PRODUCT OVERVIEW

PLASMA COMPONENTS
ELECTRON BEAM GUNS
PROCESS CONTROL
PROVEN COMPONENTS.
EXCELLENT RESULTS.
FOR YOU.

Our components are now free to explore new horizons.

OUT NOW!
WITH YOU.

What are you looking for in a supplier of components and process solutions? Experience? Reliability? A proven track record?
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.

Every day, our customers are facing the challenge of staying in a leading position. Why do they choose VON ARDENNE Process Solutions as their partner? Consider our keys to success:

Field Experience - Our technical team is comprised of engineers who have been there, in the field, delivering results. Not only does this mean we know what it takes to get the job done, in many cases we have done it before.

Simulation & Modeling - For new applications, we can guide the process design with extensive simulation and modeling capabilities. From mechanical stress, to thermal modeling, to magnetic field modeling, to charged particle motion, our team can simulate your process before we begin to ensure the highest chance of success.

Sampling Capability - VON ARDENNE has over 20 machines that are suitable for sampling. From small cluster tools to large in-line systems, we can use demonstration runs to further assure you that your process will deliver the results you need once installed.

In-House Assembly & Quality Control – VON ARDENNE builds all of our products in our facility in Germany. We conduct the most demanding quality and functional tests in the industry before shipping our products to you. We meet or exceed most of our competitor’s specifications for technical performance and reliability.

Process Knowhow – By combining our hardware and process control solutions, we can deliver the highest performing processes to the most demanding specifications. Whether you are looking for the best material properties, high rates, uniformity, utilization, or all of the above we can deliver a process that meets your requirements.

Technology Knowhow – Beyond the local coating processes, VON ARDENNE offers state-of-the-art machine control solutions. From optical inspection to automated process adjustment, we add the final pieces of technology to make not only your local process run, but to make your machine perform – to deliver a product as you need it, when you need it.

Worldwide Competence Centers – A truly global organization, VON ARDENNE's subsidiaries can provide integration and startup support, service, and training. When you need it, help is always close at hand.

Matlab/SimScape – For VON ARDENNE equipment with flash-lamp based annealing, optical inspection to automated process adjustment, we add the final pieces of technology to make not only your local process run, but to make your machine perform – to deliver a product as you need it, when you need it.

FE simulations for the analysis and optimization of different physical processes in combination with many years of experience are essential prerequisites for VON ARDENNE coating systems to meet the high quality requirements of our customers.
X- SERIES END BLOCKS

The X-Series End Blocks are drop-in end blocks for glass coating systems, such as the VON ARDENNE GC330H, GC254H, GC140H and PIA|nova. The X-Series is available for upgrades and retrofits, both for VON ARDENNE equipment and other coating systems that fulfill certain parameters. It also covers a wide range of specifications.

CONDITION-BASED MAINTENANCE

Basic maintenance
- < 30 minutes per end block
- Includes vacuum and water rotary sealings
- Typical maintenance cycle > 2 years

Advanced maintenance
- < 60 minutes per end block
- Includes all vacuum and water rotary sealings
- Additionally, the wear part cartridge at the media end block is exchanged (shaft, bearings, carbon brushes)
- Typical maintenance cycle > 5 years

PROVEN X-SERIES TOOL KIT

- A small but comprehensive tool kit is available for fast and convenient service actions.
  - Contains every tool (incl. standard tools e.g. screwdriver) for a standardized service -> no need for an additional basic tool kit
  - Each tool kit equips two technicians for parallel work on media and drive end blocks
  - Verified duration for advanced service per end block -> 60 minutes with one technician

MECHANICAL INTERFACE

The drive and media end blocks of the X-Series have a new design that ensures easy maintenance.

FEATURES

- Interface on vacuum side
- For the basic and advanced maintenance, the end block stays on the kit.
- The end block is designed as a wear cartridge.
- For advanced maintenance, the end block can be easily disassembled for replacing further parts (e.g. bearings, brush unit).

BENEFITS

- Easy change of target-to-substrate distance
- Long-time operation & low cost of ownership
- Ensures high durability of magnetron
- The maintenance can be done completely on site by the customer with a simple set of tools.
- Easy exchange of wear parts such as vacuum and water sealings in less than 30 minutes
- Typical maintenance cycles are: basic maintenance after 2 years, advanced maintenance after 5+ years

MODULAR SETUP

- All spare parts available separately
- Exchange of single parts for easy adaption of other components (e.g. miniature adjustable magnet bars,..)

EFFICIENT WEAR & SPARE PART CONCEPT

- Due to the modular setup, the easy accessibility and the robust design, only a small number of wear parts are needed:
  - Vacuum sealing cartridges
  - Water sealing cartridge
  - Wear part cartridge for media end block

Spare parts are mainly static seals and parts subjected to process technological loads and therefore show thermal and/or mechanical degradation.

For standard as well as for advanced services, the end block stays attached to the lid. Therefore, there is no need for additional end block maintenance areas near the production tools.

Only four parts must be replaced over the entire lifetime of an end block.

