EQUIPMENT FOR HIGH-EFFICIENCY SOLAR CONCEPTS

HJT Cluster
SCALA
XEA nova
XEA nova L
our work today in the fields of vacuum, plasma and electron beam technology.

The German family-owned company develops and manufactures advanced coating equipment for the deposition of ultra-thin functional layers on materials such as glass, metal strip, wafers and polymer films. Two key technologies are applied by our equipment: magnetron sputtering, a process during which materials such as metals or oxides are atomized in plasma and then condense as a layer, and electron beam evaporation, a method of vaporizing metals and alloys by bombarding them with electron beams.

Equipment, components and technologies made by VON ARDENNE make an important contribution to the protection of the environment. Our customers use them to produce sustainable products for the generation of renewable energy and the sustainable use of resources.

The major international manufacturers of crystalline and thin-film solar modules use our highly productive equipment for their production. We are also cooperating closely with them to develop the next generation of modules that will be even more efficient.

We have acquired an excellent process know-how based on the more than 150 coating systems we have installed for crystalline solar cells and thin-film solar module providers. This expertise has been incorporated into the development of coating systems for the next generations of high-efficiency solar cells.

VON ARDENNE is a major player in the heterojunction technology (HJT) market with the modular XEA|nova wafer coating system, which can be configured according to the needs of our customers. Such coating systems are currently operated in production lines with an overall capacity of 1.5 GW. The double-sided coating of wafers in just one coating cycle is just one of the features of this highly productive and flexible tool, which is suited for both standard and special wafer formats.

The two driving factors in the industry are increasing the productivity and lowering the manufacturing costs for the cells. Our latest coating system, the XEA|nova L, is designed to accommodate these factors. Depending on the cycle time, this coating system is able to process between 8,000 and 10,000 wafers in 6-inch format per hour.

This trend will continue to shape the development of the industry, which has the aim to consolidate the status of photovoltaics as a reliable and economic source of renewable energy. Therefore, VON ARDENNE will keep working on new high-efficiency cell concepts that will only be possible thanks to our highly productive and precise thin-film deposition technology.

With the flexible, modular SCALA, we offer the ideal coating system for research and development tasks as well as for pilot production.
HJT CLUSTER SYSTEM

WAVER COATING SYSTEM

EXAMPLE OF A HJT CLUSTER SYSTEM

PECVD module
\[ \text{PECVD module (stationary)} \]
\[ \text{PECVD module (inline)} \]
\[ \text{PECVD module (parallel plate, 13.6 MHz)} \]

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VON ARDENNE is your partner of choice if you are looking for systems with a modular design that can be easily tailored to your technology and productivity requirements. These modular process systems are ideally suited to be applied in research and development as well as for volume production.

Our cluster systems are based on a platform with many modular units. Therefore, every tool may be configured according to the specific applications of our customers.

For customers in the solar industry, special features for producing high-efficiency heterojunction (HJT) solar cells can be integrated into the platforms. These features are, for instance, PECVD modules for the deposition of variously doped amorphous silicon layers.

Furthermore, we can integrate deposition systems for hot wire technology applications (HWCVD) or components for very high frequency chemical vapor deposition (VHF CVD) of amorphous Si:H layers or micro-crystalline µc-Si:H layers in a frequency ranging up to 140 MHz.

A special chamber enables the low-cost deposition of ITO by means of rotatable magnetrons. Optionally, AZO can be deposited to create ZnO:Al layers. Our HJT cluster systems can also be equipped for the dry processing of layers for perovskite solar cells.

Thanks to their flexibility, VON ARDENNE cluster systems help our customers reach maximum solar cell efficiencies and reduce the cost of ownership.

HJT CELL DESIGN

HJT Cell Design

Front side metallization

TCO

p a-Si:H

i a-Si:H

i a-Si:H

TCO

n a-Si:H

Back side metallization

Technical Data

Subject to change without notice due to technical improvement.

General features

Electrical substrate / coating area up to 8” round

Substrate types glass, wafers, metal plates, polymer films, others

Substrate thickness up to 8 mm

Process system

Process direction sunny side up

No. of independent processes up to 7 process stations + 1 load lock

Sputtering DC, pulsed DC, AC

CVD capacitive, inductive coupled plasma, HF, VHF, RF, MW

Optional process features

Pre-/post-treatment (e.g. heating, cooling, ion etching, annealing ...)

Flip station

Others on request

PECVD

PECVD module, parallel plate, 13.6 MHz

PECVD ICP module

Hot wire module

PECVD CCP module

PVD

Single wafer sputter module (stationary)

Multi wafer sputter module (stationary)

Sputter chamber (inline), linear magnetron (RDM)

Post-/pre-treatment / Heating

H2 passivation module

Cleaning or etching module
The SCALA is a modular vacuum coating system with a carrier-based substrate transport. 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 SCALA, you can benefit from our experience gained from more than 150 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 SCALA can be configured according to your needs. We offer two basic configurations of the system.

