COATING SYSTEMS FOR APPLICATIONS ON GLASS

ARCHITECTURAL GLASS
SMART GLASS
FLEXIBLE GLASS
AUTOMOTIVE GLASS
VON ARDENNE has a long tradition in glass coating. In 1955, the Manfred von Ardenne Research Institute was established in Dresden. This institute achieved a leading position in electron beam and plasma technologies and their application in vacuum coating. Many times, the institute paved the way for large-area production and the development of highly productive production processes and systems offered by VON ARDENNE today.

In 1974, we have started to establish our expertise in magnetron sputtering. Since then, we have become a worldwide leading company in magnetron sputtering. We owe this success to our more than 40 years of expertise in mastering and further developing the technology, the equipment and the components.

Our expertise in magnetron sputtering continues to grow and is constantly being incorporated into the development of layer stacks and the corresponding deposition processes. This ensures excellent layer properties. It is vital that the coatings are impeccable, especially for modern architecture with large glass façades.

Another important milestone was the first inline sputter system in 1983 for continuous coating of precious metal-free mirrors for the furniture industry. The success of the project mainly depended on the newly developed large-area planar magnetron. The system was the predecessor of the equipment used for the production of heat-insulating architectural glass today.

In 1993, the planar dual magnetron was used for the first time for architectural glass coating in an upgrade project. The breakthrough came in 1996 with the first inline coater for jumbo formats (0.21 m x 6.60 m).

In the field of process control, VON ARDENNE was among the first to offer a plasma emission monitor that allows optical process control in an industrial environment. Many of our customers have first applied the first-generation PENOS, then the VAPROCCO2 process control system to enable transition mode sputtering from planar and rotatable targets.

We have also established an alternative integrated solution for optical measurement: the ExSitu measuring system. Furthermore, we have successfully launched our “online trimming & shimmering service”, which allows customers to adjust the coating uniformity of single magnetrons based on the ExSitu measurement data of single layers and predict the best glass trim and magnet bar shimmering. This calculation saves a lot of time compared to the previous trial and error approach used for the optimization of magnetron uniformity.

In 2016, we developed and built the prototype of our roll-to-roll vacuum coating system that is optimized for the processing of flexible glass. Flexible glass is a relatively new substrate material with a unique combination of properties. It is available in rolls and is ideally suited for applications such as flexible electronics, flexible photovoltaics and flexible displays.

Today, VON ARDENNE has established itself as a vital supplier for the vacuum coating industry for more than 40 years. We offer a portfolio of solutions covering many applications, especially for flat substrates and large coating areas and are a leading provider, not only of equipment, but also of process technology.
OUR STRENGTHS - A UNIQUE COMBINATION of process, technology & engineering expertise

PROCESS COMPONENTS
Planar or rotatable magnetrons with single or dual cathodes - designed and manufactured by VON ARDENNE
T-series Magnetrons - the combination of sputtering and pumping in one component
High-utilization WSM - excellent uniformity and target lifetime for very long coating campaigns
In-house manufactured end blocks, magnet bars and magnet systems
In-situ and ex-situ quality control equipment with exceptional performance and features
Flash lamp annealing systems that feature the longest tubes in the world
All components are tested in our in-house vacuum test chambers.

PROCESS TECHNOLOGY
More than 40 years of experience in vacuum coating technologies
Industry-leading application know-how for Low-E, TCO and many other coating products
In-house developed sputtering hardware & customized solutions
Advanced process control systems based on optical measurement, process simulation and feedback control
Ground-breaking anode solutions such as the Dual Anode System (DAS) for minimum substrate heat load
Technology & Application Center with state-of-the-art sampling & testing facilities

SYSTEMS ENGINEERING
Proven machine platforms developed & improved during decades
Innovative machine solutions for new applications and substrates such as flexible glass
Expertise in transport design for rigid and flexible substrates of different thicknesses
Substrate heating and cooling systems for optimized process control
Sophisticated upgrade and retrofit engineering for VON ARDENNE systems and legacy equipment

PROVEN MAGNETRON TECHNOLOGY
The main technology used for coating on VON ARDENNE equipment is magnetron sputtering. We develop and manufacture the necessary components such as magnetron sputtering sources in-house and have more than 40 years of experience with magnetron sputtering.