TECHNICAL DATA

Subject to change without notice due to technical improvement.

Mounting position: horizontal and vertical
Max. current AC/DC: 360 A (60 kHz) / 400 A
Max. power: 200 kW (50 kHz AC)
Max. target length: 4000 mm
Helium leak rate: < 1x10^-6 mbar l/s
Rotation speed: 0 min^-1 to 60 min^-1
Safe operation weight load:
- ≤ 500 kg horizontal mounting
- ≤ 300 kg vertical mounting (550 kg on demand)

The dimensions and interfaces of the end block X-series are compatible to all common magnetrons in the field and are therefore suited for retrofits.
The Y-Series end blocks are used for applications where externally mounted end blocks are required. The basic concept is a single sided design where all media connections and drive assemblies are installed in one end block. They are suited for roll-to-roll coating systems, such as the VON ARDENNE FOSA MX, but also for carrier-based coating systems such as the XEAnova or horizontal or vertical glass coating systems. The Y-Series is also available for upgrades and retrofits, both for VON ARDENNE equipment and other coating systems. It also covers a wide range of specifications.

**EFFICIENT WEAR & SPARE PART CONCEPT**

Due to the modular setup, the easy accessibility and the robust design, only a small number of wear parts are needed:

- Water sealing cartridge for basic service
- Wear part cartridge for advanced service
- Carbon brush exchange can be done individually

Spare parts are mainly static seals and parts subjected to process technological loads and therefore show thermal and/or mechanical degradation.

For standard as well as for advanced services, the end block remains attached to the lid. Therefore, there is no need for additional end block maintenance areas near the production tools.

**CONDITION-BASED MAINTENANCE**

**Basic maintenance**
- < 15 minutes per end block
- Includes water and vacuum rotary sealings
- Typical maintenance cycle > 2 years

**Advanced maintenance**
- Includes all water rotary sealings
- Additionally, the wear part cartridge at the end block (incl. shaft, bearings, carbon brushes) can be replaced completely or individual parts separately (e.g. carbon brushes)
- Typical maintenance cycle > 5 years

**QUALITY CONTROL**

VON ARDENNE ensures highest level of quality standards for all end blocks. A special test station with four vacuum chambers is used for long-time tests and quality control while manufacturing in terms of vacuum integrity. Additional test stations guarantee safe operation for high power applications and high temperature conditions.

**TECHNICAL DATA**

Subject to change without notice due to technical improvement.

- **Mounting position**: horizontal and vertical
- **Max. current AC/DC**: 350 A (60 kHz) / 400 A
- **Max. power**: 200 kW (DC/60 kHz AC)
- **Max. target length**: 4000 mm
- **Helium leak rate**: < 1x10⁻⁶ mbar*l/s
- **Rotation speed**: 0 min⁻¹ to 60 min⁻¹
- **Safe operation weight load**: ≤ 500 kg horizontal mounting
  ≤ 300 kg vertical mounting (500 kg on demand)

The Y-Series end blocks are suited for retrofits on all common coating systems in the field using side-mounted end blocks as their dimensions and interfaces are compatible.
VON ARDENNE magnet bars are state of the art in technology. We have installed more than 2000 magnet bars in all fields of coating application. In the development of our magnet bars, we focus on target erosion, layer uniformity, process stability and application depending field strengths. They are available in a wide range of strengths and lengths and are inspected in our in-house facilities for quality control.

**FEATURES**
- Optimum layer uniformity
- High target utilization
- Uniform layer properties over the full substrate width
- Optimal setting for your technology regarding
  - uniformity
  - sputter rate
  - process voltage
- Reduced process voltage
- Maximum process power (only limited by target material or banding)
- Optimum solutions and support of process requirements

**BENEFITS**
- Excellent magnetic field uniformity
- Optimized race track return design and different end caps
- Variation of sputter angle between ±15° and ±60°
- Available with inverted magnet arrangement
- Optimized cooling concept
- Technological experience
- Use with any end blocks

