

VON ARDENNE 

COATING SYSTEMS FOR THIN-FILM PV

HISS | VISS | GC120V | PIA|nova | XENIA

Our History & Experience

VON ARDENNE provides advanced PVD coating equipment for all scales of production, from laboratory to high-volume manufacturing. Our company was founded in 1991 as a spin-off of the Manfred von Ardenne Research Institute in Dresden, Germany.

With more than 60 years of experience in vacuum coating and over 45 years in magnetron sputtering, VON ARDENNE is one of the leading providers of equipment and technologies for PVD thin-film technology and vacuum processing.

We have provided more than 230 systems for customers within the thin-film photovoltaics industry, which is an equivalent of a manufacturing capacity of more than 34 gigawatts. This makes VON ARDENNE the market leader in vacuum coating equipment for thin-film PV. The reliability and productivity of these systems are well proven in the PV industry.

The importance of large-area formats is growing in the thin-film photovoltaics industry. Typically, modules for CIGS or CdTe based cells are smaller in size as compared to Si-wafer based modules due to certain historical and technical reasons, such as the cell interconnection.

VON ARDENNE is quite familiar with the development and manufacturing of larger machines, as the company has been providing coating equipment for large-area coating applications that require much wider dimensions. Moreover, we provide systems that are necessary prior to large-scale production – such as **Cluster Systems** for laboratory tests or the inline sputter systems **HISS** and **VISS** for layer stack development under pilot production conditions.

We have supplied vacuum coating equipment for the PV industry since 2004, primarily for thin-film coatings on glass. One of the most versatile coating systems VON ARDENNE offers for these applications is the **PIA|nova**. This is a horizontal glass coating system for depositing thin films using sputtering technology. Its standardized subcomponents enable custom-made configurations. Three process chamber designs are available that allow processes without heating or with heating of up to 400 °C.

The VON ARDENNE **GC120V** is a vertical in-line coating system for the deposition of oxide thin-film multilayer systems and metal layers on flat substrates. The system uses carriers for the substrate transport and enables also custom-made configurations based on standardized subcomponents.

Based on the mentioned experience, VON ARDENNE has developed the **XENIA**. The coater is a very wide horizontal sputtering machine and can therefore process multiple substrates at the same time. It is especially suited for high-productivity applications at very low costs. All our coaters are equipped with the field-proven and leading VON ARDENNE sputtering technology.

It is VON ARDENNE's mission is to continue to be the key equipment manufacturers within the photovoltaics industry. Therefore, we focus on high-efficiency and leading PV technologies and commit ourselves to the cost-effective use of solar power.

MARKET
LEADERSHIP
IN ADVANCED COATING EQUIPMENT FOR

**THIN-FILM
PHOTOVOLTAICS**

> **34 GW***

*PROVIDED CAPACITY

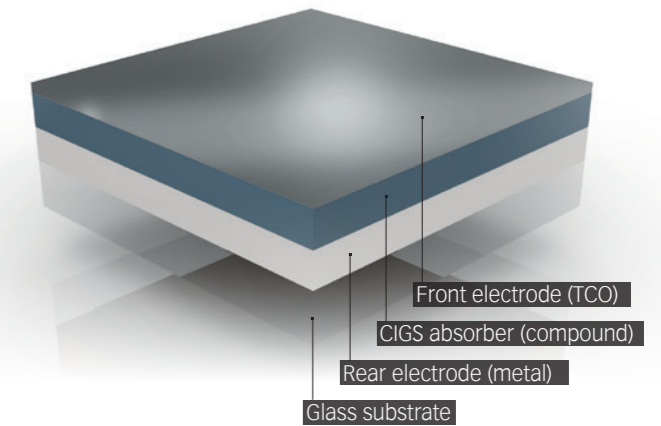
Range of Applications

CIGS Thin-Film Photovoltaics

CIGS-based thin-film solar cell modules represent the highest-efficiency alternative for large-scale, commercial thin-film solar cells. In the schematic illustration, you see a typical CIGS layer stack on glass.

In this design, the layers of the device are deposited onto a glass substrate. Sunlight enters through the top layer of the device (the transparent conducting oxide) and produces electrical current and voltage in the lower layers.

