Upscaling of Thin Film Coating Technologies for Energy Storage Applications: Some Case Studies

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Glass Coating Plant

Topcoat
Dielectric n°3
Barrier n°2
Ag n°2
Underlayer n°2
Dielectric n°2
Barrier n°1
Ag n°1
Underlayer n°1
Dielectric n°1
Glass

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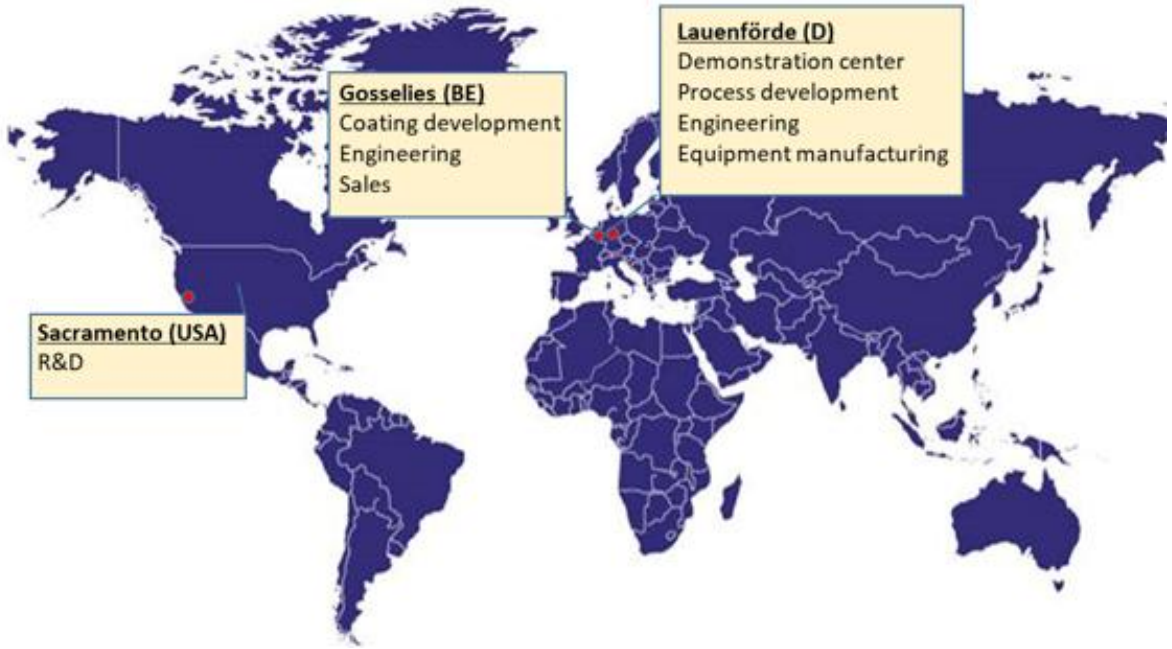
Bringing AGC's know-how in vacuum coating technology to a broad spectrum of industries outside the glass world



Leveraging on AGC's experience in:

1. Operational management of magnetron sputtering lines
2. Coating development
3. Developing new plasma technologies
4. In-house engineering and manufacturing of equipment

Services provided by AGC Plasma:

1. Product development & prototyping
2. Process development and optimization
3. Turnkey projects (Engineering, Construction, Commissioning)