VON ARDENNE MAGNETRONS
VON ARDENNE magnetrons are available for a wide range of applications. Thanks to many years of experience gained from designing and installing advanced sputtering equipment, we can offer a complete portfolio of solutions from RF and AC to DC processes, planar to rotatable applications and even magnetrons with integrated turbopumps such as the RDM.

CORE TECHNOLOGY BASED ON A LONG TRADITION
industry-proven, reliable and advanced sputtering technology

1974 - First ring gap discharge at von Ardenne Research Institute

SSM Magnetrons
WSM Magnetrons
RSM Magnetrons
RDM Magnetrons

DUAL ANODE SPUTTERING
Dual Anode Sputtering (DAS) is an industrially proven coating technology. It can be applied for highly resistive target materials such as intrinsic tin oxide (i-ZnO). The DAS method guarantees a good availability of the anode as it is cleaned periodically, even when dielectrics are sputtered.

TRIMMING & SHIMMING
A web-based trimming and shimming software is available. It enables the quick optimization of the thickness uniformity of single layers. Upon request, an online adjustable magnet bar can be offered.
ADVANTAGES & BENEFITS OF VON ARDENNE

Glass coating equipment

FLEXIBLE PROCESS COMPARTMENT CONCEPT
The process chambers can be configured individually based on the flexible VON ARDENNE compartment system. They have a scalable design and can be configured according to the requirements of our customers. The configuration can be easily changed at any given time in the future, which enables an easy adjustment to changing end-customer needs over the lifetime of the tool. All compartments are identical to provide a maximum of flexibility.

MEASURING SYSTEMS, QUALITY INSPECTION AND TRIMMING & SHIMMING SOFTWARE
IN-SITU MEASUREMENT
Combines the results from different coating steps within the coater and helps monitor the coating process for quality control.

TRIMMING & SHIMMING SOFTWARE
Web-based, enables the quick optimization of the thickness uniformity of single thin layers.

RECORDING OF PROCESS DATA
Our PROCESS DB SQL database records the process data of coating systems 24/7 allowing for detailed data analysis and correlations.

EX-SITU MEASURING SYSTEM
Quality assurance and quality monitoring for coatings on glass.

VAPROCS2 PROCESS CONTROL SYSTEM
Controls the reactive magnetron sputtering of compound layers.

SCALABILITY
VON ARDENNE provides advanced PVD coating equipment, key components and technology expertise for all scales of production, from laboratory tasks to high-volume manufacturing.

Controls the reactive magnetron sputtering of compound layers.

Our laboratory-scale coating systems and pilot production tools use the same key components as our systems for industrial production, however at a smaller scale. Thus, our customers can test their applications under laboratory conditions and save time when they scale their products up to a larger productivity or for mass production.

TRANSPORT SYSTEM
The compact tool design is fitted with a short roller-to-roller distance. This design enables the safe transport of glass sheets as thin as 2 mm without further changes and even 1.6 mm with minor transport system adjustments.

VON ARDENNE glass coaters are especially well suited to cover typical substrates for architectural glass and thin automotive glass at the same time on the same tool.

PROVEN LAYER STACK COMPETENCE
We have more than 40 years of experience with depositing functional layers on large-area glass substrates. This experience is based on more than 50 VON ARDENNE glass coating systems installed all over the world.

Furthermore, we have excellent sampling facilities and simulation software to demonstrate, develop and improve layer properties.

SIMULATION-DRIVEN PRODUCT DEVELOPMENT
Plasma process and magnetic field simulation for excellent film growth, optical simulation for outstanding film properties.

TECHNOLOGY & APPLICATION CENTER
VON ARDENNE owns a wide range of in-house coating tools and offers sampling, developing and testing of customized layer stack solutions.