- ... i-ZnO, ZnO:Al based front contact layers
- ... CuGa and In precursor layer
- ... SiOxNy barrier layers and Mo metal back contact layers

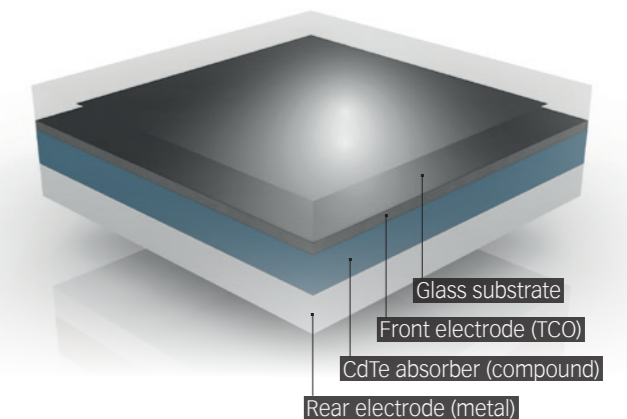


CdTe Thin-Film Photovoltaics

Solar cells based on cadmium telluride (CdTe) constitute the major segment of the global thin-film module production. Transparent conducting oxide (TCO) layers are translucent and highly conductive to transport current efficiently. Intermediate layers help in both the growth and electrical properties between the TCO and CdTe.

The CdTe film acts as the primary photoconversion layer and absorbs most visible light within the first micron of material. Together, these layers form an electric field that converts the absorbed light into current and voltage. A metal layer is deposited on the back to form electrical contacts.

- ... Metal back contact layers based on Al, Cr, Mo, NiV
- ... TCO and intermediate layers

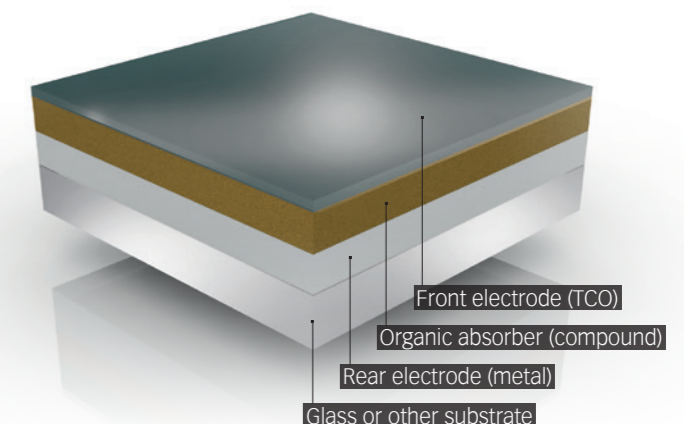


Organic Photovoltaics

Organic photovoltaics is a rapidly emerging technology with an improving cell efficiency. Furthermore, this technology shows a promising initial lifetime and potential for roll-to-roll manufacturing processes.

Organic photovoltaics might be especially interesting for the building-integrated PV market because of the ability to make efficient transparent devices and the availability of absorbers in several different colors.

- ... Deposition by sputtering and Vacuum Thermal Evaporation



Core Technology Based on a Long Tradition

Industry-Proven, Reliable and Advanced Sputter Technology

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

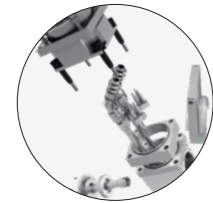
VON ARDENNE magnetrons are available for a wide range of applications. Thanks to many years of experience gained from designing and installing advanced sputtering equipment, we can offer a complete portfolio of solutions from RF and AC to DC processes, planar to rotatable applications and even magnetrons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

Sputter Components and Technology



Adjustable Magnet Bars

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



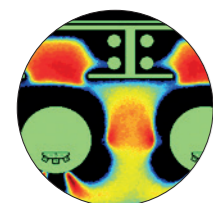
X-Series End Blocks

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 VApracos2 controls the reactive magnetron sputtering of compound layers.



