

The Solution



ALD Vacuum Technologies

High Tech is our Business

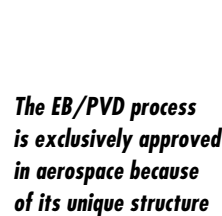
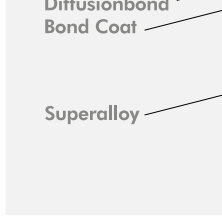
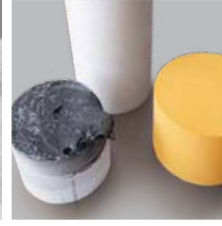
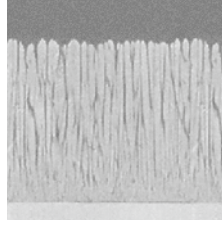
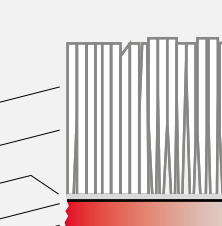
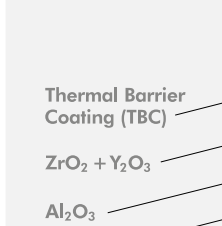
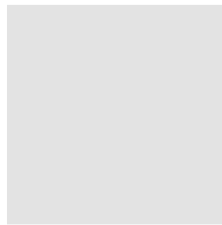
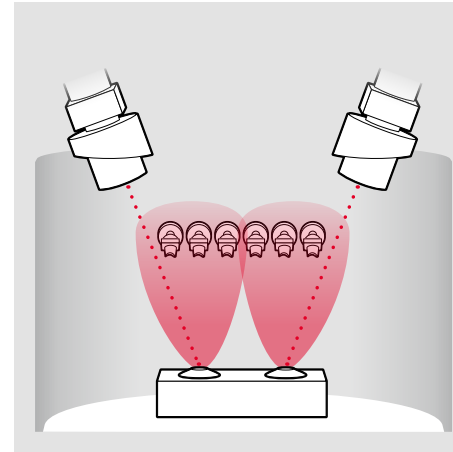
Turbine Blade Coating

EB/PVD Production Systems



EB/PVD Production Process

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



Thermal Barrier
Coating (TBC)

ZrO₂ + Y₂O₃

Al₂O₃
Diffusionbond
Bond Coat

Superalloy

*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

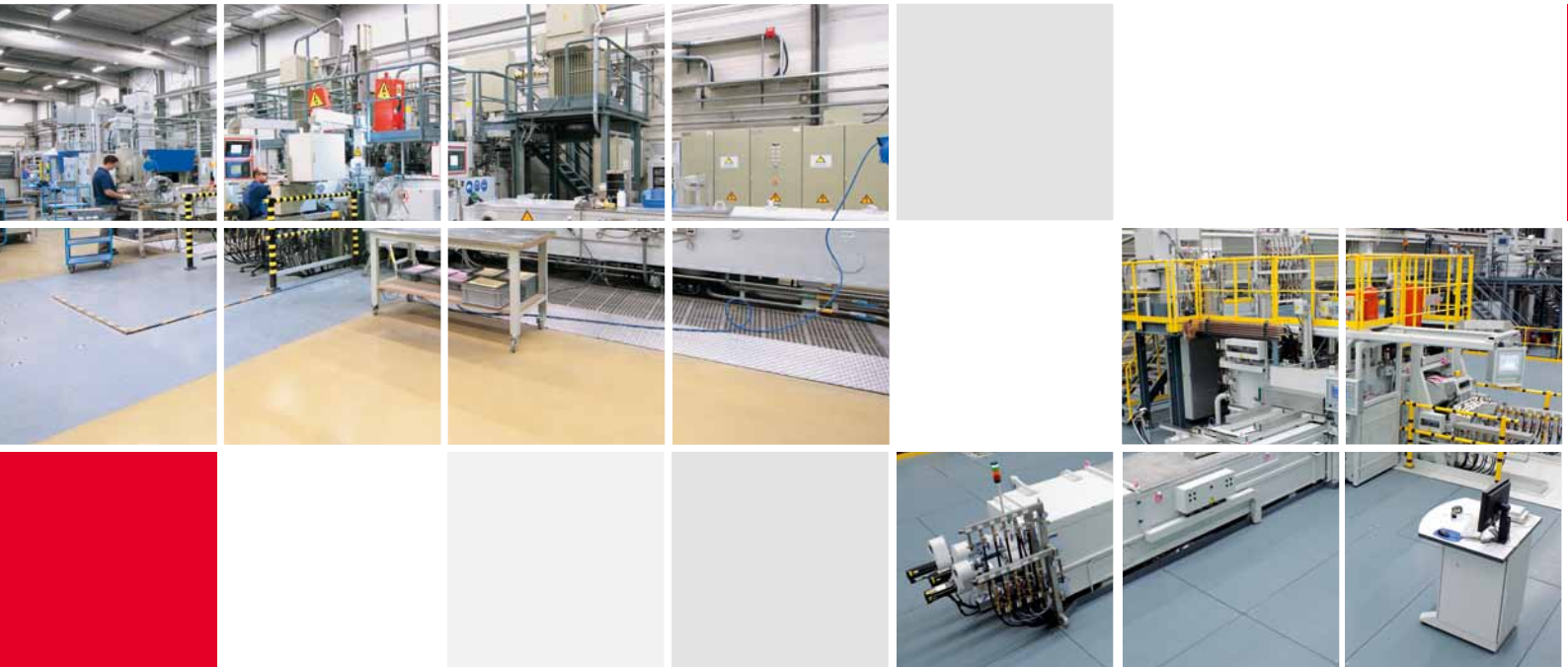
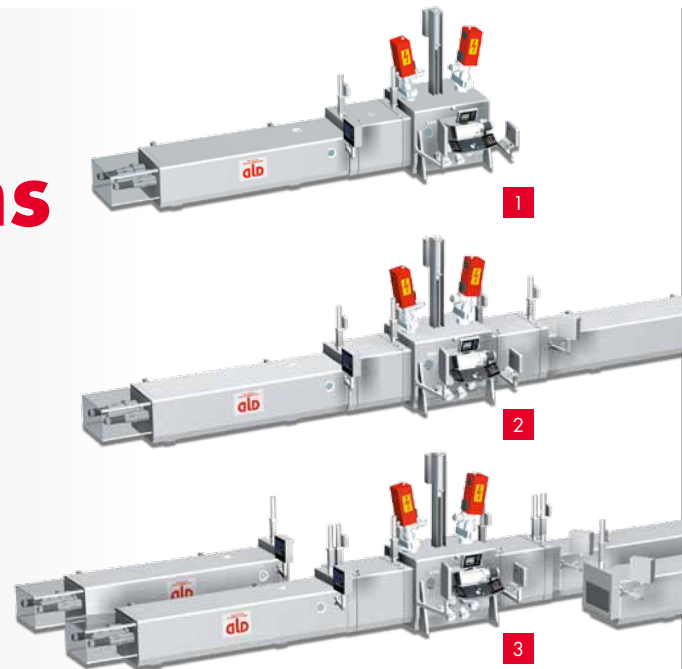
The high performance electron beam evaporates metals as well as ceramics

- 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 Zirconia



1
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



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



Typical Technical Parameters

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:	[min]	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	[°C]	2 m	20 m

Typical Dimensions

(including high voltage supply unit)

Typical Dimensions		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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