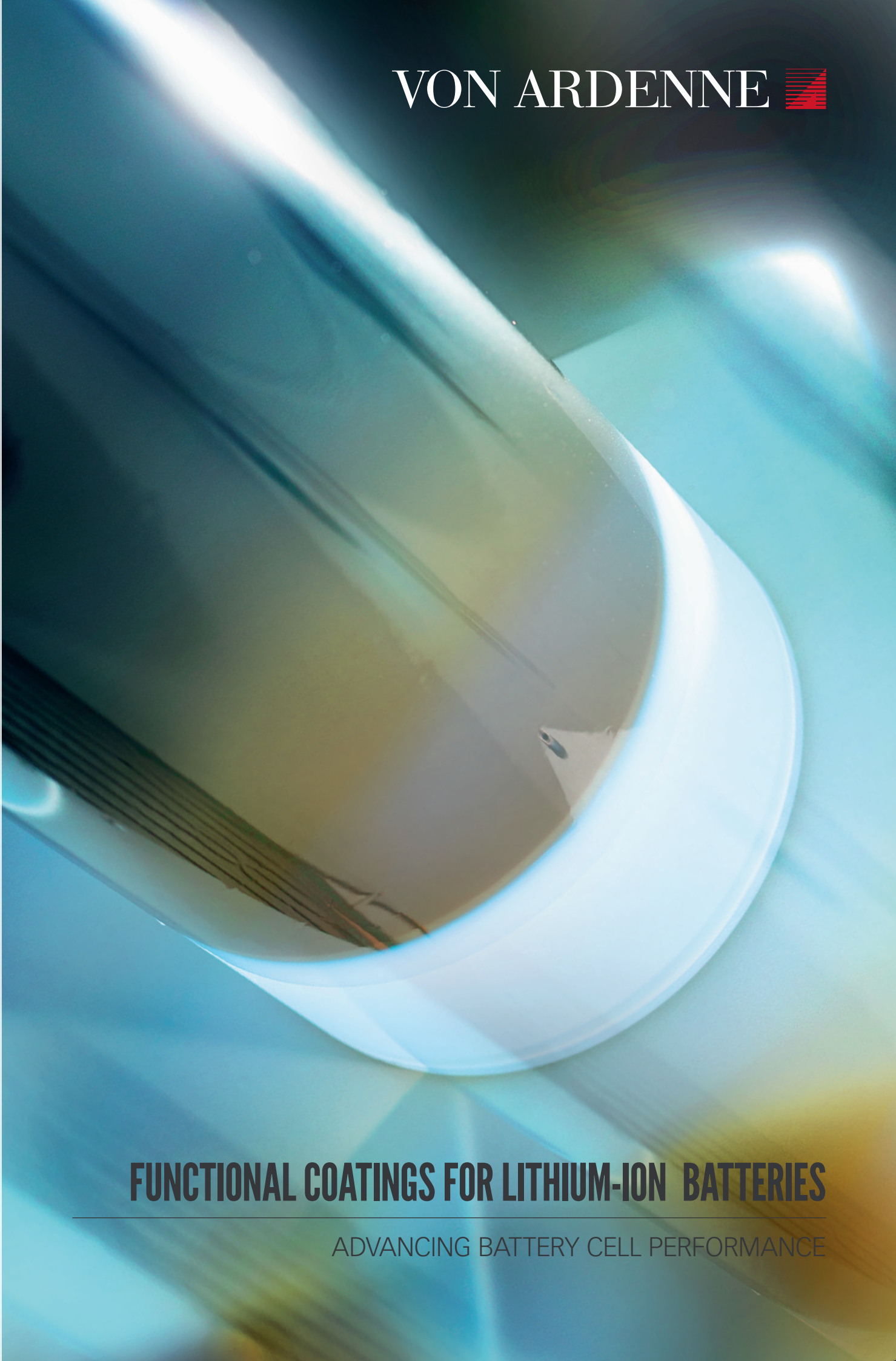
VON ARDENNE

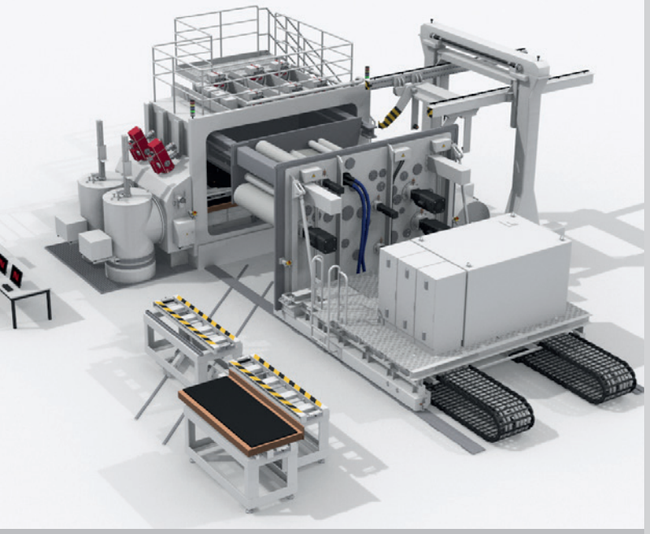


FUNCTIONAL COATINGS FOR LITHIUM-ION BATTERIES

ADVANCING BATTERY CELL PERFORMANCE

FUNCTIONAL COATINGS FOR LITHIUM-ION BATTERIES

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

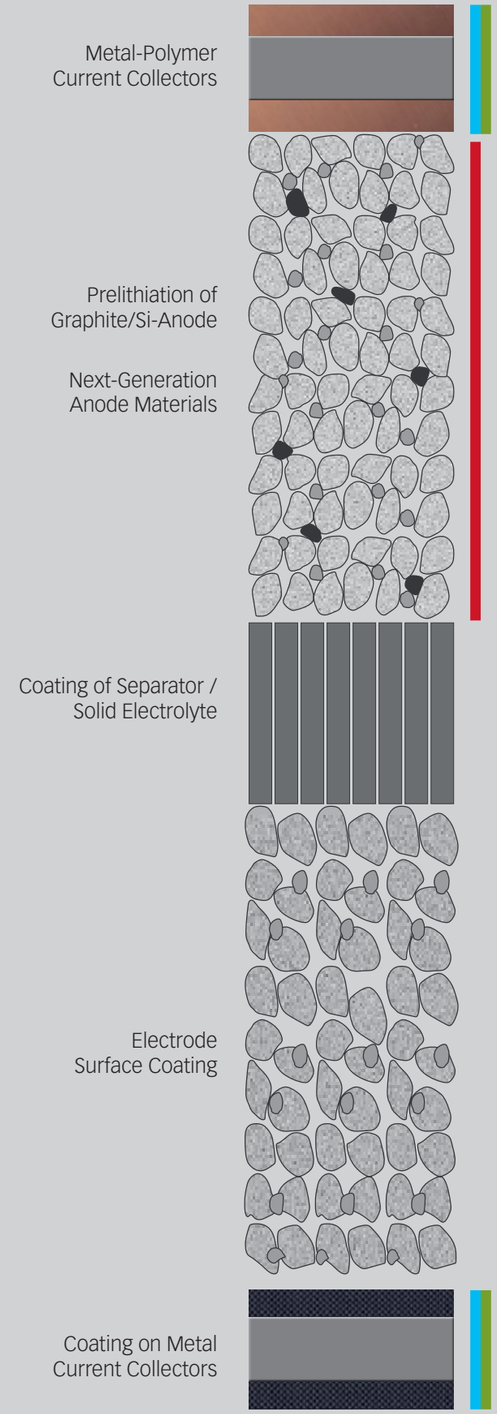
Our Offer

- 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

E-mail: battery@vonardenne.biz
Phone: +49 351 2637 300