VERTICAL INLINE SYSTEM
• Heated system
• Plasma pretreatment
• Planar and rotatable magnetrons
• Carrier based substrate transport

Our in-house horizontal inline coating system "Adele"

HORIZONTAL SYSTEM FOR SPITTER-UP PROCESSES
• Heated system
• Plasma pretreatment
• Carrier based substrate transport

HORIZONTAL INLINE COATING SYSTEM
• Inline washing and coating system
• Ex-situ measuring station
• Planar and rotatable magnetrons
• Roller based substrate transport

ADVANCED LAYER SYSTEMS
for Low-E & Solar Control

For more than 50 years, the glass industry has been striving to increase the comfort of buildings, to minimize the transmission of heat into the interior and the heat loss through the windows by means of coated glass. Every since the beginning of the oil crisis in 1973 and the resulting drastic price increase for fossil fuels, energy saving and efficiency have become increasingly important. The development of the corresponding technologies has been accelerated by the growing awareness of the climate change caused by greenhouse gas emissions.

After thermal coating methods such as thermal evaporation had initially dominated in the early years, magnetron sputtering became prevalent in the 1970ies.

In 1974, we have started to establish our expertise in magnetron sputtering. Since then, we have have become a worldwide leading company in magnetron sputtering. We owe this success to our more than 40 years of expertise in mastering and further developing the technology, the equipment and the components.

Our expertise in magnetron sputtering continues to grow and is constantly being incorporated into the development of layer stacks and the corresponding deposition processes. This ensures excellent layer properties. It is vital that the coatings are impeccable, especially for modern architecture with large glass façades.

This is true no matter for what climate zones and requirements the energy efficient glass coatings are needed. Whether it is Solar Control, Single, Double or Triple Low-E coatings, with VON ARDENNE equipment you will achieve your required visible transmittance and infrared reflectance as well as the best optical performance.

Beyond that, a high uniformity is crucial for the quality of the layer systems. VON ARDENNE coating systems easily achieve a thickness uniformity of ±0.8 percent for Triple Low-E layer systems at a maximum long-term stability for an efficient production process. On top of that, the mechanical stability of the layers is excellent, which is an ideal precondition for further processing.
GC330H | GC254H

for architectural glass applications including 100", Jumbo & Super Jumbo

With our GC330H and GC254H glass coating systems, we offer equipment to produce a high-quality product portfolio of architectural glass for all global markets. We have delivered more than 50 of these coating systems to customers all over the world.

We provide our inline systems in customized configurations suitable for all common glass sizes including 100", Jumbo and Super Jumbo format.

VON ARDENNE PROCESS CHAMBERS

The sputtering chamber consists of a customized number of universal compartments with a standard width of 780 mm. All compartments are identical to provide for maximum flexibility.

PROVEN SPUTTERING TECHNOLOGY

The technology used for glass coating on VON ARDENNE equipment is magnetron sputtering:

- High rates, excellent uniformity: By magnetron sputtering, all required layers can be manufactured at high rates and a coating uniformity of ±0.8%.
- Over 40 years of experience: We develop and manufacture the necessary components such as magnetron sputtering sources in-house and have more than 40 years of experience with magnetron sputtering.

**TECHNICAL DATA GC330H**

Subject to change without notice due to technical improvement.

<table>
<thead>
<tr>
<th><strong>SUBSTRATE</strong></th>
<th>Flat glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size Jumbo (W x L), other options possible</td>
<td>3300 x 6000 mm</td>
</tr>
<tr>
<td>Size Super Jumbo (W x L), other options possible</td>
<td>3100 x 7800 mm</td>
</tr>
<tr>
<td>Thickness (including uneveness)</td>
<td>2 mm to 19 mm</td>
</tr>
</tbody>
</table>

**DEPOSITION SYSTEM**

Base pressure in sputtering chamber ≤ 5 x 10^-4 mbar

Cycle time ≤ 28 s

**UTILITY & SUPPLY**

Mains connection 400 VAC, 50 Hz or 480 VAC, 60 Hz

**PLANAR MAGNETRONS WITH EXCEPTIONAL TARGET UTILIZATION AND UNIFORMITY**

VON ARDENNE has developed the PLANAR XT magnetron which features more than 4000 kW target per-time of a 30 mm silver target (Jumbo size) and still delivers best-in-class uniformity at the beginning (< ±1.0%) and the end (< ±1.5%) of target life. The main benefits of this component are longer campaign times without being forced to vent the system due to a lack of silver target stock and the ability to produce complex layers throughout the whole production campaign.

