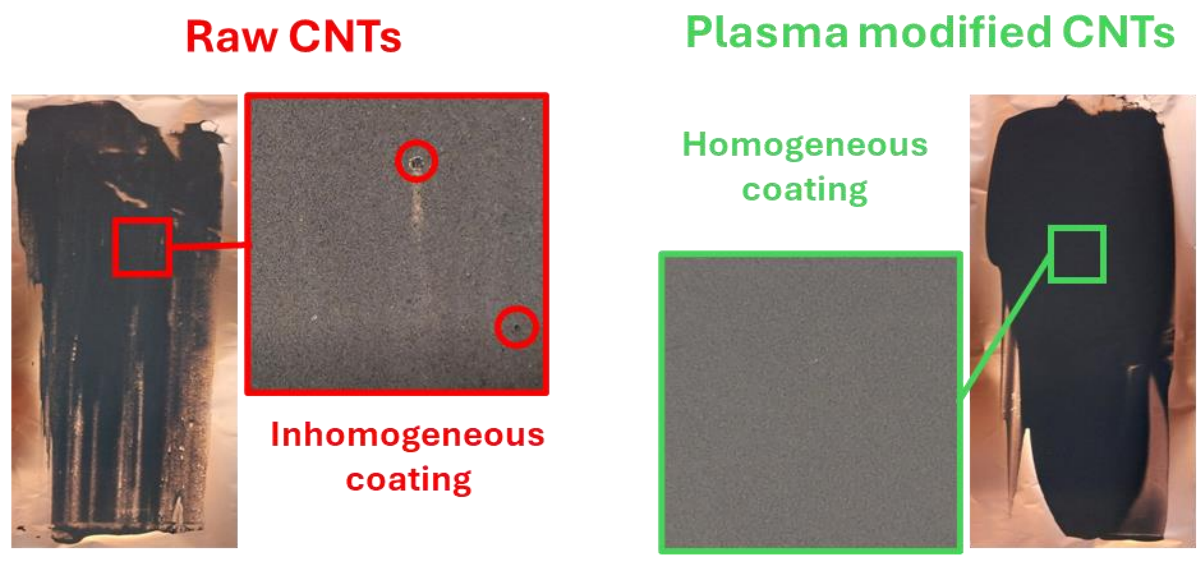


SEM pictures of TiO_2 powder surface before (left) and after (right) metal-doped carbon coating

Key results



Pictures of both treated and untreated CNTs dispersed in water and NMP



Pictures of water-based electrodes prepared by blade casting using raw and plasma modified CNTs

- **Easy integration of TiO_2 powders into aqueous slurry.**
- **High capacities in coin cell batteries (0.1 C = 238 mAh/g) for plasma modified TiO_2 powders.**
- **Slight beneficial impact of plasma coating on cell longevity for electrodes made with nano Si powders (80% of initial capacity being kept up to 110 cycles (vs. 92 cycles for the pristine sample)).**
- **Much better water-based slurry homogeneity obtained with modified carbon black and CNTs**
- **Further studies needed to better evaluate the influence of the coatings on battery performance.**

Acknowledgements

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