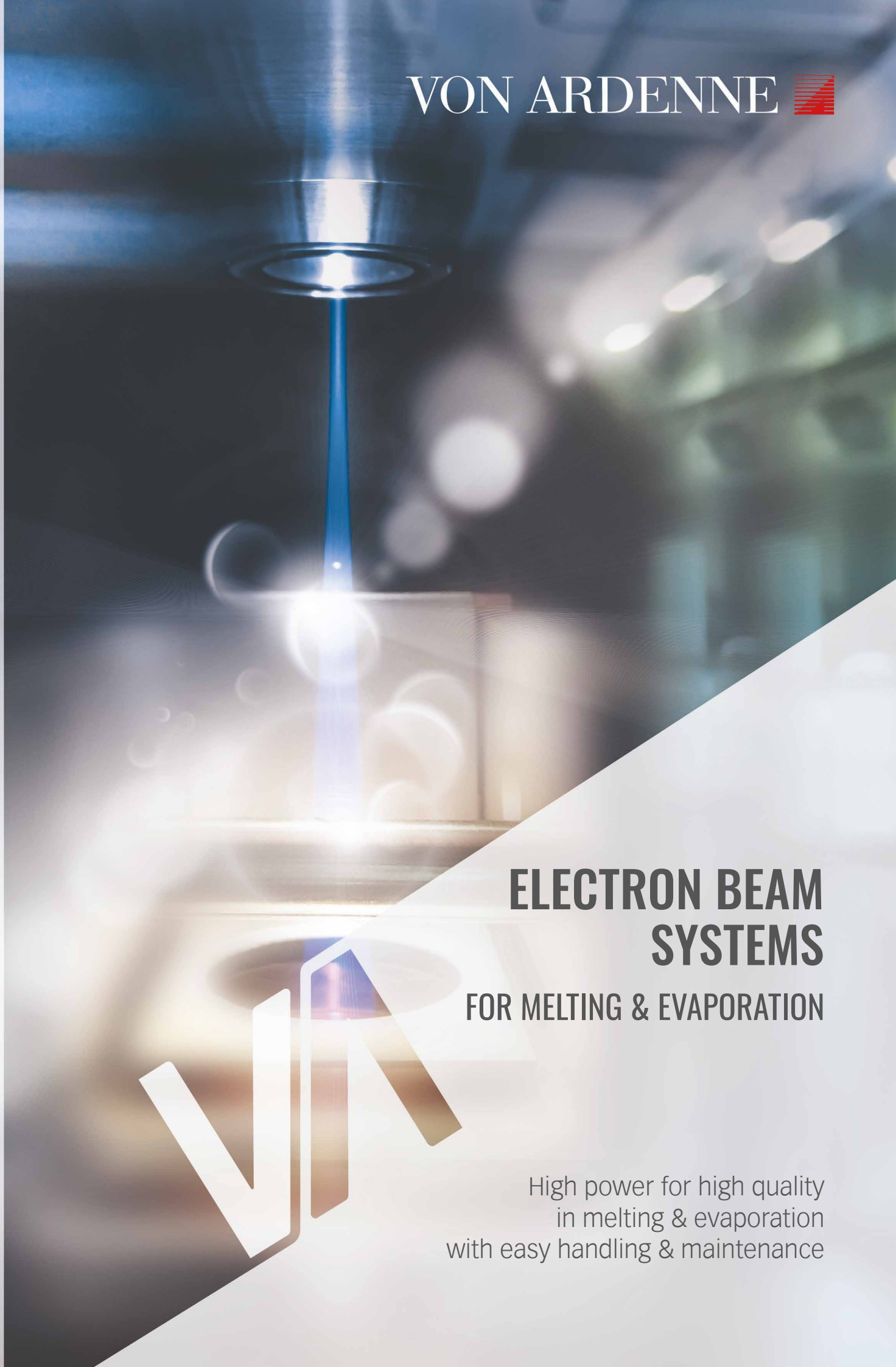
VON ARDENNE



ELECTRON BEAM SYSTEMS

FOR MELTING & EVAPORATION

High power for high quality
in melting & evaporation
with easy handling & maintenance

