

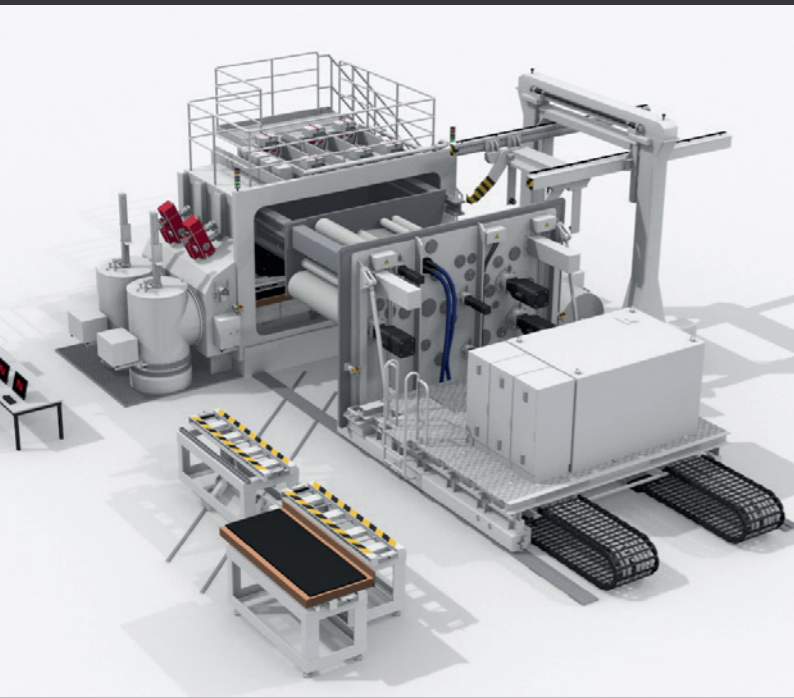
VON ARDENNE 

FUNCTIONAL COATINGS FOR LITHIUM-ION BATTERIES

FUNCTIONAL COATINGS FOR LITHIUM-ION BATTERIES

ADVANCING BATTERY CELL PERFORMANCE

Who We Are & What We Offer



VON ARDENNE develops and manufactures industrial equipment for vacuum coatings on materials such as glass, wafers, metal strip and polymer films.

By using our in-depth expertise in applying thin films, we have identified different approaches along the production chain of lithium-ion batteries to improve their performance and cost-efficiency by functionalizing cell component surfaces.

Additionally, our novel technologies open promising paths to circumvent existing challenges and enable alternative production processes for the next-generation of lithium-ion batteries.

Our Competence

- ... High-throughput PVD coating of substrates with inorganic materials (electron beam & sputtering, roll-to-roll or sheet-to-sheet)
- ... Plasma pre-treatment for surface activation, cleaning and removing of native oxide
- ... Designing and manufacturing equipment for R&D, pilot and high-volume production

Our Offer

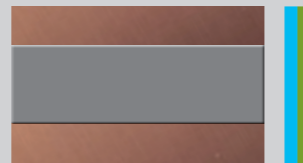
- ... Discussion of your coating requirements, assessment of manufacturability
- ... Adaptation or development of coating system concept
- ... Cost of ownership calculation
- ... Proof of principle tests
- ... Sheet-to-sheet (S2S) and roll-to-roll (R2R) sample coating
- ... Equipment that is ideal for your requirements

Your Contact

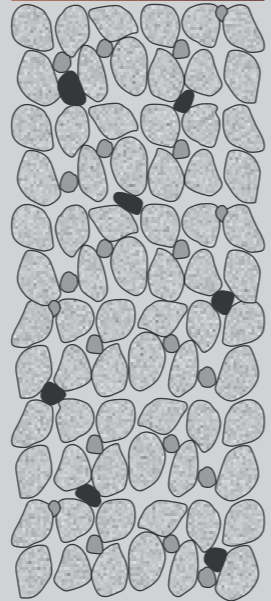
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PVD Applications for Lithium-Ion Battery Cells

Metal-Polymer Current Collectors



Prelithiation of Graphite/Si-Anode

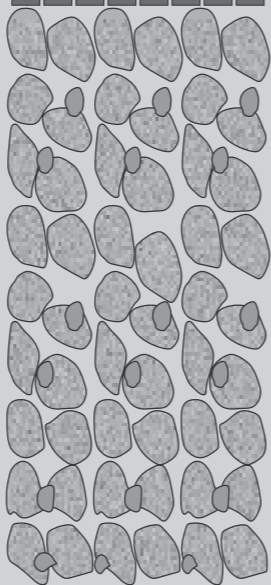


Next-Generation Anode Materials

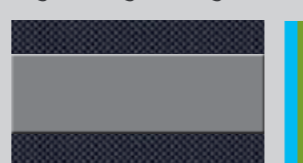
Coating of Separator / Solid Electrolyte