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

<table>
<thead>
<tr>
<th></th>
<th>RVA 30</th>
<th>RVA 50</th>
<th>RVA 70</th>
<th>RVA 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. magnetic-field flux density at target surface (Ø 152 mm)</td>
<td>30 mT</td>
<td>50 mT</td>
<td>70 mT</td>
<td>100 mT</td>
</tr>
<tr>
<td>Target utilization</td>
<td>&gt; 85 % with dog bone targets</td>
<td>&gt; 85 % with straight targets</td>
<td>&gt; 85 % with straight targets</td>
<td>&gt; 85 % with straight targets</td>
</tr>
<tr>
<td>Application</td>
<td>Architectural glass, web coating/display, AR, special applications</td>
<td>Architectural glass, photo voltaics, web coating/display, AR, special applications</td>
<td>Architectural glass, photo voltaics, web coating/display, AR, special applications</td>
<td>ITO, photo voltaics, web coating/display, special applications</td>
</tr>
<tr>
<td>Length</td>
<td>Up to 4000 mm</td>
<td>Up to 4000 mm</td>
<td>Up to 4000 mm</td>
<td>Up to 4000 mm</td>
</tr>
<tr>
<td>Typical target materials</td>
<td>Sn, Zn, ZnSn, Si, TiO2, ...</td>
<td>Sn, Zn, ZnSn, Si, TiO2, Cu, Al, Ag, In, ...</td>
<td>CuGa, AZO, ZnTe, Si, metals, ...</td>
<td>ITO</td>
</tr>
<tr>
<td>Magnetic field uniformity</td>
<td>± 1.25 %</td>
<td>± 1.25 %</td>
<td>± 1.25 %</td>
<td>± 1.25 %</td>
</tr>
<tr>
<td>Resulting layer uniformity, down to</td>
<td>± 0.5 %</td>
<td>± 0.5 %</td>
<td>± 0.5 %</td>
<td>± 0.5 %</td>
</tr>
</tbody>
</table>
We offer state-of-the-art planar magnetrons for high-end technology applications. Our components are developed and manufactured 100 percent by VON ARDENNE. Their performance has been industry-proven in depositing blocker and absorber layers for high-end triple Low-E coatings on glass coating systems but also in PV coating systems, in roll-to-roll web coaters and coating systems for display and other special applications.

We have sold more than 350 planar magnetrons for a wide range of different applications. They are available for retrofits and as adaption for new coating lines. Furthermore, we can provide them as complete process lids with and without direct pumping. Hot target clamping available (e.g. for ITO process evaluations for NiCr, Cr, Ag and others).

The product family consists of three different types of magnetrons: the Standard WSM, the High-Utilization Planar Magnetron WSM-HU and the Planar XT.

**FEATURES**

- **STANDARD WSM BODY**
  - Common planar type in last years
  - Simple target design
  - Target utilization 30 %
  - Coating uniformity of ≤ 1.0 %

- **HIGH-UTILIZATION PLANAR HU-WSM BODY**
  - Target lifetime 6000 kWh for 30 mm Ag
  - Target utilization ≈ 35 % to 40 %
  - Coating uniformity ≤ 1.0 %
  - Coating uniformity for planar cathodes ≤ 1.5 %

- **PLANAR XT BODY**
  - Target lifetime potentially > 7000 kWh for Ag
  - Target utilization > 40 %
  - Coating uniformity for planar cathodes ≤ 0.5 %
  - Simple target design

**ALL**

- Sealed cooling channel
- Magnets are not exposed to water, no water seals are broken during target exchange.

**BENEFITS**

- Stable operation
- Good layer uniformity
- Longer target lifetime
- Higher target utilization
- Stable performance over whole target life time
- High-performance in layer uniformity over whole target life time
- Long target life time
- Highest target utilization
- Simple and easy to manufacture target designs

**TECHNICAL DATA**

Subject to change without notice due to technical improvement.

<table>
<thead>
<tr>
<th></th>
<th>WSM</th>
<th>HU-WSM</th>
<th>PLANAR XT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target materials</td>
<td>Ag, NiCr, Cr, Ti</td>
<td>Ag limited by cooling</td>
<td>Ag, NiCr, Cr, Ti</td>
</tr>
<tr>
<td>Target life (kWh/m) for 30 mm Ag target</td>
<td>&gt; 10% kWh/m</td>
<td>&gt; 15% kWh/m</td>
<td>&gt; 16% kWh/m</td>
</tr>
<tr>
<td>Target utilization for 30 mm clamped Ag target</td>
<td>up to 30 %</td>
<td>&gt; 35 %</td>
<td>&gt; 40 %</td>
</tr>
<tr>
<td>Magnetic field strength at 30 mm Ag target thickness</td>
<td>11 mT</td>
<td>15 mT</td>
<td>20 mT</td>
</tr>
<tr>
<td>Max. process power</td>
<td>&gt; 16 kW/m</td>
<td>8 kW/m</td>
<td>&gt; 16 kW/m</td>
</tr>
<tr>
<td>Proven magnetic field uniformity</td>
<td>≤ ± 1.5 %</td>
<td>≤ ± 1.5 %</td>
<td>≤ ± 1.5 %</td>
</tr>
<tr>
<td>Resulting layer uniformity, down to</td>
<td>≤ ± 0.8 %</td>
<td>≤ ± 0.6 %</td>
<td>≤ ± 0.5 %</td>
</tr>
</tbody>
</table>

**BEST QUALITY CONTROL ON THE MARKET**

- In-house quality control of magnets - only magnets meeting our demanding specifications are used for assembly of magnetic systems
- Our magnetic systems are assembled by skilled workers.

**COMPONENTS FOR PLANAR MAGNETRONS**

- High sensitivity magnetic measurement during assembly (3 sensor simultaneous measurement for fast and complete 2D magnetic field scan)
- Re-assembly of magnetic systems if needed, until uniformity spec is fulfilled

Automated inhouse QC of magnets

2D magnetic field measurement for planar bodies with 3 sensors to ensure excellent magnetic field uniformity

Application ex. Planar XT: resulting layer uniformities large-area coating

3D magnetic field simulation HU WSM body
VA PROCOS 2 is a modular process control system that is specially designed for the stabilization of reactive sputter processes in the critical transition mode. It is suitable for process characterization by optical emission lines, cathode voltage, oxygen partial pressure, combinations thereof and/or further PLC signals. Furthermore, it can be used for the stabilization of the plasma discharge and thus of the product properties by adjusting the supply of one or more reactive gases.