ELECTRON BEAM SYSTEMS FOR MELTING & EVAPORATION

ELECTRON BEAM TECHNOLOGY

Versatile tool with power & precision for melting & evaporation

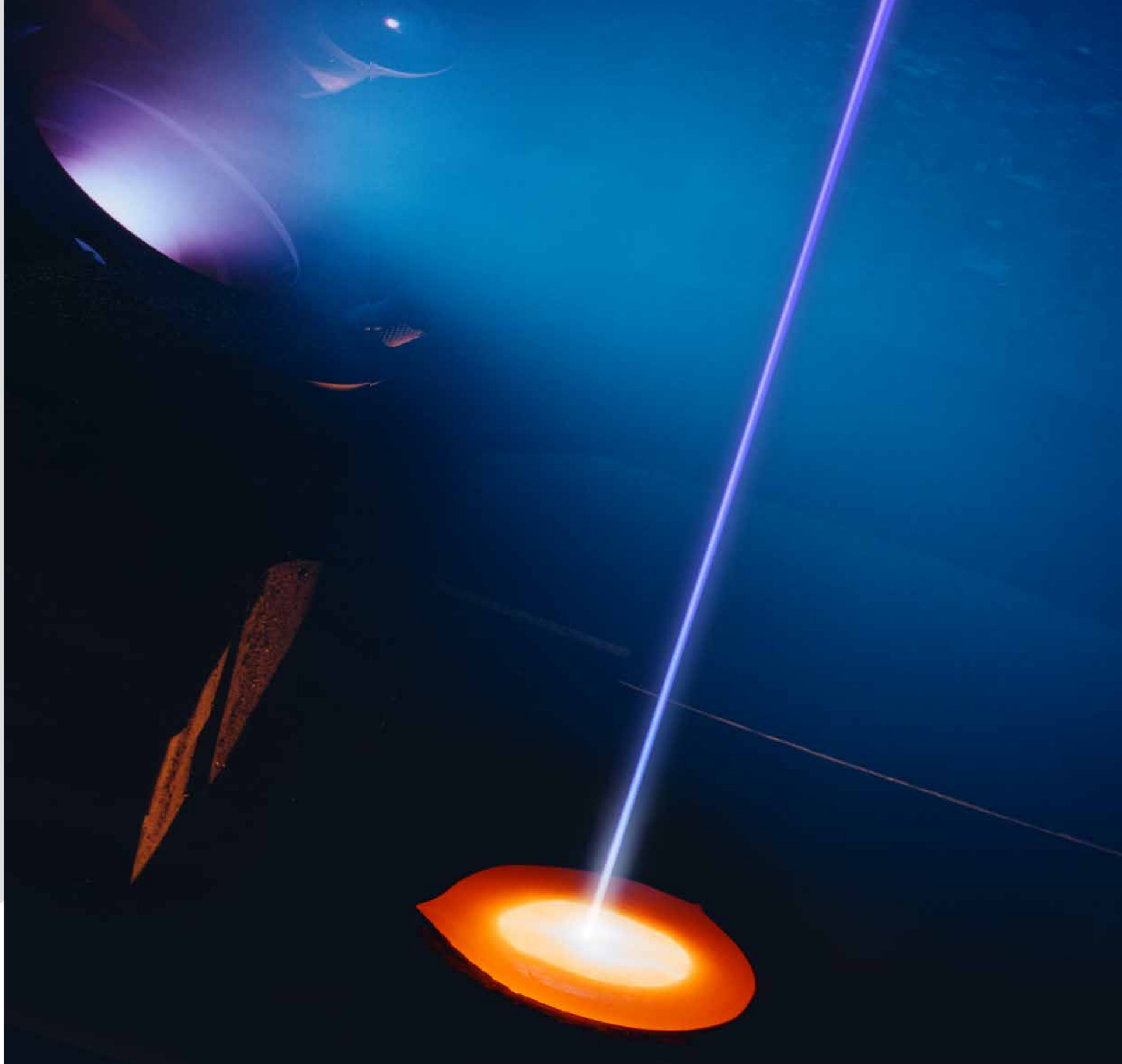
Electron beam technology has been used for decades as a powerful tool in various industries. Examples include melting, vaporizing, separating, structuring and hardening metals and compounds, and polymerizing plastics.