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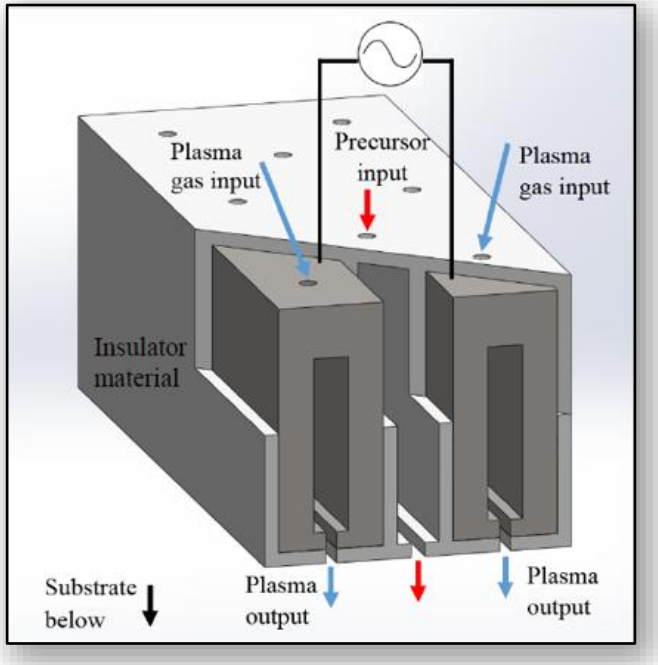
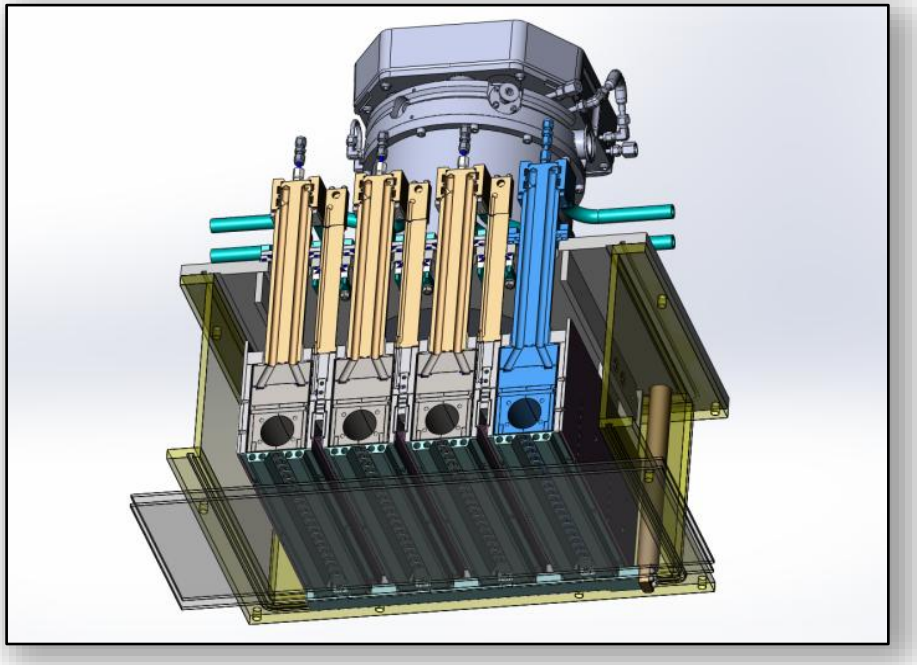
Case Study 1: Silicon Anode Synthesis via PECVD

Silicon Anode Synthesis
Working Principle PECVD





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Silicon Anode Synthesis
PECVD Integrated into Roll-to-Roll Coater

