ALD Vacuum Technologies

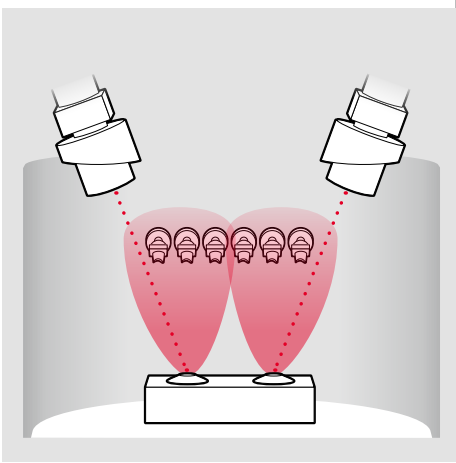
High Tech is our Business

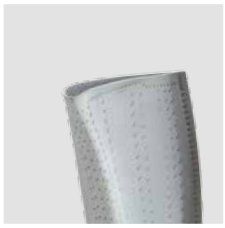
Turbine Blade Coating

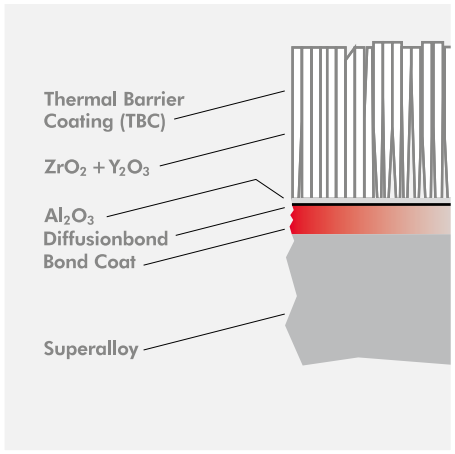
EB/PVD Production Systems

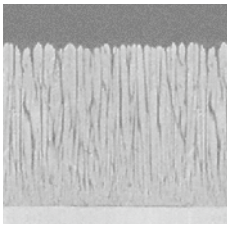
EB/PVD Production Process

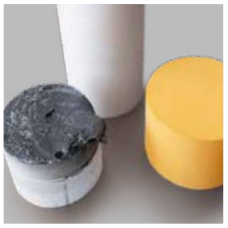
Electron Beam Physical Vapour Deposition (EB/PVD) of Thermal Barrier Coatings (TBC)











The EB/PVD process is exclusively approved in aerospace because of its unique structure

Benefits of TBC

TBC absorb high thermal stress and enable higher turbine operating temperatures

- Reduced fuel consumption
- Higher efficiency
- Longer turbine life-time

TBC have a broad application range in

- Aerospace
- Power generating units

Benefits of EB/PVD

EB/PVD produces superior coating quality thanks to

- Homogeneous cloud of vapour responsible for
- Controlled thickness distribution of layers with
  - Superior dendritic structure and
  - Firmly anchored roots and
  - Smooth surface properties

The EB/PVD process is virtually exclusively approved in aerospace for high temperature turbine blades and vanes

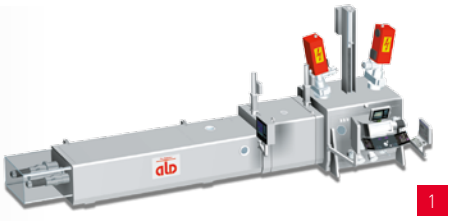
The high performance electron beam evaporates metals as well as ceramics

- Bond, diffusion and thermal barrier coatings
- can be produced in a step by step process
- With high deposition speeds

High Volume Production Systems

XXL Coater
Throughput of turbine blades up to 200.000 pcs/p.a. coated with YSZ*

*Yttria Stabilized Zirkonia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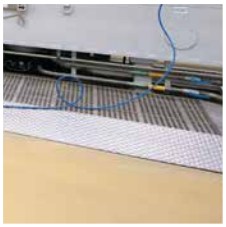




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The SL XXL Coater with 1 Feeder

The starting model into mass production with pilot size capacity

Large chamber volume and bigger gate valves enable

- Coating of bigger parts
- Handling of 4 axes in 1 feeder

The modular design allows further extensions

- e.g. retrofit to a 2-feeder coater is possible

2

The DL XXL Coater with 2 Feeders

Production system with two loading stations and medium size capacity

- Embedded are 40 years of experience and dozens of references
- Coating of blades and vanes