In this process, electrons are released from an electrode and accelerated in an electric field. When these electrons hit a solid body with their kinetic energy, they are decelerated. The heat released in the process is used to process the material. If the electron beam is very finely focused and specifically deflected, metals can be welded together or separated.

Electron beams of very high power can be used to **melt and refine metals with a high melting point** very efficiently. Alternatively, the material can be **evaporated** to condense on a variety of substrates. Very high coating rates can be achieved, ten to a hundred times higher than with magnetron sputtering.

VON ARDENNE as one of the few companies in this industry specializes in both **melting** and **evaporation**. With more than 400 electron beam systems in operation all over the world, VON ARDENNE has acquired extensive know-how.

- 10 to 100 times higher coating rates
  compared to magnetron sputtering for certain materials
- Complete technology from a single source:
  from the electron beam gun to the coating system
- Efficient melting & evaporation processes
  through high energy density processes



ELECTRON BEAM SYSTEMS

HIGH POWER FOR HIGH QUALITY

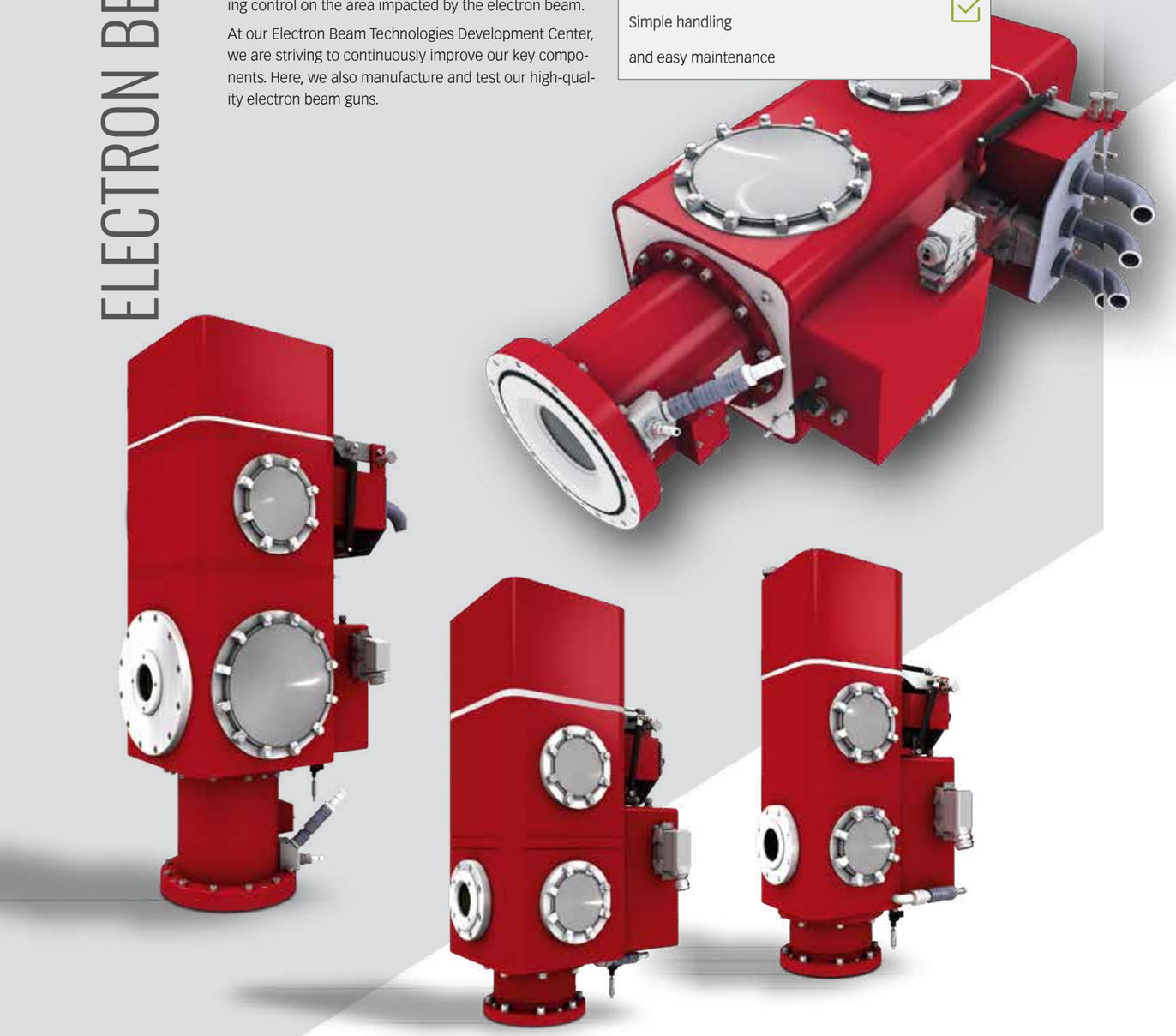
in melting & evaporation

With the EH150V, EH 300V and EH800V electron beam guns, we offer you components for high-performance applications. This applies to melting and refining as well as evaporation of metals, alloys and composites.

As our customer, you will benefit from the comprehensive know-how we have acquired through more than 400 electron beam systems in operation all over the world. It includes beam generation, generator technology, beam focusing and digital beam deflection processes. These processes enable dedicated power distribution and timing control on the area impacted by the electron beam.

At our Electron Beam Technologies Development Center, we are striving to continuously improve our key components. Here, we also manufacture and test our high-quality electron beam guns.