AGC Glass Europe

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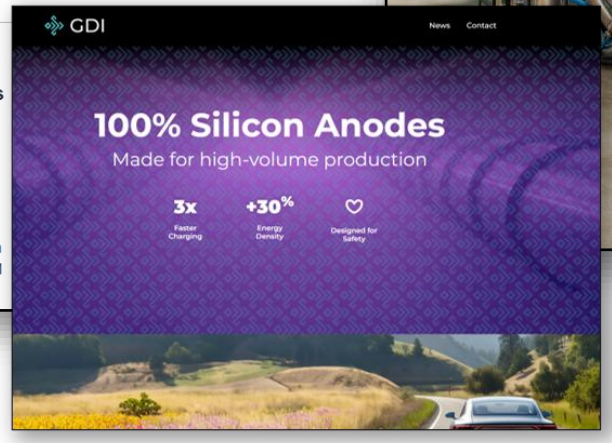
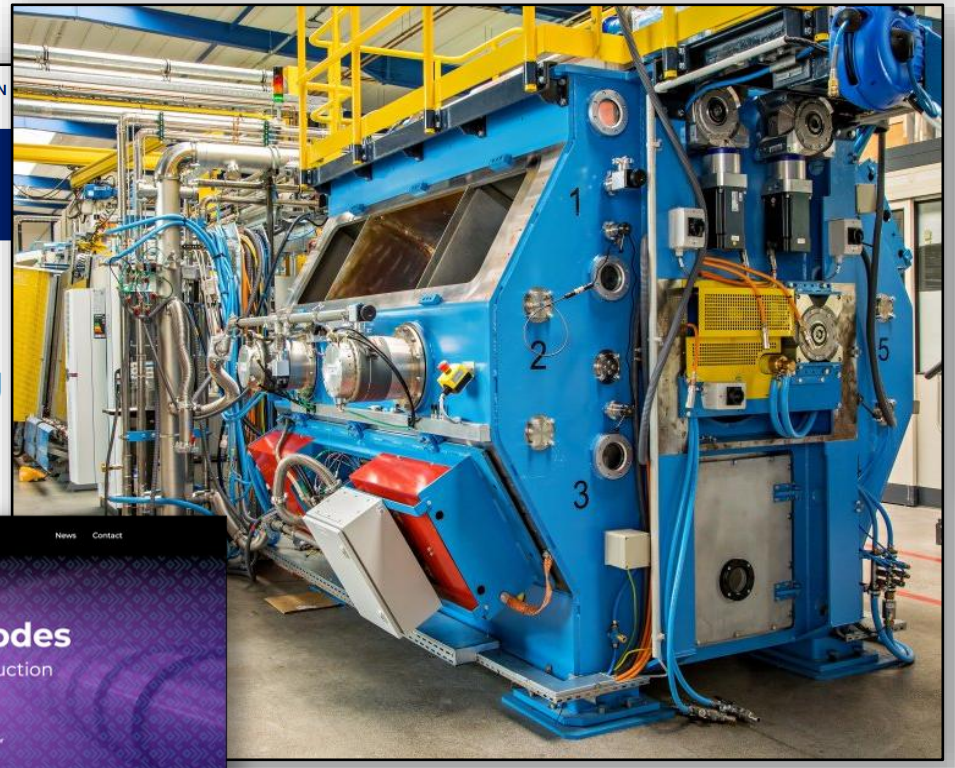
GDI, AGC Glass Europe and Carl Schlenk sign MoU starting the first industry alliance in Silicon Battery Anode Manufacturing and Supply

On 29 September 2022, GDI, manufacturer of 100% silicon anodes, AGC Glass Europe (AGC), a world leader in flat glass for the automotive, solar, and high-tech industries, and Carl Schlenk A.G. (Schlenk), a German-based leading international manufacturer of metal powders, pigments, and foils for a wide variety of industries, signed a Memorandum of Understanding (MoU) to take the lead in the market with an Advanced Silicon Anode Alliance.

Over the next decade, AGC and Schlenk will work in close collaboration with GDI to provide technology, raw materials, know-how, and services required for the alliance to grow production of GDI's 100% silicon anode to industrial scale with the goal of achieving 100 MWh of anode production capacity in 2026 and 1 GWh in 2029.