3

The DTL XXL Coater with 4 Feeders

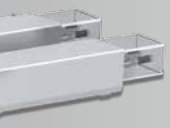
The top model of the XXL product line

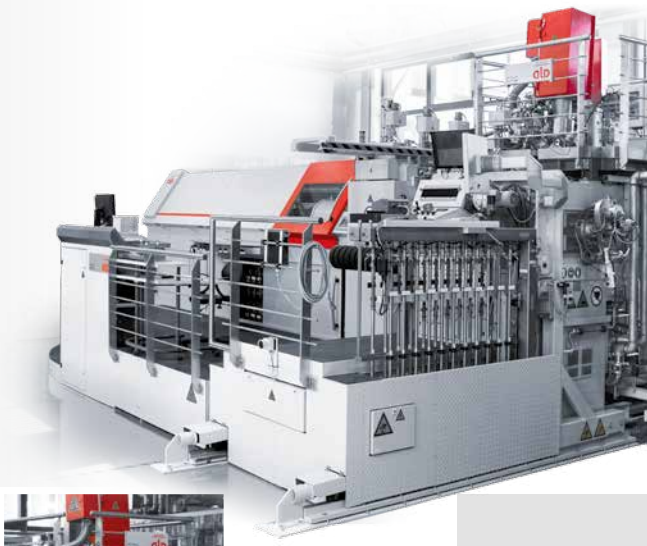
The four feeders

- Enable continuous mass production of turbine components with
- High throughput and efficiency

Pilot, Repair and R&D System

The New SMART Coater





The new SMART Coater – Proven components

Based on ALD´s approved standard and XXL concepts the new SMART Coater incorporates their proven components

- highly reliable EB guns
- vapour cloud management
- controlled part movements
- sophisticated quality control

New features

- Short campaign times and
- Small investment costs
- High part flexibility
- Small floor space requirements/no pit
- One man operation and service
- Small volumes

Further options

- 2 layer coating systems (2 crucibles)
- Multi layer coating systems (special crucible)
- Metal coatings
- Advanced layer monitoring
  - by integration of a Residual Gas Analyzer in coating chamber
- Advanced quality management systems

EB/PVD Systems from ALD

ALD – Solution provider with market leading EB/PVD technology

- First EB/PVD system introduced already in the 1960‘s
- Dozens of systems are installed in the field
- ALD offers a complete model range
  - From XXL Coater for mass production
  - Up to SMART Coater for repair/ R&D/ pilot production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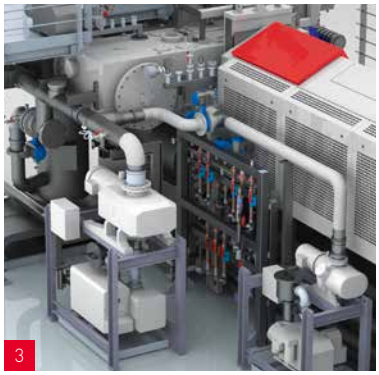
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Market leading technology features of ALD´s EB/PVD systems

Corporate features of ALD´s EB/PVD systems

1 High coating quality by fully reproducible control over vapour cloud and parts movements

- Computer controlled scan of the electron beam over the molten pools (ECOSYS)
- Optimal rotating and tilting of parts in the vapour deposition cloud

2 Heating with advanced graphite heater

- Accurate pressure control during preheating

3 Shortest down time by fast evacuating/venting cycles

- Rough pumping by mechanical pumps
- Fine pumping by high performance diffusion pumps
- Dynamic seal pumping

4 Sophisticated quality control

- Identification, pre- and post- weighing of parts
- Recipe handling and quality reporting
- Integration into host computer environment

5 Proven electron beam gun design for high performance and reliability

- Double pressure stage pumping
- Pressure control at gun pressure stage
- High beam power thanks to proprietary HV transformers


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Typical Technical Parameters

		SMART COATER	2-FEEDER XXL COATER
Total evaporation power installed:		1 EB-Gun 250 kW	2 EB-Guns, 500 kW total
Coating uniformity:	[min]	< ± 10 % of the average deposited thickness for planar panels over the length of the coating area	
Coating window:	[mm]	210 x 140	420 x 140
Substrate temperature/Coating:	[°C]	max. 1,000 - 1,100	max. 1,000 - 1,100
Substrate temperature/Preheating:	[°C]	550 to max. 1,200 adjustable	
Ingot Capacity	[m]	2 m	20 m

Typical Dimensions (including high voltage supply unit)

		SMART COATER	2-FEEDER XXL COATER
Width, approx.:	[m]	7.1	12
Length, approx.:	[m]	8.4	20
Height, approx.:	[m]	4.2	8.2
Weight, approx.:	[t]	33	90
Installed Power:	[kVA]	500	1400
Cooling water:	[m^3/h]	75	125
No of floor levels		Single	Dual

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