- Reliable & proven
  as a series product in many applications
- Modular design
  with clear interfaces for system integration
- Simple handling
  and easy maintenance



APPLICATIONS

Recyclable Food Packaging

Metallic Bipolar Plates

Lithium-Ion Batteries

Turbine Blades

TECHNICAL DATA

Subject to change without notice due to technical improvement.

	EH150V	EH300V	EH800V
Maximum beam power	150 kW	300 kW	800 kW
Beam power control range			
Power control by VARIOCATHODE (space charge limited mode)	~ 20 % to 100 %	~ 20 % to 100 %	~ 20 % to 100 %
Power control by bombardment power (temperature limited mode)	~ 0 % to 20 %	~ 0 % to 20 %	~ 0 % to 20 %
Max. acceleration voltage	35 kV	45 kV	60 kV
Average lifetime of cathodes at max. beam power	100 h to 200 h	100 h to 200 h	200 h to 300 h
Maximum deflection angle			
1 kHz system (coil/amplifier) 10 kHz system 20 kHz system	± 40° ± 25° -	± 40° ± 25° -	± 45° ± 25° ± 40°
Minimum spot diameter (at distance of 1 m, max. beam power and max. acceleration voltage)			
At process pressure of $5*10^2$ Pa At process pressure of $5*10^2$ Pa	≈ 10 mm ≈ 15 mm	≈ 15 mm ≈ 20 mm	≈ 30 mm ≈ 50 mm
Maximum process pressure	≈ 5 Pa	≈ 5 Pa	≈ 2 Pa
Recommended size of vaccum pumps			
Turbomolecular pump at cathode chamber	300 l/s	300 l/s	500 l/s
Turbomolecular pump at cathode chamber	300 l/s	300 l/s	1600l/s
Roughing pump for both turbomolecular pumps	20 m^3/h	20 m^3/h	35 m^3/h
Pump-down time	< 10 min	< 10 min	< 15 min
X-ray leakage	< µSv/h	< µSv/h	< µSv/h
Total cooling water consumption	0.5 m^3/h	0.5 m^3/h	2.2 m^3/h
Compressed air supply (dry)	0.5 MPa	0.5 MPa	0.5 MPa
Height (with closed lid)	900 mm	1010 mm	1400 mm
Maximum radius (without vacuum pumps)	350 mm	350 mm	400 mm
Weight	150 kg	190 kg	550 kg
Connection flange of the gun	DN 160 ISO-F	DN 160 ISO-F	DN 250 ISO-F
Connection flanges for vaccum pumps	ISO-F	ISO-F	ISO-F
Cathode chamber	DN 100	DN 100	DN 160
Intermediate chamber	DN 100	DN 100	DN 250