Since 1980, VON ARDENNE has been in a leading position in reactive sputtering processes. Furthermore, we have provided and optimized our process control system VA PROCOS for many years. Our current VA PROCOS 2 controls the reactive sputtering of compound layers and reliably stabilizes the working points in the crucial transition region. Furthermore, the system controls one or more reactive gas inlets (e.g. oxynitrides).

OPTICAL INTENSITY MEASURING SYSTEM MS601
- Wavelength range: 185 nm to 900 nm
- Vacuum connection: DN 40 ISO KF
- Temperature stabilized with water cooling: 24 V DC / 160 mA
- Collimators: approx. 1 x 1.7 m², e.g. 6 x 9 6” wafers
- Max. ambient temperature of fiber optic: 300 ºC

Mass flow controllers
- Single
- Trim gas 3, 5 or more channels

Generic: -10 V to +10 V

Power Supply
- 24 V DC / 150 mA

Optical emission (photomultiplier)
- Light intensity (single lambda)
- Light intensity (full spectrum)

Voltage / impedance of discharge
- Voltage

Oxygen partial pressure (lambda sensor)
- O₂ partial pressure

Additionally
- Generic: -10 V to +10 V
- PLC signals

Various

FEATURES
- PEM control, impedance control, Lambda control, balance/MBAL
- Higher sputtering rate
- Optimized layer and stoichiometry uniformity
- Specialized processing for ARC event detection and handling
- Stable measurements and control for low intensity plasma
- Choice of working point
- Increased productivity
- Automatic on-line balancing
- Less energy consumption (less power for same deposition rate)
- Thermal stabilized photomultiplier for PEM
- New applications (Stoichiometry, morphology)
- Unified analog I/O port for all sensors and actors
- Process adapted and ready to use configuration
- IP67, robust cases, EMI shielded
- Flexible configuration of hardware
- Designed for operation in an industrial environment

BENEFITS
- Stabilization of process, reduction of loss and longer campaign times
- Optimized layer and stoichiometry uniformity
- Stable measurements and control for low intensity plasma
- Increased productivity
- Less energy consumption (less power for same deposition rate)
- New applications (Stoichiometry, morphology)
- Process adapted and ready to use configuration
- Designed for operation in an industrial environment

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

O₂-LAMBDA PROBE
- ZrO₂ sensor length: 250 mm (other lengths on request)
- Vacuum connection: DN 25 ISO KF
- Analog gain: 10x
- Output voltage: 0 V to 10 V
- Casing: IP67

VA PROCOS 2 BASE
Main controller for monitoring or process control application with 4 or 8 general purpose I/O channels;
- Profinet interface and Profinet as option (automatic baud rate detection)
- 10/100 MBit Ethernet connection, 4/8 x 16 Bit AD 4/8 x 16 Bit DA 4/8 x low pass with 500 Hz edge frequency variable digital filter

VA PROCOS 2 EXTENDER
Unit to decentralize extend BASE with 4 or 8 general purpose I/Os
- Profinet Interface, See VA PROCOS BASE

VA PROCOS 2 SOFTWARE
Monitor (trending) and process control
- 5 ms

APPLICATION EXAMPLES
- HIGHER SPUTTERING RATE
- MORE PRODUCTIVITY
- NEW FILM PROPERTIES
- NEW APPLICATIONS
- REDUCED ARCING/NODULES
- LONGER CAMPAIGN TIMES

INPUT

SENSORS
- Optical emission (photomultiplier)
- Voltage / impedance of discharge
- Oxygen partial pressure (lambda sensor)
- PLC signals

PHYSICAL QUANTITIES
- Light intensity (single lambda)
- Light intensity (full spectrum)
- Voltage
- O₂ partial pressure
- Various

OUTPUT

ACTORS
- Mass flow controllers
- Trim gas 3, 5 or more channels

PHYSICAL QUANTITIES
- Reactive gas flow
- Generic: -10 V to +10 V
- Power Supply

INPUT

APPLICATION EXAMPLES
- HIGHER SPUTTERING RATE
- MORE PRODUCTIVITY
- NEW FILM PROPERTIES
- NEW APPLICATIONS
- REDUCED ARCING/NODULES
- LONGER CAMPAIGN TIMES

OUTPUT

MAIN CONTROLLER
- Monitoring or process control application with 4 or 8 general purpose I/O channels;
- Profinet interface and Profinet as option (automatic baud rate detection)
- 10/100 MBit Ethernet connection, 4/8 x 16 Bit AD 4/8 x 16 Bit DA 4/8 x low pass with 500 Hz edge frequency variable digital filter

VA PROCOS 2 EXTENDER
Unit to decentralize extend BASE with 4 or 8 general purpose I/Os
- Profinet Interface, See VA PROCOS BASE

VA PROCOS 2 SOFTWARE
Monitor (trending) and process control
- 5 ms
VON ARDENNE develops and manufactures electron beam systems which are used for melting, refining, evaporation or heat treatment. The first electron beam gun was developed in 1959 at the Manfred von Ardenne Research Institute. Our 60 years of experience are reflected in over 400 electron beam systems installed worldwide. Our current EH150V, EH300V and EH800V electron beam guns are the most powerful in the world.