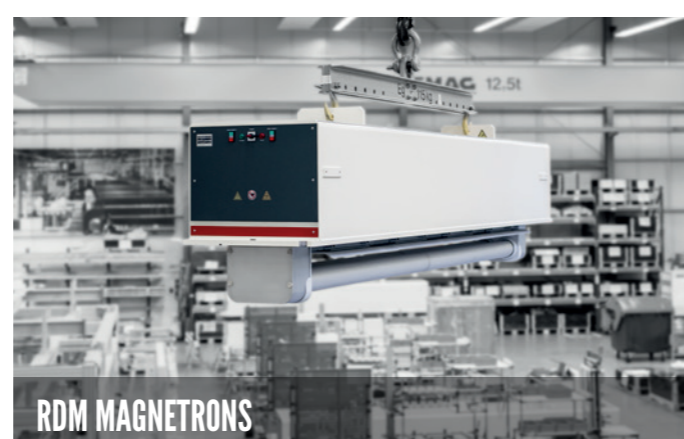
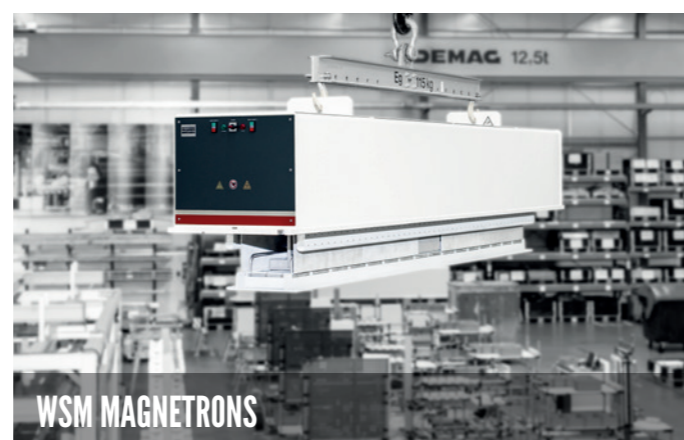
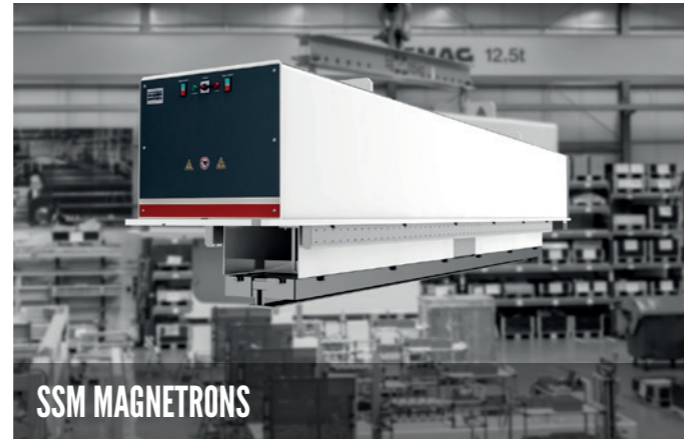
Dual Anode Sputtering

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



Features and Benefits of VON ARDENNE Equipment

Modular, Scalable and Flexible Design Based on German Engineering

Individual Process Chambers

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 components our systems are fitted with have proven in the industry for many years.

Transport System

The substrate transport system used in our equipment can be either carrier-less or carrier-based depending on the process and the requirements of the customer. The customer can also choose between systems with a horizontal or a vertical substrate transport.

Furthermore, there are two drive modes, one for use in vacuum and one for operation under atmospheric pressure. The substrates can be transported either as a single item or as multiple items in a batch.