MATERIALS [SELECTION]

Metals (reactive): e.g. Al, Ti, Ni, Cu, Cr

Metals (refractory or high-melting): e.g. Mo, Ta, Nb, Zr, Hf, V

Precious metals: e.g. Ir, Rh

Alloys: e.g. Ti_6Al_4V and many others (e.g. for aerospace)

Metal oxides: e.g. Al_2O_3 (e.g. packaging), ZrO_2 (e.g. TBC) and many others

VA BCOS

CONTROL UP TO 8 ELECTRON BEAM GUNS

with a reliable software solution

The beam guidance system is an electronic unit for controlling and monitoring the electron beam of an electron beam gun by means of electromagnetic lenses and deflection coils.

It consists of an industrial PC, a beam guidance base unit, a control console and associated beam guidance software.

- Extensive figure library
- You can easily add your own figures
- Flexible applications

VA BCOS is MS Windows-based beam guidance software and performes the following tasks:

- Control of up to 8 electron beam guns
- Generation of deflection figures
- Generation of deflection sequences
- Management of technological process sequences (recipes)
- Continuous beam deflection with simultaneous adjustment of shape, position, size and dwell time of individual deflection figures
- Adjustment of electron beam focusing
- Display and data recording of all process-relevant operating parameters
- Transmission of data
- Interface for external access via internet connection

TEST & SIMULATE

JOINT TESTING, SAMPLING & IMPROVEMENT

From Simulation to Pilot Production

Sampling & Layer Development

With a wide range of equipment

At our Technology & Application Center (TAC), we work togehter with you on the next generation of your coating applications.

From the simulation of layer stacks and their functionality, to sample production on a laboratory and pilot scale, to the measurement and evaluation of coating and substrate properties: We are prepared to meet a wide range of requirements.

This gives you the opportunity to test the function of the coating for your product in advance on relevant sample sizes.

- Gaining knowledge through simulation of layer composition & properties
- Risk reduction & quicker market maturity through industrial trials
- Individual access to a variety of coating materials & services
- Optimal equipment configuration through testing in a scalable process

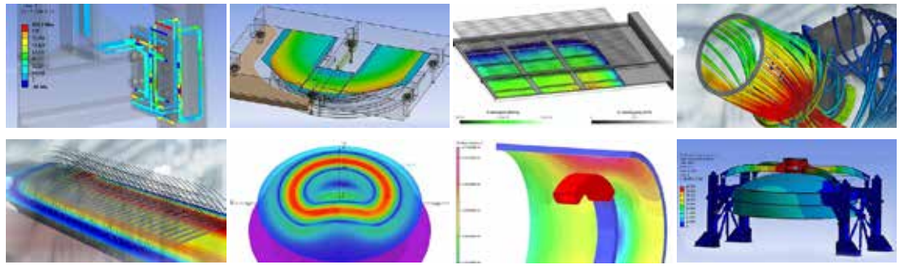
SIMULATION

Helps You Understand Your Process

You want to accelerate your product development. And you know that the answer is multi-physical simulation and modeling. You want accurate results. But which solution is right for you?

We can accelerate your product development and upgrade process by reducing engineering effort with state-of-the-art modeling and simulation. This allows you to design your custom vacuum solution or perform feasibility studies for upgrading a running system.

We have outstanding expertise in multiscale simulation and have leveraged it to ensure highly optimized system performance and best process quality.



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.

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

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
- Institutes of the Helmholtz Association
- Universities
- Companies

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.

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.

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