Electrode Surface Coating



Coating on Metal Current Collectors



Functional Coatings

For Lithium-Ion Batteries

Metalized polymer film for current collectors

FEATURES

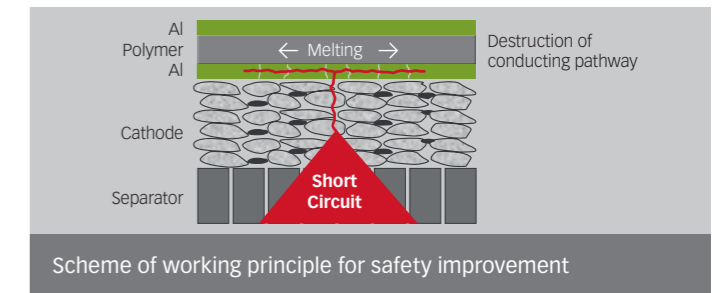
- ... Metal layer with thickness up to 2 μm and sheet resistance $\leq 50 \text{ m}\Omega/\square$
- ... Polymer substrate with thicknesses $\leq 6 \mu\text{m}$ and widths up to 2400 mm
- ... Good adhesion, homogeneous, virtually pinhole-free



Polymer film R2R-coated with aluminum (left) and copper (right)

BENEFITS

- ... Thermal runaway is avoided
- ... Increased productivity per electrode coating line
- ... Reduced weight and thickness compared to metal foils

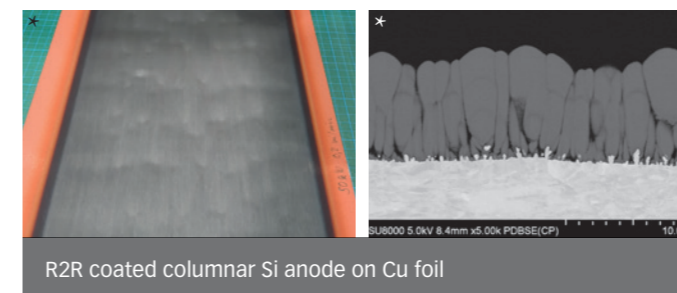


Scheme of working principle for safety improvement

Columnar silicon anodes

FEATURES

- ... 100 % binder-free pure silicon
- ... Excellent adhesion by anchoring effect
- ... Intrinsic porosity to compensate volume expansion



R2R coated columnar Si anode on Cu foil

BENEFITS

- ... Energy density of $\geq 1.000 \text{ Wh/l}$
- ... Rate capability of $\sim 86\%$ at 3C
- ... Initial efficiency above 93 %



	NMC/C	NMC/Si
Initial efficiency	88.2 %	93.8 %
Energy density	466 Wh/l	998 Wh/l
Capacity at 3C	2.3 Ah	2.5 Ah
Cycle at 80 % capacity	525	68

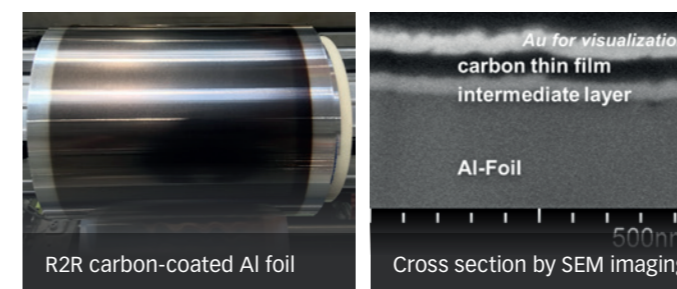
*The results have been achieved in cooperation with Fraunhofer FEP and Fraunhofer IWS through the BMBF-funded project "ProSiSt" (FKZ 03XP0130A). For R&D requests, please contact: Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology (FEP), Winterbergstrasse 28, 01277 Dresden, Germany. Mr. Claus Luber, E-mail: claus.luber@fep.fraunhofer.de, phone: +49 (0) 351 2586 123



Carbon-coated metal foils for current collectors – XPRIME®

FEATURES

- ... Homogeneous, dense, binder-free, ultra-thin, non-particulate
- ... Reduced contact resistance between current collector and active material
- ... Customized layer system depending on application
- ... XPRIME® is a VON ARDENNE development and protected by patent