**MEASURING SYSTEMS & QUALITY INSPECTION**

In-Situ Measurement: Combines the results from different coating steps within the coating and helps monitor the coating process for quality control

Recording of process data: Our PROCESSDB SQL data base records the process data of coating systems 24/7 allowing for detailed data analysis and correlations.

Ex-Situ Measuring System: Quality assurance and quality monitoring for coatings on glass

**DEPOSITION SYSTEM**

Deposition type DC, pulsed DC, AC

Magnetron type planar, single or dual rotatable

Sputter arrangement vertical

Substrate temperature range RT / 200 °C / 400 °C

Substrate potential floating

Number of independent process gases up to 4 (Ar, O₂, N₂, X)

**TRANSPORT**

Type of transport inline, carrier-based

Orientation of substrate Tilting 0°/0°/±7° vertical, U/L, R/L

Transport speed ≤ 3.5 m/min

Cycle time ≤ 30 s

**CLEANING OF MAGNETRON CHAMBERS**

Cleaning principle mechanical exchange of shields

Cleaning cycle 7 to 35 days, depending on configuration

The **GC120VCR** is a vertical inline coating system for the deposition of metal and oxide thin-film multilayer systems on flat glass substrates or other materials.

As a leading developer and manufacturer of vacuum coating equipment for large-area applications, VON ARDENNE has incorporated its broad knowledge and expertise in PVD technologies into the **GC120VCR** platform. The reliability of this system is well proven in the PV industry.

**TECHNICAL DATA**

**SUBSTRATE**

Material glass

Dimensions (W x L), max. 1250 mm x 1550 mm (others on request)

Thickness 0.5 mm to 4 mm (others on request)

Pre-treatment linear ion source or plasma glow discharge

**DEPOSITION SYSTEM**

Deposition type DC, pulsed DC, AC

Magnetron type planar, single or dual rotatable

Sputter arrangement vertical

Substrate temperature range RT / 200 °C / 400 °C

Substrate potential floating

Number of independent process gases up to 4 (Ar, O₂, N₂, X)

**TRANSPORT**

Type of transport inline, carrier-based

Orientation of substrate Tilting 0°/0°/±7° vertical, U/L, R/L

Transport speed ≤ 3.5 m/min

Cycle time ≤ 30 s

**CLEANING OF MAGNETRON CHAMBERS**

Cleaning principle mechanical exchange of shields

Cleaning cycle 7 to 35 days, depending on configuration

**SMALL FOOTPRINT**

The **GC120VCR** does not need much floor space and requires fewer maintenance intervals due to its vertical design.

**HIGH YIELD AT LOW DEFECT RATE**

It is also thanks to the vertical orientation that low film defect rates can be achieved during production campaigns. In-situ and Ex-situ optical measurement equipment can be integrated in order to measure film properties in a continuous manner.

**GOOD MAINTAINABILITY**

The optimized machine design enables easy access to the magnetron environment for target exchange and maintenance. Due to its vertical door opening concept, no overhead crane is required to maintain the system.

**UTILITIES & SUPPLY**

Automated substrate loading and unloading on request

Carrier storage racks on request

Phase 3 phases

Voltage 230 V, 400 V, 480 V

Frequency 50 Hz to 60 Hz

Power consumption depending on configuration

Cooling system separate cooling circuit with heat exchanger

Cooling supply primary cooling water supply by customer

Venting medium ambient air, compressed dry air or N₂

Process gases central supply by customer or local by gas cabinet

**SYSTEM CONTROL & SOFTWARE**

Computer hardware PLC, Siemens S7, AB Rockwell

User interface VON ARDENNE user interface according to specifications

**SYSTEM DIMENSIONS**

Total system size (L x W x H) customized × 15 m × 3.7 m

Total system weight customized × 15 m × 3.7 m

depending on configuration

**PROVEN SPUTTERING TECHNOLOGY**

The technology used for glass coating on VON ARDENNE equipment is magnetron sputtering:

- High rates, excellent uniformity: By magnetron sputtering, all required layers can be manufactured at high rates and a coating uniformity of ±0.8%.
- Over 40 years of experience: We develop and manufacture the necessary components such as magnetron sputtering sources in-house and have more than 40 years of experience with magnetron sputtering.