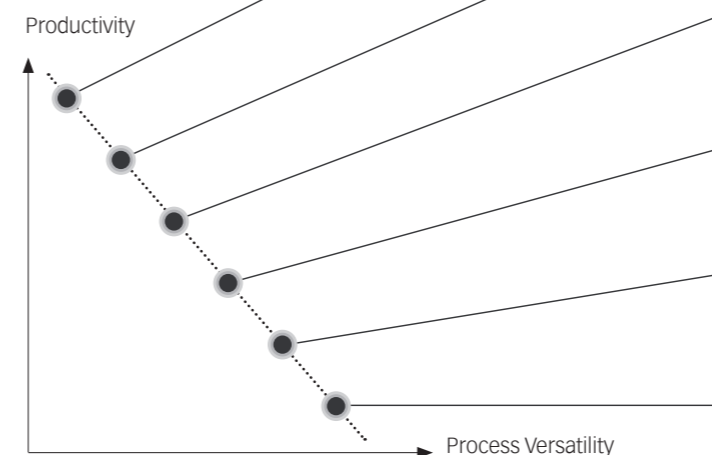
Heating Control System

The VON ARDENNE advanced heating control system is the first solution worldwide for the reliable and even heating of substrates before and during the coating process. The system is characterized by easy operation and helps increase the efficiency of the production process and lower operating costs. The reliable and quick setting of the substrate temperature within narrow tolerances and the high temperature uniformity shorten the ramp up time and minimize breakage and scrap. The VON ARDENNE advanced heating control system is a standard component for heating treatment, e.g. in the coating systems PIA|nova®, GC120V and XENIA.

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.

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.



Cooling System

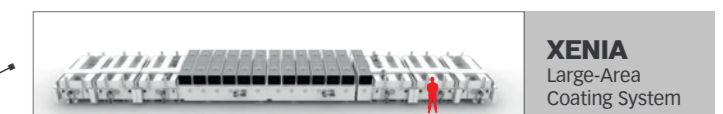
The VON ARDENNE solution for the critical phase of the temperature treatment is our uniquely designed substrate cooling station that is positioned downstream the vacuum chambers. It cools by means of the air convection principle.

Core Competencies for Thin-Film Photovoltaics

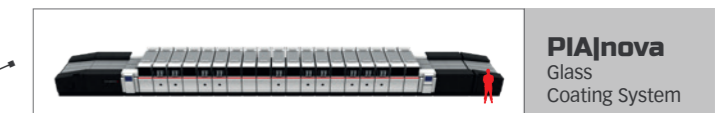
Providing solutions for complex thin-film PV products, including

- ... handling glass substrates in various sizes,
- ... in a specific atmosphere,
- ... within a demanding temperature.

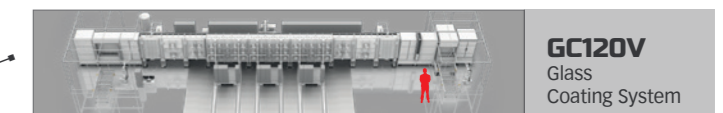
VON ARDENNE value contribution: From continuous improvement to scaling and new concepts, meeting and exceeding customer expectations concerning cost of ownership (CoO) and leveled cost of electricity (LCOE)



XENIA
Large-Area
Coating System



PIA|nova
Glass
Coating System



GC120V
Glass
Coating System



VISS
Vertical
Coating System



HISS
Modular
Coating System



CLUSTER SYSTEM
Wafer & Glass
Coating System

HISS Modular Coating System

R&D and Pilot Production for High-Efficiency Solar Cells



TECHNICAL DATA

Subject to change without notice due to technical improvement.

GENERAL FEATURES

Wafer compatibility	all common formats: M2, M4, M6, M10 and G12
Throughput	
HISS LabX:	≈ 60 wafers/hour
HISS PilotX:	≈ 1200 M2 wafers/hour; ≈ 1400 M4 – M6 wafers/hour
Substrates	silicon wafers, metal plates, polymer films, glass, plastics ...
Substrate size	6" (standard), other substrate sizes possible
Substrate thickness	≤ 20 mm
Coating area on carrier	
LabX	≈ (520 x max. 900) mm ² , e.g. (3 x 5) M2 – M4 wafers
PilotX	≈ (500 x 1,000) mm ² , e.g. (3 x 6) M2 wafers ≈ (520 x 900) mm ² , e.g. (3 x 5) M4 – M6 wafers

SPUTTERING SYSTEM

Magnetron type	single or dual rotatable, planar
Sputter arrangement	sputter-up, sputter-down, double-sided
Deposition type	DC, pulsed DC, AC, RF
Thermal evaporation source	linear
Number of independent processes	on request
Gases and media	e.g. Ar, Ar/O ₂ (max. 20 % O ₂), Ar/H ₂ (max. 2.8 % H ₂)

OPTIONAL FEATURES

Substrate heating	
Pre-treatment (e.g. Ion etching,...)	
Automated substrate loading & unloading	
Automated carrier return system	
Controlled heating and cooling unit (CHU)	
Dry air supply (CDA)	
Carrier storage racks	
Movable carrier stacker	
Others on request	



The **HISS** is a modular vacuum coating system for the horizontal processing of substrates.