We work on the continuous improvement of our key components at our development center for electron beam technologies. This is where we produce and test all our high-quality electron beam guns.

### FEATURES

- Power control by means of a patented VARIOCATHODE
- High degree of pressure decoupling
- Internal valve to separate EB gun from process chamber
- Quick and simple changing of cathode plug

### BENEFITS

- Easy handling and maintenance
- High reliability
- High acceleration voltage up to 60 kV
- Magnetically self-focusing beam

### TECHNICAL DATA

Subject to change without notice due to technical improvement.

<table>
<thead>
<tr>
<th></th>
<th>EH150V</th>
<th>EH300V</th>
<th>EH800V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended size of vacuum pumps</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbomolecular pump at cathode chamber</td>
<td>300 l/s</td>
<td>300 l/s</td>
<td>500 l/s</td>
</tr>
<tr>
<td>Turbomolecular pump at intermediate chamber</td>
<td>300 l/s</td>
<td>300 l/s</td>
<td>1600 l/s</td>
</tr>
<tr>
<td>Roughing pump for both turbomolecular pumps</td>
<td>20 m³/h</td>
<td>20 m³/h</td>
<td>35 m³/h</td>
</tr>
<tr>
<td><strong>Pump down time</strong></td>
<td>&lt; 10 min</td>
<td>&lt; 10 min</td>
<td>&lt; 15 min</td>
</tr>
<tr>
<td><strong>X-ray leakage</strong></td>
<td>&lt; 1 µSv/h</td>
<td>&lt; 1 µSv/h</td>
<td>&lt; 1 µSv/h</td>
</tr>
<tr>
<td><strong>Total cooling water consumption</strong></td>
<td>0.5 m³/h</td>
<td>0.5 m³/h</td>
<td>2.2 m³/h</td>
</tr>
<tr>
<td><strong>Compressed air supply (dry)</strong></td>
<td>0.5 MPa</td>
<td>0.5 MPa</td>
<td>0.5 MPa</td>
</tr>
<tr>
<td><strong>Height (with closed lid)</strong></td>
<td>900 mm</td>
<td>1010 mm</td>
<td>1400 mm</td>
</tr>
<tr>
<td><strong>Maximum radius</strong></td>
<td>200 h</td>
<td>200 h</td>
<td>200 h</td>
</tr>
<tr>
<td><strong>Number of X/Y coils</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>150 kg</td>
<td>190 kg</td>
<td>550 kg</td>
</tr>
<tr>
<td><strong>Maximum deflection angle</strong></td>
<td>± 40º</td>
<td>± 25º</td>
<td>± 45º</td>
</tr>
<tr>
<td><strong>Recommended vacuum pumps for EB gun and maximum acceleration voltage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 kHz system</td>
<td>250 l/s</td>
<td>250 l/s</td>
<td>250 l/s</td>
</tr>
<tr>
<td>5 kHz system</td>
<td>20 l/s</td>
<td>20 l/s</td>
<td>20 l/s</td>
</tr>
<tr>
<td><strong>Minimum spot diameter (at distance of 1 m, maximum beam power and maximum acceleration voltage)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All process pressure of 5·10⁻⁶ Pa</td>
<td>10 mm</td>
<td>15 mm</td>
<td>30 mm</td>
</tr>
<tr>
<td>At process pressure of 5·10⁻⁵ Pa</td>
<td>15 mm</td>
<td>20 mm</td>
<td>50 mm</td>
</tr>
<tr>
<td><strong>Maximum process pressure</strong></td>
<td>± 5 Pa</td>
<td>± 5 Pa</td>
<td>± 2 Pa</td>
</tr>
</tbody>
</table>

### BENEFITS

- Freely programmable time & power based beam scanning sequences
- Comprehensive scanning figure library
- Signal processor-based calculation of all dynamic functions
- Tracks: automatically moving scanning figures
- Online geometrical and dynamic correction of scanning sequences
- Synchronization of scanning sequences of multiple EB guns
- User permissions management
- Latest software technology and architecture
- Integration of various process control modules – VA BCOR / VA PROCESS MASTER / customer controllers
- Reliable process control for certified products
- Flexible adaptation to VON ARDENNE or customer machines
- Controlled continuous beam scan despite digital figure coordinate definition
- Open customer interface
- Easy and flexible operator interaction as well as automatic process control
- Implementation on standard industrial hardware components
- Implementation on standard industrial hardware components
VON ARDENNE has developed a broad portfolio of plasma treatment sources. Surface treatment is often used as pre-treatment in the process of record (POR) in order to clean, remove or activate the topmost sheet and to create an optimal interface for the next layer that is to be deposited. This is necessary because the substrate surface is often not well defined and shows various residues, like oxides and hydroxides of the substrate material, water from the environmental air, moisture, adsorbed gases and residual contaminants from previous processes. These impediments may prevent a reliable mechanical or functional layer attachment. Two of our components for surface treatment are the Linear Ion Source LION® and the HCS.