**TECHNICAL DATA GC254H**

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<tr>
<td>Size Super Jumbo (W x L), other options possible</td>
<td>3100 x 7800 mm</td>
</tr>
<tr>
<td>Thickness (including uneveness)</td>
<td>2 mm to 19 mm</td>
</tr>
</tbody>
</table>

**DEPOSITION SYSTEM**

Base pressure in sputtering chamber ≤ 5 x 10^-4 mbar

Cycle time ≤ 18 s

**UTILITY & SUPPLY**

Mains connection 400 VAC, 50 Hz or 480 VAC, 60 Hz

**GC120VCR**

**VERTICAL GLASS COATING SYSTEM**

industry-proven production tool with a small footprint

The **GC120VCR** is a vertical inline coating system for the deposition of metal and oxide thin-film multilayer systems on flat glass substrates or other materials.

As a leading developer and manufacturer of vacuum coating equipment for large-area applications, VON ARDENNE has incorporated its broad knowledge and expertise in PVD technologies into the **GC120VCR** platform. The reliability of this system is well proven in the PV industry.

**TECHNICAL DATA**

**SUBSTRATE**

Material glass

Dimensions (W x L), max. 1250 mm x 1550 mm (others on request)

Thickness 0.5 mm to 4 mm (others on request)

Pre-treatment linear ion source or plasma glow discharge

**DEPOSITION SYSTEM**

Deposition type DC, pulsed DC, AC

Magnetron type planar, single or dual rotatable

Sputter arrangement vertical

Substrate temperature range RT / 200 °C / 400 °C

Substrate potential floating

Number of independent process gases up to 4 (Ar, O₂, N₂, X)

**TRANSPORT**

Type of transport inline, carrier-based

Orientation of substrate Tilting 0°/0°/±7° vertical, U/L, R/L

Transport speed ≤ 3.5 m/min

Cycle time ≤ 30 s

**CLEANING OF MAGNETRON CHAMBERS**

Cleaning principle mechanical exchange of shields

Cleaning cycle 7 to 35 days, depending on configuration

**SMALL FOOTPRINT**

The **GC120VCR** does not need much floor space and requires fewer maintenance intervals due to its vertical design.

**HIGH YIELD AT LOW DEFECT RATE**

It is also thanks to the vertical orientation that low film defect rates can be achieved during production campaigns. In-situ and Ex-situ optical measurement equipment can be integrated in order to measure film properties in a continuous manner.

**GOOD MAINTAINABILITY**

The optimized machine design enables easy access to the magnetron environment for target exchange and maintenance. Due to its vertical door opening concept, no overhead crane is required to maintain the system.
FOSA LabX 330 GLASS
Roll-to-roll vacuum coating system for flexible glass

FOSA MX VACUUM WEB COATING SYSTEM
for flexible electronics & window films

Flexible glass is a relatively new substrate material with a unique combination of properties. It is available in rolls and is ideally suited for applications such as flexible electronics, flexible photovoltaics and flexible displays.

VON ARDENNE has developed the FOSA LabX 330 Glass, a roll-to-roll vacuum coating system optimized for the processing of flexible glass. This system is based on the VON ARDENNE FOSA LabX platform. This is a flexible web coating platform designed for R&D purposes, small-scale production and technology transfer from laboratory to industrial scale.

CONFIGURATION OPTIONS
Thanks to its unique arrangement with 9 process sections, the FOSA LabX can be equipped for many applications on various substrates. You can easily reconfigure the system according to your requirements and your future business.

DEMONSTRATION COATER AVAILABLE IN DRESDEN
VON ARDENNE and Fraunhofer FEP offer access to the prototype of the FOSA LabX 330 Glass to experience R2R flexible glass handling in a PVD vacuum coating system optimized for the processing of flexible glass. This system is based on the VON ARDENNE FOSA LabX platform. This is a flexible web coating platform designed for R&D purposes, small-scale production and technology transfer from laboratory to industrial scale.