The SCALA LabX is a single-ended tool for horizontal batch processing with or without load lock. It is ideally suited for process and application development at laboratory scale.

The SCALA PilotX, on the other hand, is designed for horizontal inline operation and therefore suitable for pilot production.

**APPLICATION**

- **HJT**
  - High-performance TCO contact layers and metalization
- **IBC**
  - High-performance metalization layers and back side mirror combined with lowest cost of ownership
- **Passivated Contacts**
  - Single-sided deposition of in-situ doped amorphous silicon as well as SiN layer for hydrogenation

**PROVEN PROCESS COMPONENTS**

Our proven process technology guarantees excellent layer properties and coating uniformity. VON ARDENNE has been developing and manufacturing magnetrons for various applications for more than 40 years and we have more than 10 years of experience in thermal evaporation and CVD.

**HEATING**

For transparent conductive oxides like ITO or other special applications, the substrate temperature can be precisely controlled in order to achieve reproducible and ideal layer characteristics by optional active heating or cooling.

**PROCESS CHAMBER**

The process chamber can be equipped with up to five different process stations in a sputter down arrangement, or with process components for thermal evaporation, PECVD or HWCVD. It enables simultaneous or sequential processing of different material compositions, which is particularly suited for R&D purposes.

**FLEXIBLE AND DYNAMIC DESIGN**

The standardized subcomponents enable custom-made configurations with a high degree of flexibility. That means that the system can be adapted to changing processes or requirements. Therefore, our customers are able to act very dynamically and to adapt to the evolution of their product.

**TECHNICAL DATA**

- **Substrate**
  - Substrates: wafers, metal plates, polymer films, glass, others
  - Substrate size: 6" (standard), other substrate sizes possible
  - Substrate thickness: ≤ 3 mm
- **Coating area on carrier**
  - LabX: ≈ (480 x 480) mm², e.g. (3 x 3) 6" wafers
  - PilotX: ≈ (480 x 800) mm², e.g. (3 x 5) 6" wafers
- **Type of sputter source**
  - Single or dual rotatable, planar magnetron
- **Thermal evaporation source**
  - Linear, ≤ 800 °C
- **PECVD source**
  - 13.56 MHz
- **HWCVD source**
  - Number of independent processes: ≤ 4 (for LabX, PilotX on request)
- **Gases and media**
  - e.g. Ar, H₂, O₂, N₂, H₂O, X

Subject to change without notice due to technical improvement.

**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
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**PROCESS UNITS WITH UP AND/OR DOWN ARRANGEMENT**

For the substrate treatment, the retractable process units (PUs) in the process chamber can be equipped with various process tools in up and down arrangement.

**SIMULTANEOUS OR SEQUENCED PROCESSING**

The combination of up and down arrangements facilitates simultaneous or sequenced processing of both substrate sides without additional handling or breaking the vacuum.

**CONVENIENT AND QUICK MAINTENANCE**

The optimized machine design enables easy access to the process environment and the auxiliary chambers. Due to the plug-and-play design of the process units, they can be maintained during production, a fact that shortens the green to green times even more.

**BROAD THROUGHPUT RANGE AND HIGH PROCESS FLEXIBILITY**

Depending on the market and process demands of the customer, the maximum substrate throughput can be exceptionally high. The process chamber can be configured with rotatable magnetrons, thermal evaporators as well as ion pretreatment or heating and cooling units. All auxiliary chambers, like entry/exit, buffer and transport chamber, can be upgraded in a similar manner.

**FLEXIBLE AND DYNAMIC IN PRODUCTION**

The standardized subcomponents enable custom-made configurations with a high degree of flexibility. That means that the system can be adapted to changing processes or requirements. Therefore, our customers are able to act very dynamically and to keep their production in accordance with the evolution of their product.

**TECHNICAL DATA**

**GENERAL FEATURES**

| Throughput | ≤ 5500 substrates/hour |
| Substrates | wafers, metal plates, polymer films, others |
| Substrate size | 6" (standard), other substrate sizes possible |
| Substrate thickness | ≤ 3 mm |
| Coating area on carrier | ≈ (1 x 1.7) m², e.g. (6 x 9) 6" wafers |

**SPUTTERING SYSTEM**

- Magnetron type: single or dual rotatable
- Sputter arrangement: sputter up and sputter down
- Deposition type: DC, pulsed DC, AC
- Number of independent processes: unlimited
- Gases and media: e.g. Ar, O₂, N₂, H₂O, X

**Target utilization** > 80%, depending on process & material

**OPTIONAL PROCESS FEATURES**

- Substrate heating
- Pre-treatment (e.g. ion etching …)
- Alternative deposition technologies upon request

**OPTIONAL FEATURES**

- Automated substrate loading & unloading
- Automated carrier return system
- Controlled heating and cooling units (CHUs)
- Dry air supply (CDA)
- Carrier storage racks
- Others on request

**VON ARDENNE benefits:**

- Expertise in PVD processing, especially TCO such as ITO
- Expertise in large-area deposition
- Expertise in process upscaling
- Global network and worldwide service

**PROVEN MAGNETRON TECHNOLOGY**

Proven rotatable magnetron technology guarantees excellent target utilization. For more than 40 years, VON ARDENNE has been developing and manufacturing proprietary magnetrons for all kinds of applications.