The patented Hollow Cathode Source HCS is characterized by a hollow structure and an integrated anode. Species generation is extensively independent from the substrate or, respectively, the carrier and occurs in front of the cathode. The substrates can either be electrically conductive or insulating. The electrons are confined between the potential drops on the cathode’s trench walls. This increases the gas ionization and, therefore, the plasma density. The superposing of plasma in the trenches result in a very intense, bright plasma below the electrode plate.

Cross section of plasma generation principle in a HCS structure

**FEATURES**
- Hollow cathode design, substrate-independent
- High electron densities and ionization efficiencies facilitate a high radical density for processing
- Scalable source for surface cleaning, activation and etching
- Coating of thin films is applicable for certain front part designs
- To be used for moving and static substrates
- Continuous sheet by sheet, carrier by carrier or roll-to-roll processing
- Integrated gas shower with optional cross flow feature
- Front part: quickly changeable, highly adoptable trench design
- Integrated gas shower with optional cross flow feature
- Operation modes: face-up, face-down and vertical
- Freely adjustable electrode distance to match process

**BENEFITS**
- Simple & scalable design for robust behavior & easy customization
- Can compete with CCP and ICP in high density plasma processing and at lower costs compared to ICP
- RF and VHF processing
- Low discharge voltage for gentle processing
- Low generator power
- Low discharge voltage for gentle processing
- Maintenance free (recommended sealings exchange after 5 years)
- Broad process window:
  - Work pressure depends less from electrode-substrate distance
  - RF amplitude is nearly constant over a broad pressure range
- Pre-treatment of different substrate materials

**TECHNICAL DATA**
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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective substrate width</td>
<td>up to 3300 mm</td>
</tr>
<tr>
<td>Power supply</td>
<td>13.54 MHz up to 80 MHz</td>
</tr>
<tr>
<td>Substrate temperature</td>
<td>up to 400°C (higher an request)</td>
</tr>
<tr>
<td>Electrode distance</td>
<td>manually adjustable</td>
</tr>
<tr>
<td>Operation pressure</td>
<td>1 Pa to 1000 Pa = 0.01 mbar to 10 mbar</td>
</tr>
<tr>
<td>Treatment gases</td>
<td>CF₄, NF₃, SF₅Cl, H₂O₂, Ar, F₂, etc.</td>
</tr>
<tr>
<td>Electron density/energy</td>
<td>10¹⁰ cm⁻³ to 10¹¹ cm⁻³ V⁻¹ eV</td>
</tr>
<tr>
<td>Operating voltage (max./typ.)</td>
<td>5 kV  &lt; 3 kV</td>
</tr>
<tr>
<td>Operating pressure (max./typ.)</td>
<td>2E⁻¹ mbar &lt; 1E⁻¹ mbar</td>
</tr>
<tr>
<td>Gas type</td>
<td>Ar / O₂</td>
</tr>
<tr>
<td>Power (max./typ.) in focussed Ar-operation</td>
<td>1.2 / 0.8 kW</td>
</tr>
<tr>
<td>Power (max./typ.) in focussed O₂-operation</td>
<td>1.8 / 1.2 kW</td>
</tr>
</tbody>
</table>

**LION®** and glass substrate - etch rate SiO₂: 5 nm/min

**FEATURES**
- Simple - robust and scalable design
- Highly energetic and strongly focussed beam
- Excellent etching uniformity
- Pre-treatment of different substrate materials
- Easy customization

**BENEFITS**
- Campaign time up to four weeks
- Excellent etching uniformity
- Easy customization

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LION450 Length body (scales in 150 mm steps)</td>
<td>420 mm</td>
</tr>
<tr>
<td>Effective etch width</td>
<td>300 mm</td>
</tr>
<tr>
<td>Power (max./typ.) in focussed Ar-operation</td>
<td>1.2 / 0.8 kW</td>
</tr>
<tr>
<td>Power (max./typ.) in focussed O₂-operation</td>
<td>1.8 / 1.2 kW</td>
</tr>
<tr>
<td>Operating voltage (max./typ.)</td>
<td>5 kV  &lt; 3 kV</td>
</tr>
<tr>
<td>Operating pressure (max./typ.)</td>
<td>2E⁻¹ mbar &lt; 1E⁻¹ mbar</td>
</tr>
<tr>
<td>Gas type</td>
<td>Ar / O₂</td>
</tr>
<tr>
<td>Power (max./typ.) in focussed Ar-operation</td>
<td>10 / 6.3 kW</td>
</tr>
<tr>
<td>Power (max./typ.) in focussed O₂-operation</td>
<td>14 / 9.8 kW</td>
</tr>
<tr>
<td>Operating voltage (max./typ.)</td>
<td>5 kV  &lt; 3 kV</td>
</tr>
<tr>
<td>Operating pressure (max./typ.)</td>
<td>2E⁻¹ mbar &lt; 1E⁻¹ mbar</td>
</tr>
<tr>
<td>Gas type</td>
<td>Ar / O₂</td>
</tr>
<tr>
<td>Gas flow Ar (max.)</td>
<td>240 sccm</td>
</tr>
</tbody>
</table>