PVD Applications for Lithium-Ion Battery Cells



Functional Coatings

For Lithium-Ion Batteries

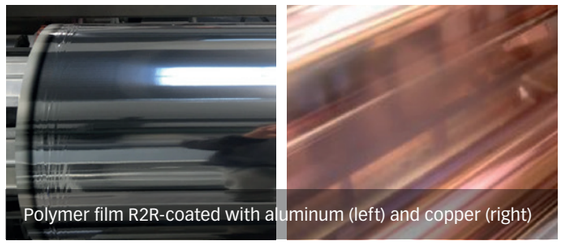
Metalized polymer film for current collectors

FEATURES

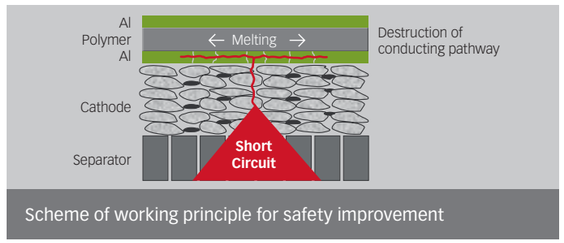
- Metal layer with thickness up to 2 µm and sheet resistance ≤ 50 mΩ□
- Polymer substrate with thicknesses ≤ 6 µm and widths up to 2400 mm
- Good adhesion, homogeneous, virtually pinhole-free

