**Our History & Experience**

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 coating 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 (3.21 m x 6.00 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 PEMOS, then the VAProcess and now the VAProcess2 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 & shimming service". It allows customers to adjust the coating uniformity of single magnetrons based on the ExSitu measurement data of single layers and predict the best gas trim and magnet bar shimming. 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.

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**Equipment and Applications**

**Functional Coatings on Flat Glass or Web for Architectural Glass**

VON ARDENNE has the number one supplier of automotive glass coatings either on glass or web to create window film. A majority of the world’s thin-film coating capacity relies on VON ARDENNE coating equipment.

Sunlight protection coatings prevent the interiors of cars from heating up, thereby reducing the energy consumption. This is extremely relevant for electric vehicles: if the coating reduces the energy consumed by cooling, the battery lasts longer and the range of the vehicle is increased.

For automotive applications on flat glass, the GC254H glass coating system is a suitable platform. The FOSA MX, a web coating system with a modular design, is ideal for high-volume production of window film.

VON ARDENNE has developed the FOSA LabX 330 Glass, a roll-to-roll vacuum coating system that is optimized for the processing of flexible glass.

**Functional Coatings on Flat Glass or Web for Automotive Glass**

VON ARDENNE is the number one supplier of automotive glazing manufacturers when it comes to window coatings. With our GC330H and GC254H glass coating systems, we offer equipment suited for the production of a high-quality product portfolio of architectural glass for all global markets.

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.

We have delivered more than 50 of these coating systems to customers all over the world.

**Switchable Coatings for Architectural and Automotive Glass**

For smart glass applications, such as electrochromic or other switchable glasses, we offer equipment solutions that match the process defined by the customer. Among the applications are privacy glass, which can switch from transparent to opaque if necessary, electrochromic glass that offers sun and heat protection or dimmable windows in buildings and vehicles.

With these coating systems, for example a customized version of the GC120VCR, our customers can deposit the transparent conductive oxide layers. An example for such coatings is ITO, which is necessary to functionalize glass and turn it into smart glass.

Our customers can rely on our experience with coating systems and process technology for ITO thin-films for many different applications.
Our Strengths

Unique Combination of Process, Technology & Engineering Expertise

Industry-Proven, Reliable and Advanced Sputter and 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 45 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 RDMT.

Sputter Components and Technology

Magnet Bars
All magnet bars and magnet systems are similar in mechanical design and therefore interchangeable.

X-Series End Blocks
With our state-of-the-art X-Series end blocks, we offer both drop-in and cantilever solutions for our coating systems.

Process Control
The VON ARDENNE process control system VAprocos2 controls the reactive magnetron sputtering of compound layers.

Dual Anode Sputtering
Dual Anode Sputtering (DAS) is an industrially proven coating technology. It can be applied for highly-resistant 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.

Core Technology
Based on a Long Tradition

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 45 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
Advantages & Benefits of VON ARDENNE

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 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

VAProsco2 Process Control System
Controls the reactive magnetron sputtering of compound layers

Proven Layer Stack Competence
We have more than 45 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

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 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.
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.

Planar Magnetrons with Exceptional Target Utilization and Uniformity

VON ARDENNE has developed the PLANAR XT magnetron which features more than 6000 kWh target up-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 coater and helps monitor the coating process for quality control.

Recording of process data: Our PROCESSDB 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.

**TECHNICAL DATA GC330H**

SUBSTRATE

<table>
<thead>
<tr>
<th>Material</th>
<th>fl. glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size Jumbo (W x L), other options possible</td>
<td>3000 x 6000 mm</td>
</tr>
<tr>
<td>Size Super Jumbo (W x L), other opt. poss.</td>
<td>3000 x 7800 mm</td>
</tr>
<tr>
<td>Thickness (including uneveness)</td>
<td>1.6 mm to 19 mm</td>
</tr>
</tbody>
</table>

DEPOSITION SYSTEM

<table>
<thead>
<tr>
<th>Base pressure in sputtering chamber</th>
<th>≤ 5 x 10⁻⁶ mbar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle time</td>
<td>≥ 20 s</td>
</tr>
</tbody>
</table>

UTILITY & SUPPLY

<table>
<thead>
<tr>
<th>Utility requirements</th>
<th>depending on application and throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains connection</td>
<td>400 VAC, 50 Hz or 480 VAC, 60 Hz</td>
</tr>
</tbody>
</table>

**TECHNICAL DATA GC254H**

SUBSTRATE

<table>
<thead>
<tr>
<th>Material</th>
<th>fl. glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>2540 mm x 3810 mm</td>
</tr>
<tr>
<td>Thickness (including uneveness)</td>
<td>2 mm to 19 mm</td>
</tr>
</tbody>
</table>

DEPOSITION SYSTEM

<table>
<thead>
<tr>
<th>Base pressure in sputtering chamber</th>
<th>≤ 5 x 10⁻⁶ mbar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle time</td>
<td>&lt; 18 s</td>
</tr>
</tbody>
</table>

UTILITY & SUPPLY

<table>
<thead>
<tr>
<th>Utility requirements</th>
<th>depending on application and throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains connection</td>
<td>400 VAC, 50 Hz or 480 VAC, 60 Hz</td>
</tr>
</tbody>
</table>
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 industry.

**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.

The GC120VCR does not need much floor space and requires fewer maintenance intervals due to its vertical design.
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 products to make high-quality products such as architectural glass, displays for smartphones and touchscreens, solar modules and heat protection window film for automotive glass.

WHO WE ARE & WHAT WE DO

VON ARDENNE supplies 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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Reference Buildings with Glazings Coated on VON ARDENNE Equipment

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