As fabricated double-sided Si-anode

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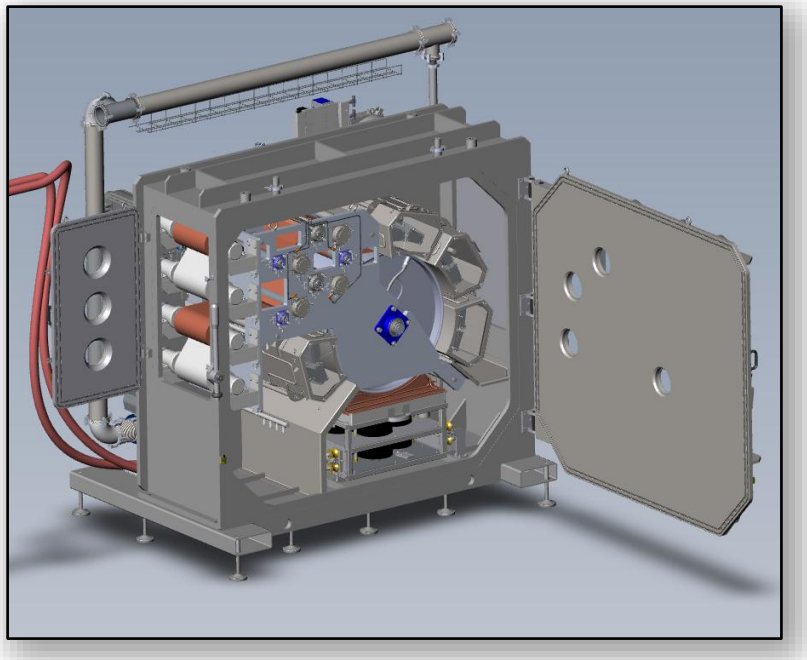
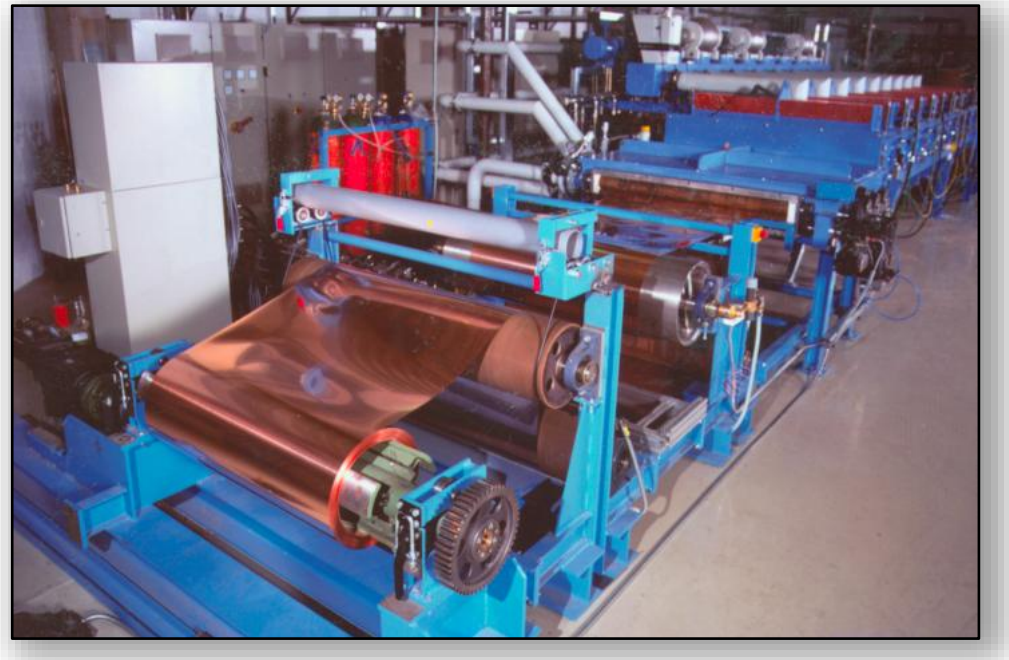
Case Study 2: Lithium Metal Anode Thermal Evaporation