**PRECISE TEMPERATURE CONTROL OF SUBSTRATES**

For transparent conductive oxides like ITO or other special applications, the substrate temperature can be precisely controlled in order to achieve reproducible and ideal layer characteristics.

**HIGH PERFORMANCE TCO CONTACT LAYERS AND METALLIZATION**

- High-performance TCO contact layers and metallization
- Excellent target utilization
- Proven technology over 40 years

**HIGH PERFORMANCE METALLIZATION LAYERS AND BACK SIDE MIRROR**

- High-performance metallization layers
- Back side mirror with lowest cost of ownership
- Proven technology over 40 years

**APPLICATION**

**HIGH THROUGHPUT RANGE AND HIGH PROCESS FLEXIBILITY**

- Depending on the market and process demands of the customer, the maximum substrate throughput can be exceptionally high.
- The process chamber can be configured with rotatable magnetrons, thermal evaporators as well as ion pretreatment or heating and cooling units. All auxiliary chambers, like entry/exit, buffer and transport chamber, can be upgraded in a similar manner.

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- **HIGH PERFORMANCE METALLIZATION LAYERS AND BACK SIDE MIRROR**
  - High-performance metallization layers
  - Back side mirror with lowest cost of ownership
  - Proven technology over 40 years
The XEA|nova L is an inline coating system based on our proprietary large-area coating technology. The system is wider than the XEA|nova and can process more substrates at the same time. Therefore it is especially suited for high productivity applications at very low costs. It is suited for silicon wafers or other small and even very thin substrates. Thanks to its modular design, the XEA|nova L can be equipped with rotatable magnetrons for the sputter deposition of high-performance TCO layers or several other materials, such as metals and metal oxides. It can also be adapted for other deposition technologies. The substrates can also be pre-treated by cleaning or etching, either under vacuum or before it enters the vacuum.

VON ARDENNE is also working on introducing single-sided passivated contacts processed by means of high-rate soft sputtering into mass production. The necessary sputtering process technology will be designed to fit into the XEA|nova L platform.

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

**GENERAL FEATURES**
- Throughput: 8000 wph to 10,000 wph
- Substrates: wafers, metal plates, polymer films, others
- Substrate size: 6" (standard), other substrate sizes possible
- Substrate thickness: ≤ 3 mm
- Coating area on carrier: ≈ (1.5 x 2.3) m², e.g. (9 x 12) 6" wafers

**SPUTTERING SYSTEM**
- Magnetron type: single or dual rotatable, planar
- Sputter arrangement: sputter down and sputter up
- Deposition type: DC, pulsed DC, AC
- Number of independent processes: unlimited
- Gases and media: e.g. Ar, H₂, O₂, N₂, H₂O, X
- Target utilization: > 80 %, depending on process & material

**OPTIONAL PROCESS FEATURES**
- Substrate heating
- Pre-treatment (e.g. Ion etching …)
- Alternative deposition technologies upon request

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**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 XEA|nova L offers best cost of ownership by providing applicable economy of scale.

**PROVEN MAGNETRON TECHNOLOGY**
Proven rotatable magnetron technology guarantees excellent target utilization. For more than 40 years, VON ARDENNE has been developing and manufacturing proprietary magnetrons for all kinds of applications.

**PROCESS CHAMBER**
The process chamber enables simultaneous processing of different material compositions, such as TCO’s, TCO stack layers and/or combinations of TCO, metal oxides and metal stacks.

**PRECISE TEMPERATURE CONTROL OF SUBSTRATES**
For transparent conductive oxides like ITO or other special applications, the substrate temperature can be precisely controlled in order to achieve reproducible and ideal layer characteristics by optional active heating or cooling.

**EDGE EXCLUSION, FULL AREA, ALL AROUND & BEVEL**
The innovative VON ARDENNE carrier concept is very flexible and enables the deposition on substrates with full or partial edge exclusion. Furthermore, the substrate can be coated on the full area and all around, including the bevel.

**CONVENIENT AND QUICK MAINTENANCE**
The optimized machine design enables easy access to the process environment and the auxiliary chambers.

**FLEXIBLE AND DYNAMIC IN PRODUCTION**
The standardized subcomponents enable custom-made configurations with a high degree of flexibility. This means that the system can be adapted to changing processes or requirements. Therefore, our customers are able to act very dynamically and to keep their production in accordance with the evolution of their product.

**OPTIONAL FEATURES**
- Automated substrate loading & unloading
- Controlled heating and cooling unit (CHU)
- Dry air supply (CDA)
- Carrier storage racks
- Others on request

**AUTOMATION OPTIONS**
- Configuration
- Automation system
- Substrate feeding
- Single- or double-end
- Fully automatic
cassette, box, other
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.