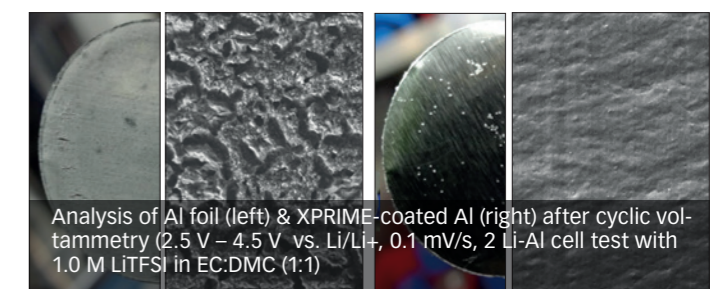


R2R carbon-coated Al foil

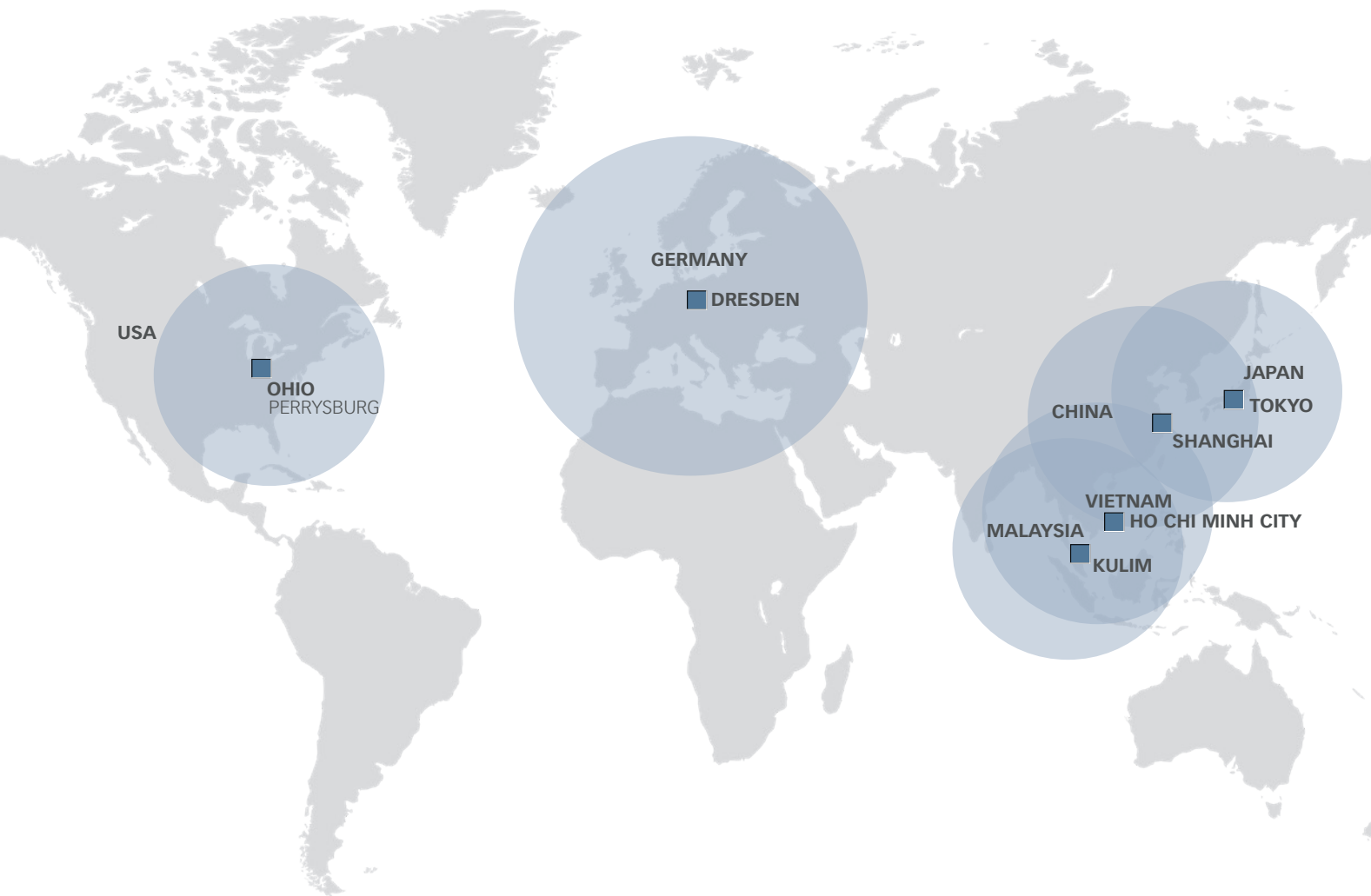
Cross section by SEM imaging

BENEFITS

- ... Passivation of metal foil, e.g. avoiding the corrosion in water based electrode manufacturing or cells with alternative electrolytes
- ... Introducing new functionalities, e.g. smooth lithium-metal deposition in anode free cells



Analysis of Al foil (left) & XPRIME-coated Al (right) after cyclic voltammetry (2.5 V – 4.5 V vs. Li/Li+, 0.1 mV/s, 2 Li-Al cell test with 1.0 M LiFSI in EC:DMC (1:1))



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COMPONENTS



www.vonardenne.biz

WHO WE ARE & WHAT WE DO

VON ARDENNE develops and manufactures industrial equipment for vacuum coatings on materials such as glass, wafers, metal strip and polymer films. These coatings give the surfaces new functional properties and can be between one nanometer and a few micrometers thin, depending on the application.

Our customers use these materials to make high-quality products such as architectural glass, displays for smartphones and touchscreens, solar modules and heat protection window film for automotive glass.

We supply our customers with technologically sophisticated vacuum coating systems, extensive expertise and global service. The key components are developed and manufactured by VON ARDENNE itself.

Systems and components made by VON ARDENNE make a valuable contribution to protecting the environment. They are vital for manufacturing products which help to use less energy or to generate energy from renewable resources.



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