In the configuration specified here, it is primarily designed for crystalline photovoltaics applications on silicon wafers. However, it can also be adjusted for thin-film photovoltaics applications on glass or other applications on various flat substrates.

With the **HISS**, you can benefit from our experience gained from hundreds of coating systems that we have delivered to the PV industry. It is the perfect choice if you are looking for highly flexible production equipment with a small or medium throughput equipped with proven technology.

Thanks to its modular design, the **HISS** can be configured according to your needs. We offer two basic configurations of the system.

The **HISS LabX** is a single-ended tool for horizontal batch processing. It is ideally suited for process and application development at laboratory scale.

The **HISS PilotX**, on the other hand, is designed for horizontal inline operation with an automated carrier return system, which makes it suitable for pilot production.

VISS Vertical Glass Coating System

Industry-Proven Production Tool with a Small Footprint



The vertical inline sputter system **VISS** is an appropriate, modular solution for vertical deposition processes when scaling up from laboratory use to production. The tool is available either as a single end inline or for continuous processing and is uniquely suited for scaling up to substrate sizes of approximately 400 mm x 400 mm.

The substrates are transported by a carrier system, which is tilted vertically by seven degrees. The substrates can be loaded without touching their front side.



TECHNICAL DATA

Subject to change without notice due to technical improvement.

TARGET

Material	metals, ceramics
Utilization	planar > 25 %, rotatable > 75 %

SUBSTRATE

Material	glass, polymers
Dimensions (L x W)	approx. 400 mm x 400 mm

DEPOSITION SYSTEM

Deposition type	DC, pulsed DC, AC
Magnetron type	planar, rotatable
Substrate temperature range	RT / 200 °C / 350 °C
Substrate potential	floating
Number of independent process gases	4 (e.g. Ar, Ar/O ₂ , N ₂ , O ₂)

TRANSPORT

Type of transport	inline, carrier-based
Orientation of substrate during deposition	vertical
Transport speed, max.	≤ 1.5 m/min

CLEANING OF CHAMBER

Cleaning principle	mechanical exchange of shields
Cleaning cycle	7 to 25 days, depending on configuration

UTILITIES & SUPPLY

Power (phase/voltage/frequency)	3 AC/230 V, 400 V, 480 V/50 Hz, 60 Hz
Power consumption	depending on configuration
Cooling system	water cooling, separated cooling circuit
Cooling supply	primary supply by customer
Venting system	1 system per lock chamber
Venting medium	ambient air, compressed dry air
Process gases	cabinets or central supply by customer

SYSTEM CONTROL & SOFTWARE

Computer hardware	PLC, Siemens S7
User interface	VON ARDENNE user interface
MES link	according to specifications

SYSTEM DIMENSIONS

Total system size (L x W x H)	depending on configuration
Total system weight	depending on configuration

PIA|nova[®] Horizontal Glass Coating System

Industry-Proven, Reliable Standard Production Tool



The **PIA|nova[®]** is our modular coating platform for solar applications. It allows VON ARDENNE to offer standard, yet flexible, manufacturing equipment for depositing thin films using physical vapor deposition (PVD) technology.

VON ARDENNE has incorporated its vast process know-how into this platform, gained from hundreds of industry-proven glass and photovoltaic coating systems. The **PIA|nova[®]** is our answer to customers looking for productive and flexible production equipment combined with tried and tested technology and design.



Horizontal Substrate Transport

The substrates are transported horizontally through the chambers combined with a sputter-down arrangement.