ABEE
AVESTA BATTERY & ENERGY ENGINEERING





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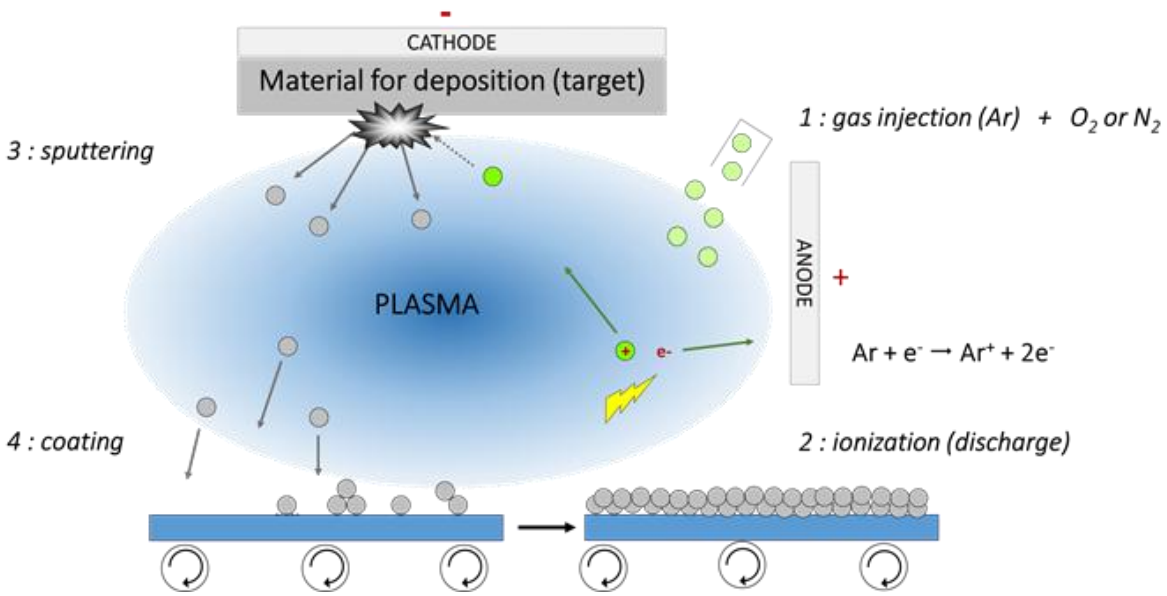
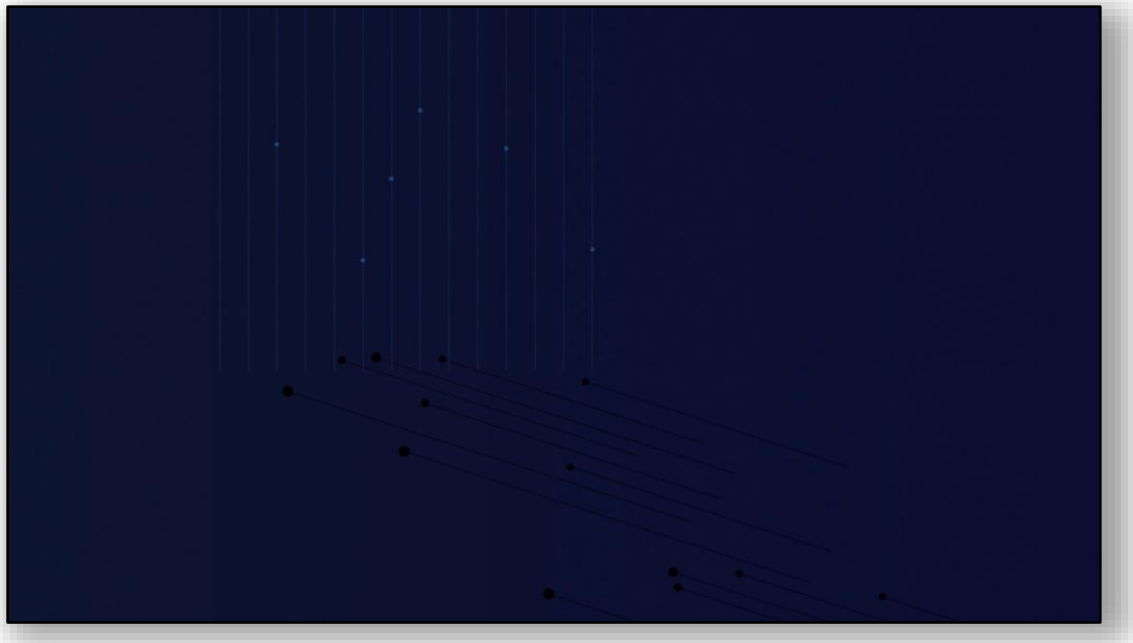
Case Study 3: Magnetron Sputtering of Solid Electrolyte and Cathode





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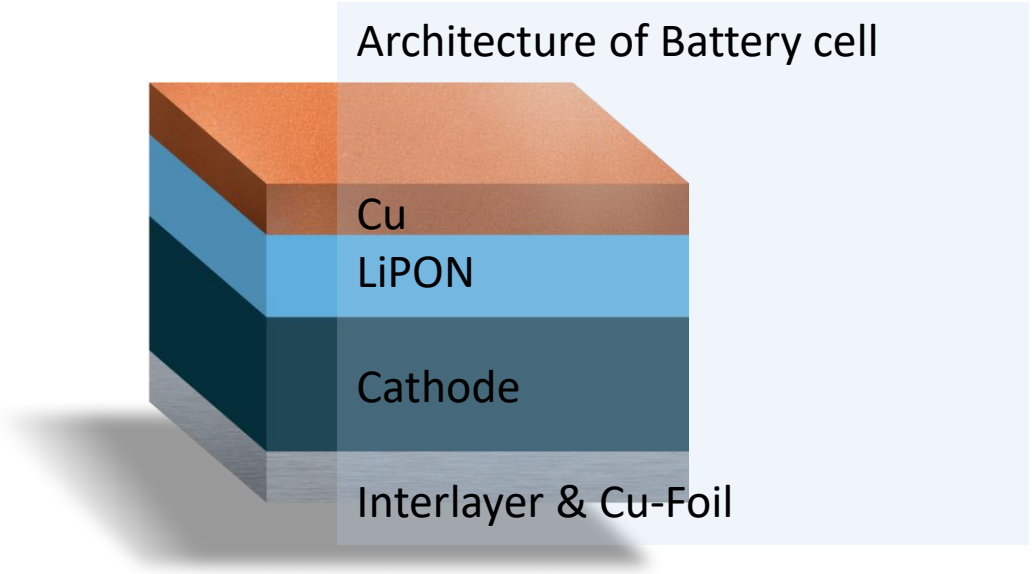
Case Study 3: Magnetron Sputtering of Solid Electrolyte and Cathode