The main applications for the LION® are large-area glass coating and metal strip coating. It is available as a remote mounted version with an adjustable incidence angle or as a Flange mount version.
Apart from physical vapor deposition (PVD) sources, VON ARDENNE offers various chemical vapor deposition (CVD) sources. The CVD technology enables certain layer characteristics which can either not be obtained with PVD at all, or at only high effort and costs. VON ARDENNE supplies physically-enhanced CVD (PECVD) sources with particular, tweaked matchboxes and generator systems, as well as gas supply systems. Remark: For static mode PECVD chambers and sources, please consult the VON ARDENNE Modular Process Systems brochure.

The Linear PECVD is similar to standard static capacitively coupled plasma electrodes. However, this particular VON ARDENNE source is run in an infinite dynamic mode. The substrate, carrier or web is permanently moved past the electrode and continuously coated.

**FEATURES**

- Capacitively coupled dynamic PECVD for moving substrates
- Continuous sheet by sheet, carrier by carrier or roll-to-roll processing
- Integrated sidelong gas supply system
- Integrated process gas extraction system
- Free operation modes: face-up, face-down and vertical
- Adjustable electrode distance to match process position
- For plasma chemical etching, surface engineering and material deposition

**BENEFITS**

- Scalable high-throughput option for all state-of-the-art CCP CVD processes
- Continuous sheet by sheet, carrier by carrier or roll-to-roll processing
- Dynamic deposition on various substrates
- Enables high layer homogeneities
- Permits large area deposition at RF and VHF
- Long campaign deposition runs for different set-ups and materials
- High durability
- Maintenance free (recommended sealings exchange after 5 years)
- No starting layer on substrate

**FEATURES**

- Inorganic (e.g. SiH4) and organic (e.g. C2H2), plastic monomers, precursors usable
- Integrated gas distribution system
- Continuous sheet by sheet, carrier by carrier or roll-to-roll processing
- Free operation modes: face-up (limited), face-down (limited) and vertical
- Adjustable wire distance to match process
- Integrated thermocouples
- Optional pyrometer for process control and surveillance

**BENEFITS**

- Divided source design with separated wire mounting for quick exchange and quick process restart – the uptake flange simply stays on the lid or door
- Wires can be energized in selectable form which can be used to prolong coater’s productive uptime
- No plasma process: No ion bombardment, no field accelerated electrons and therefore smooth and highly conformal layer deposition with low internal stress
- Inherently free of dust
- Deposition rate up to factor 10 higher than PECVD processes
- No RF equipment
- High gas utilization of 40 % to 80 % and very low parasitic deposition in pumps and ductwork

**TECHNICAL DATA**

- Substrate width: up to 3300 mm
- Power supply: 13.56 MHz to 80 MHz (higher on request)
- Electrode distance: up to 400 °C (higher on request)
- Operation pressure: 1 Pa to 1000 Pa or 0.1 mbar to 10 mbar
- Process gases: SiH4, H2, NH3, C2H2, SF6, O2, N2, F2, CCl4, etc.
- Deposition rate: 0.4 nm/s to 12 nm/s
- Dep. rate SiH4: 3 nm/s to 10 nm/s
- Dep. rate F2: 2.2 nm/s to 6.1 nm/s
- Substrate width: up to 1600 mm (higher on request)
- Power supply: DC or AC (50 Hz to 60 Hz)
- Layer thickness inhomogeneity: ± 1 % to 3 %

**REFERENCE LITERATURE**

**LINEAR ORGANIC EVAPORATOR**

The VON ARDENNE LOE is a component that thermally evaporates organic material in a closed crucible. The vapor is distributed through a heated pipe in the direction across the substrate and released to the substrate through a linear nozzle array. All parts that are in contact with the organic vapor – primarily crucible and nozzle pipe – are made of ceramics that are completely inert to the OLED materials. The crucible and nozzle pipe are heated to a temperature above the condensation point of the organic materials. The surfaces facing the substrate are shielded by directly cooled copper parts to minimize the thermal load on the OLED substrate. The system enables the inert loading and unloading of air-sensitive evaporation materials.

**FEATURES**
- Evaporation of small-molecule materials
- Evaporation of solid or fluid precursors
- Single, co-, or triple evaporation
- Vertical or horizontal operation
- Substrate width up to 1200 mm

**BENEFITS**
- Linear organic source enables inline processing of organic devices at high throughput
- Optimal thermal design minimizes heat impact on evaporant and substrate for processing of sensitive organics
- Superior homogeneity and stability of rate allows precise optimization of organic stacks to produce highest efficiency OLED and OPV devices
- High material utilization of costly organics keeps product costs in acceptable range
- 100 % inert materials in vapor path

**TECHNICAL DATA**

Subject to change without notice due to technical improvement.