BENEFITS

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



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



Scheme of working principle for safety improvement

Columnar silicon anodes

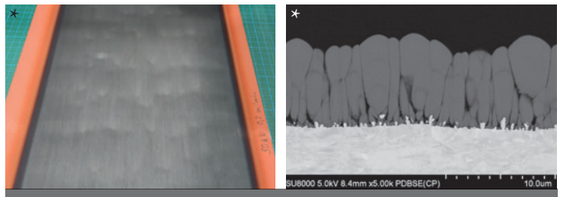
SPONSORED BY THE
Federal Ministry of Education and Research
Fraunhofer IWS
Fraunhofer FEP

FEATURES

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

BENEFITS

- Energy density of ≥ 1.000 Wh/
- Rate capability of ~86 % at 3C
- Initial efficiency above 93 %



R2R coated columnar Si anode on Cu foil

	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*

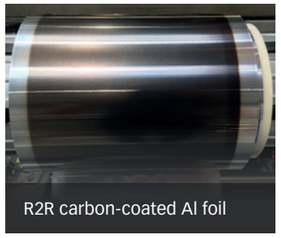
Carbon-coated metal foils for current collectors – XPRIME®

FEATURES

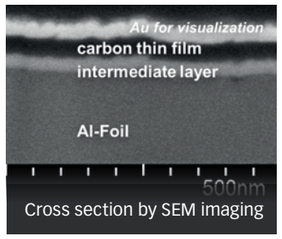
- Homogeneous, dense, binder-free, ultra-thin, non-particulate
- Reduced contact resistance between current collector and active material
- Customized layer system depending on application
- XPRIME® is a VON ARDENNE development and protected by patent

BENEFITS

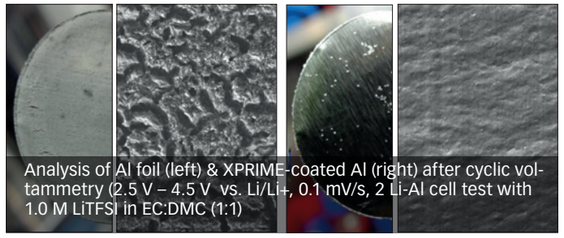
- Passivation of metall foil, e.g. avoiding the corrosion in water based electrode manufacturing or cells with alternative electrolytes
- Introducing new functionialities, e.g. smooth lithium-metal depositi-on in anode free cells



R2R carbon-coated Al foil



Cross section by SEM imaging



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 LiTFSI in EC:DMC (1:1)

OUR STRENGTHS

In-House Technology & Application Center

- Sample coatings of customer applications
- Development of customized layer stacks
- Product & process verification and optimization
- Testing of new technologies and components

Professional Simulation Support

We offer professional simulation technology to ensure best process quality with regards to plasma, heat and cooling. Furthermore, our simulation tools help demonstrate, develop and improve layer properties and define or optimize processes, details and the performance of our systems.

Close Partnership

VON ARDENNE has a network of partners for even more profound R&D work and to identify future technologies. It consists of:

- Fraunhofer Institutes
- Institutes of the Helmholtz Association
- Universities
- Companies

Global Project Experience

VON ARDENNE equipment is used in over 50 countries. We have established an installed base of hundreds of coating systems worldwide, ranging from small tools to equipment for large-area coating applications for several markets.

Comprehensive Service Portfolio

- VON ARDENNE service hubs around the world
- On-site service
- Remote access by our technology department
- Regular technical and technological trainings
- Spare & wear part warehouse close to customers
- Lifecycle extension of wear parts

Upgrades & Retrofits

As soon as your business is growing, your VON ARDENNE equipment will grow accordingly - thanks to its modular design and the upgrades we provide. We will also supply you with the necessary technology upgrades if you decide to change your applications.
Furthermore, when your equipment is ageing, we will retrofit your systems with new components, no matter if they are VON ARDENNE or third-party machines.

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.

WORLDWIDE SALES AND SERVICE

VON ARDENNE GmbH (headquarters) I Am Hahnweg 8 I 01328 DRESDEN I GERMANY
Sales: +49 (0) 351 2637 189 I sales@vonardenne.com
Service: +49 (0) 351 2637 9400 I support@vonardenne.com
VON ARDENNE Vacuum Equipment (Shanghai) Co., Ltd. I +86 21 3769 0555 I sales-vave@vonardenne.com; support-vave@vonardenne.com
VON ARDENNE Malaysia Sdn. Bhd. I +60 4408 0080 I sales-vama@vonardenne.com; support-vama@vonardenne.com
VON ARDENNE North America, Inc. I Ohio office I +1 419 386 2789 I sales-vana@vonardenne.com; support-vana@vonardenne.com
VON ARDENNE Vietnam Co., Ltd. I +84 28 6272 3189 I sales-vavn@vonardenne.com; support-vavn@vonardenne.com
VON ARDENNE India Pvt. Ltd. I sales-vaid@vonardenne.com; support-vaid@vonardenne.com

Company | Career | Applications | Products | Service