OUR EXPERIENCE
- R2R sputter deposition of ITO on flexible glass for OLED applications (15 dyn/cm)
- Practical expertise in roll-to-roll (R2R) handling and coating of flexible glass rolls provided by the main suppliers
- R2R fabrication of flexible OLEDs in R&D coating system in collaboration with Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP
- Development and demonstration of layer stacks on flexible glass: ITO for OLED, AR, ITO/ML for touch screens, AM (insulator metal insulator), others e.g. your layer stack

TECHNICAL DATA
Subject to change without notice due to technical improvement.

<table>
<thead>
<tr>
<th>SUBSTRATE Width</th>
<th>Thickness</th>
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</thead>
<tbody>
<tr>
<td>PET, PE, PI, TAC</td>
<td>300 mm to 1,600 mm</td>
</tr>
<tr>
<td>23 µm to 250 µm</td>
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<tr>
<th>DEPOSITION SYSTEM</th>
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</thead>
<tbody>
<tr>
<td>Deposition type: AC/DC or bipolar power</td>
</tr>
<tr>
<td>Magnetron type: up to 12 planar or rotatable per coating drum</td>
</tr>
<tr>
<td>Single layer uniformity: up to +/- 1.5%</td>
</tr>
<tr>
<td>Process gases: up to 3 per magnetron</td>
</tr>
<tr>
<td>Reactive process control: available, impedance or PEM control</td>
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</tbody>
</table>

<table>
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<tr>
<th>PUMP-DOWN TIMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winding chamber: approx. 30 min</td>
</tr>
<tr>
<td>Process compartment: approx. 60 min</td>
</tr>
<tr>
<td>Ultimate base pressure: 8 x 10^-7 mbar</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>ADVANCED WINDING SYSTEM</th>
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<tbody>
<tr>
<td>Outer roll diameter: max. 800 mm</td>
</tr>
<tr>
<td>Coating direction: bidirectional</td>
</tr>
<tr>
<td>Speed range: 0.3 m/min to 20 m/min</td>
</tr>
<tr>
<td>Accuracy: ± 0.5%</td>
</tr>
<tr>
<td>Options: web edge control + teetering + particle cleaning rollers</td>
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<table>
<thead>
<tr>
<th>TRANSPORT Type of transport: roll-to-roll</th>
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<tbody>
<tr>
<td>Substrate speed: up to 10 m/min</td>
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</table>

<table>
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<tr>
<th>FACILITY REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suitable for cleanroom: yes</td>
</tr>
<tr>
<td>Service tools incl. for coil, target exchange, compartment maintenance: yes</td>
</tr>
<tr>
<td>Heat exchanger: optional, provided by VON ARDENNE</td>
</tr>
<tr>
<td>Dimensions: length: 21 m, height: 3.6 m, width: 10 to 14 m</td>
</tr>
</tbody>
</table>

APPLICATIONS
- Advanced complex layer stacks (AR, window films)
- High-throughput sensor applications (ITO & Cu coating)

KEY FEATURES
- High-volume production tool
- Multi-chamber design
- Load locks with gate valves for short campaign times
- Individually pumped process sections
- Superior maintenance concept
- High-utilization, large-scale rotatable magnetron technology

PROCESS BOX DESIGN
- Up to 6 particle-optimized process compartments arranged around one coating drum
- Effective maintenance: full separation of sputter shield, target and winding section

PRE-TREATMENT
- IR heater
- Plasma discharge
- Option: in separate intermediate chamber C2

SPUTTER RATE EXAMPLES at dual rotatable magnetron
- DC powered pair of rotatable cathodes, 1 µm/min, FT – ddr
- AC powered pair of rotatable cathodes, 1.5 µm/min, FT – ddr
- 80 nm/min, Nb, O2 – ddr

VACUUM
- Process chamber made of mild or stainless steel
- Active gas separation between adjacent process compartments: standard 1:100, max. 1:300
- Cryo trap at unwinder, pre-treatment and in each process compartment
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.