**Source setup**
- Single and co-evaporation

**Substrate width**
- 300 mm to 1200 mm

**Source-to-substrate distance**
- 120 mm to 250 mm

**FLASH LAMP ANNEALING**

Tempering processes are often used in thin-film technology to improve electrical or optical properties. However, they are usually time-consuming, energy-intensive and cause thermo-mechanical stress within the substrate. They also require long heating processes, which cause diffusion processes and make the use of additional barrier layers necessary.

Flash lamp annealing, on the other hand, causes no or only minor thermo-mechanical stress within the substrate and suppresses diffusion processes. Therefore, there is no need for additional barrier layers. Flash lamp annealing improves the optical and electrical properties of coatings and surfaces. VON ARDENNE has demonstrated that by using this technology for improving architectural glass coatings. Beyond that, FLA has improved the electrical properties such as the sheet resistance of products or samples significantly in industry-related bench-scale tests.

Among the most promising applications for this technology are transparent conductive layers and sol-gel coatings on polymers and glass and the pre-treatment of lacquers and paints. Beyond that, FLA can be used to improve haptic and mechanical properties of polymer films and decorative layers.

We offer our partners our technology expertise in flash lamp annealing in order to develop further fields of applications with them.

**FEATURES**
- Fast processing
- Low energy consumption
- Scalable, modular concept
- Homogeneous energy distribution
- Inline capability
- Surface treatment only

**BENEFITS**
- High throughput
- Low cost of ownership
- Easy integration/adaption
- Suitable for large-area application
- Small foot print
- Low impact on (organic) substrate, no diffusion process

**TECHNICAL DATA**

Subject to change without notice due to technical improvement.

**PROCESS RANGE**

Energy density: 0.5 J/cm² to 15 J/cm² optically
- Pulse durations: 0.3 ms to 30 ms
- Substrate sizes: from 1" wafers to 3,760 mm wide substrates

**Environment:** Vacuum, atmosphere or process gas

**Substrate transport:** Wafer handling in batch or cluster systems, S2S and R2R for industry solutions
VA TRIM & SHIM TOOL

The VON ARDENNE Online Trimming and Shimming Module is a web-based application that enables the quick optimization of the thickness uniformity ("% range") of a single thin layer.

After entering a measured thickness profile and the current trim gas settings, it proposes new trim gas settings that lead to improved uniformity. In the same manner, the magnet bar adjustment ("shimming") for optimal settings can be calculated.

TRIMMING AND SHIMMING

Trimming means the adjustment of gas flows at each individual gas inlet segment of the magnetron in order to achieve the most uniform layer thickness at any position of the glass pane. This adjustment can be carried out while the coater is operating using the VON ARDENNE Ex-Situ Measuring System and visualization together with the Trimming & Shimming Module. Trimming adjustment is usually the first choice to improve the thickness uniformity.

Shimming is the adjustment of the magnetic system of rotatable magnetrons in order to improve the thickness uniformity locally on the glass substrate.

PROCEDURE

Initially, a sample coating of a single layer is made under the current conditions. The measured color data is imported from the ex-situ measuring system into the trimming and shimming software. In the next step, the current trimming gas settings/shimming values are typed in.

First, the application calculates the layer thickness profile based on the measured spectra. Then, new trimming gas settings/shimming values for improved thickness uniformity are calculated. This data is entered into the visualization. Subsequently, a new sample coating is made and the thickness is measured again to confirm the improvement.

This procedure only needs to be repeated if the result is not satisfactory. Generally, it takes two to three iterations to obtain the best result.

FEATURES

BENEFITS

- Analysis of inline measurement:
  - Mean and uniformity values of thin layers
- Closed-loop control of:
  - Process power
  - Reactive gas feed
  - Magnet bar (shim settings)
- Subject judgement replaced by objective predictable behavior
- Permanent action
- Deviations held at zero instead of waiting for threshold violation
- No "Sawtooth" curves on startup
- Full overview
- Simultaneous control of all magnetrons
- Simultaneous mean-value (power) and balance control
- 24/7 operation
- Machine state survey
- Automated check of process values, e.g. voltage, pressure, voltage drift
- Configurable by recipe
- Summarized „Production Ready“ flag

VA PROCESS MASTER

Process control in large-area coating is usually a non-automated task. It requires permanent monitoring of online measurements by human operators to detect deviations from a given reference spectrum. Such deviations result from different sources. Typically, the operator must decide which process parameters need to be adjusted. The operator’s experience is crucial to achieve fast and reproducible results.

The VA PROCESS MASTER is the tool for automated process setting and control for all layer systems. It follows a novel approach in process control and leads to best results without operator interaction. It also allows for a fully-automated drift compensation of the sputtering process and improves product quality. In a further step, this tool enables our customers to create complex recipes for attractive products. The tool also helps increase the productivity of a coating system, as it enables a faster adjustment to a new recipe.

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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.