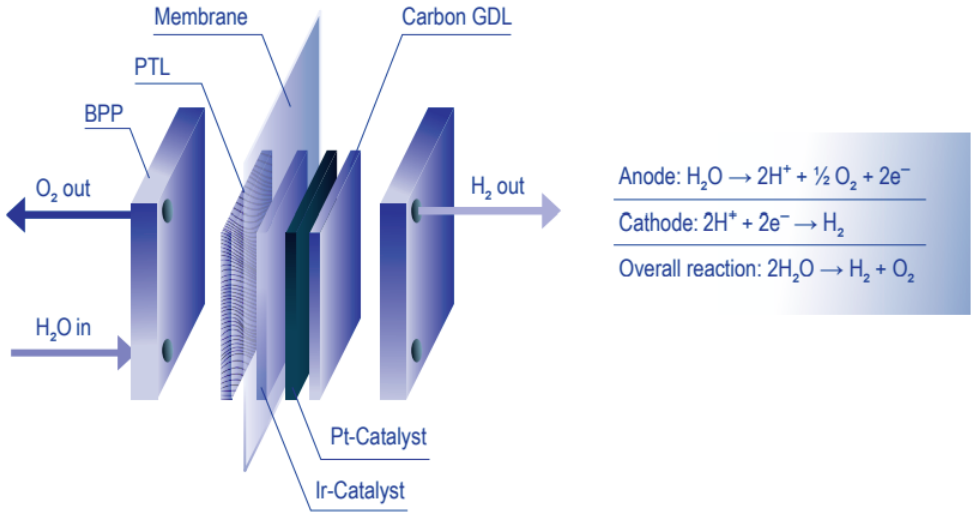


- BTRY uses **magnetron sputtering** to deposit **LiPON electrolyte and cathode**.

- **Sputtering insulating materials** like LiPON is challenging and usually need RF sputtering, which is not ideal for mass production. BTRY's technical approach solved this challenge

- AGC supports BTRY by enabling **DC sputtering with a doped LiPON target**, restoring insulation during reactive sputtering.

Case Study 4: Magnetron Sputtering
Platinum for Porous Transport Layers of PEM electrolyzers



- **Cost-effective platinum coatings** via magnetron sputtering: Reduces precious metal usage by enabling ultra-thin, uniform layers on Porous Transport Layers and Bipolar Plates—cutting material costs compared to traditional wet-chemical methods

- **Good adhesion** with plasma pre-cleaning & undercoat: Ensures durable platinum attachment that enhances corrosion, oxidation resistance, and electrical performance in harsh electrolyzer environments

- **Scalable, eco-friendly PVD process**: AGC's modular sputtering equipment (R&D to high-volume) uses no hazardous chemicals, offers reproducible uniform coatings via iOSMB technology, and supports vertical cathode setups to minimize particle contamination

Conclusions

Thin film coating technology is a proven industrial process.

Potential applications in battery & hydrogen manufacturing include:

1. **Silicon Anodes:** PECVD process to convert silane gas into amorphous silicon

2. **Lithium Deposition:** Thermal evaporation offers a cleaner, more efficient alternative to lithium foil lamination and allows the integration of a protective top layer in a single step.

3. **Solid Electrolyte:** Sputtering technology can deposit electrical insulating materials

4. **Pt protective coating on PTL**: Sputtering of dense thin layers of noble metals as an alternative to electrochemical deposition

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