Heating Technology

There are three fundamental process chamber types for processes:

- ... without heating (option to preheat)
- ... with heating up to 200 °C
- ... with heating up to 400 °C

TRANSPORT

Type of transport	inline
Orientation of substrate during deposition	horizontal, LEL, SEL
Conveyor speed	≤ 3.5 m/min

CLEANING OF CHAMBER

Cleaning principle	mechanical exchange of shields
Cleaning cycle	7 to 35 days, depending on configuration

UTILITIES & SUPPLY

Phase	3 phases
Voltage	230 V, 400 V, 480 V
Frequency	50 Hz to 60 Hz
Power consumption	depending on configuration
Cooling system	water cooling, separated cooling circuit
Cooling supply	primary supply by customer
Venting system	1 system per lock chamber
Venting medium	ambient air, compressed dry air or N ₂
Process gases	central supply by customer or local by gas cabinet

SYSTEM CONTROL & SOFTWARE

Computer hardware	PLC, Siemens S7
User interface	VON ARDENNE user interface
MES link	according to specifications

SYSTEM DIMENSIONS

Total system size (L x W x H)	customized x 9 m x 2.8 m
Total system weight	depending on configuration

TECHNICAL DATA

Subject to change without notice due to technical improvement.

TARGET

Material	metals, ceramics
Utilization	planar > 30 %, rotatable > 80 %

SUBSTRATE

Material	glass
Dimensions (L x W), max.	1 650 mm x 1 400 mm
Thickness	1.8 mm (1.4 mm) to 4 mm for glass

DEPOSITION SYSTEM

Deposition type	DC, pulsed DC, AC
Magnetron type	planar, single or dual rotatable
Sputter arrangement	sputter down
Substrate temperature range	RT / 200 °C / 400 °C
Substrate potential	floating
Number of independent process gases	up to 4 (Ar, O ₂ , N ₂ , X)

GC120V Vertical Glass Coating System

Industry-Proven Production Tool with Small Footprint



The **GC120V** 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 **GC120V** platform. The reliability of this system is well proven in the PV industry.

Small Footprint

Due to its vertical and carrier-based design, the **GC120V** does not need much floor space and requires fewer maintenance intervals.

Good Maintainability

The optimized machine design enables easy access to the magnetron environment for target exchange and maintenance.

TECHNICAL DATA

Subject to change without notice due to technical improvement.

TARGET

Materials	metals, ceramics
Utilization	planar > 30 %, rotatable > 80 %

SUBSTRATE

Material	glass
Dimensions (L x W), max.	1 550 mm x 1 200 mm (others on request)
Thickness	1.8 mm (1.4 mm) to 4 mm (others on request)

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, O ₂ , N ₂ , X)



TRANSPORT

Type of transport	inline, carrier-based
Orientation of substrate	vertical, LEL, SEL
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

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 N ₂
Process gases	central supply by customer or local by gas cabinet

SYSTEM CONTROL & SOFTWARE

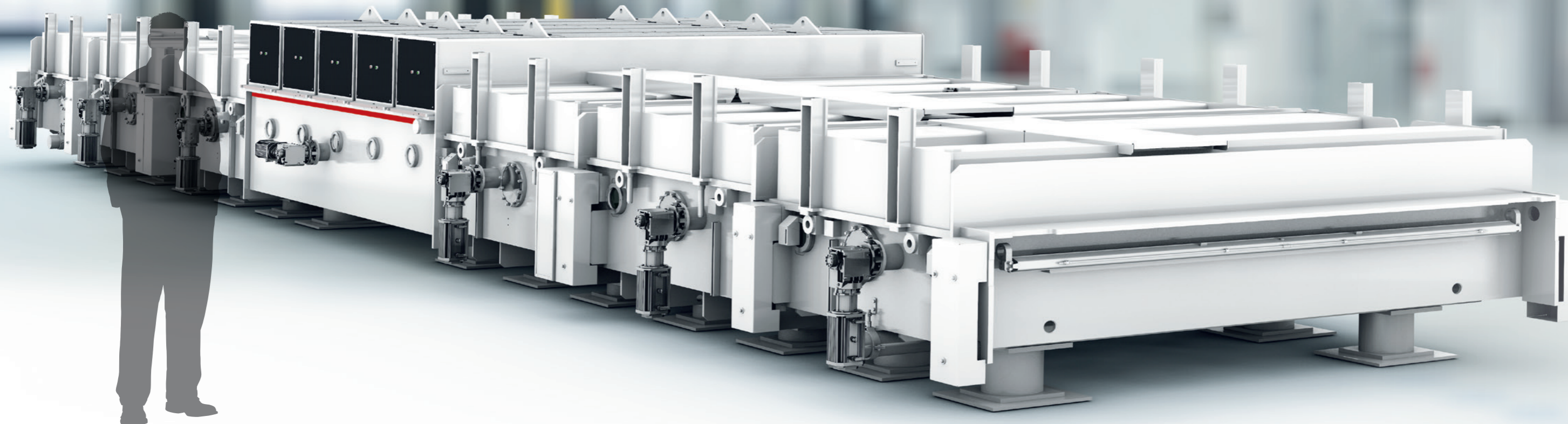
Computer hardware	PLC, Siemens S7
User interface	VON ARDENNE user interface
MES link	according to specifications

SYSTEM DIMENSIONS

Total system size (L x W x H)	customized x 13 m x 3.5 m
Total system weight	depending on configuration

XENIA Horizontal Glass Coating System

High-Volume Production Tool for Best Cost Efficiency



The **XENIA** is an inline coating system based on our proprietary large-area coating technology. As the coater is very wide and can therefore process many substrates at the same time, it is especially suited for high productivity applications at very low costs. It is suited for large-area glass substrates.

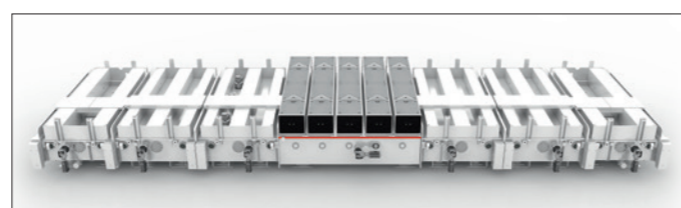
The **XENIA** benefits from our experience gained from delivering more than 150 coating systems to the photovoltaics industry. It is the perfect choice for customers looking for highly productive and flexible production equipment combined with proven technology and design.

Highest Economy of Scale

Due to its large width, the productivity of the tool is exceptionally high while the process utilization is brought to a maximum. Thus, the **XENIA** offers best cost of ownership by providing applicable economy of scale.

Individual Process Chambers

The process chamber can be equipped with five or more different process stations in a sputter down arrangement. It enables simultaneous processing of different material compositions from metallic and ceramic targets.



TECHNICAL DATA

Subject to change without notice due to technical improvement.

TARGET

Material	metals, ceramics
Utilization	planar > 30 %, rotatable > 80 %

SUBSTRATE

Material	glass
Dimensions (L x W), max.	2000 mm x 2400 mm
Thickness	1.8 mm (1.4 mm) to 4 mm

DEPOSITION SYSTEM

Deposition type	DC, pulsed DC, AC
Magnetron type	planar, single or dual rotatable
Sputter arrangement	sputter down
Substrate temperature range	RT / 200 °C / 400 °C
Substrate potential	floating
Number of independent process gases	up to 4 (Ar, O ₂ , N ₂ , X)

TRANSPORT

Type of transport	inline
Orientation of substrate during deposition	horizontal, LEL, SEL
Conveyor speed	≤ 4.5 m/min

CLEANING OF MAGNETRON CHAMBERS

Cleaning principle	mechanical exchange of shields
Cleaning cycle	7 to 35 days, depending on configuration

UTILITIES & SUPPLY

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 N ₂
Process gas	central supply by customer or local by gas cabinet

SYSTEM CONTROL & SOFTWARE

Computer hardware	PLC, Siemens S7
User interface	VON ARDENNE user interface
MES link	according to specifications

SYSTEM DIMENSIONS

Total system size (L x W x H)	customized (min. 20 m) x 16.5 m x 3.5 m
Total system weight	depending on configuration

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



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.



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 such as IPMS, FEP, IST and ISE
- ... Institutes of the Helmholtz Association (Jülich, Berlin)
- ... Universities (Kiel, Dresden, Sheffield)
- ... Companies such as FAP GmbH, scia Systems GmbH



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.



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.



PRODUCT TOPICS



PRODUCT INDEX



COMPONENTS



vonardenne.com

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.



SALES CONTACTS



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