Oerlikon Balzers
Aerospace and Gas Turbine
Surface Solutions

JUNE 2018

BALINIT® coatings for Aerospace

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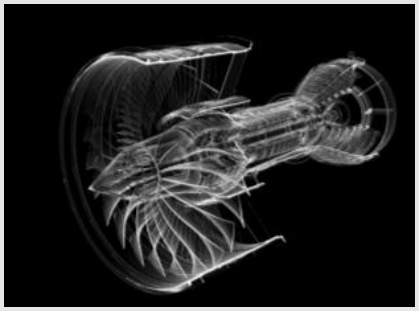
Engine mounts

- **Engine pylons**
  BALINIT® A or BALINIT® C reduce the danger of fretting corrosion (pins).

Landing gear

- **Shafts, pins and bearings**
  BALINIT® C protects lightweight titanium alloys against seizure.

Turbine



- Bearings
- Accessory gear box
- Fuel injection nozzles
- **Compressor blades & blisks**
  BALINIT® coatings protect compressor blades & blisks against erosion.

BALINIT® coatings for Aerospace

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Actuation systems

- Flight control systems
- Thrust reverser
- Door locking mechanism
- **Landing Flaps**
  BALINIT® A or BALINIT® C reduces the danger of seizure of landing flap connecting bolts.

Hydraulic systems & Fuel pumps

- **Axial piston pump**
  BALINIT® C reduces the friction and protects against wear for longer service life.

Interior decoration

- Cabin elements
- **Instruments**
  Black and grey colored coatings like BALINIT® DLC make instrument dials non reflective.

BALINIT® coatings on Gears (highly loaded / fast running)

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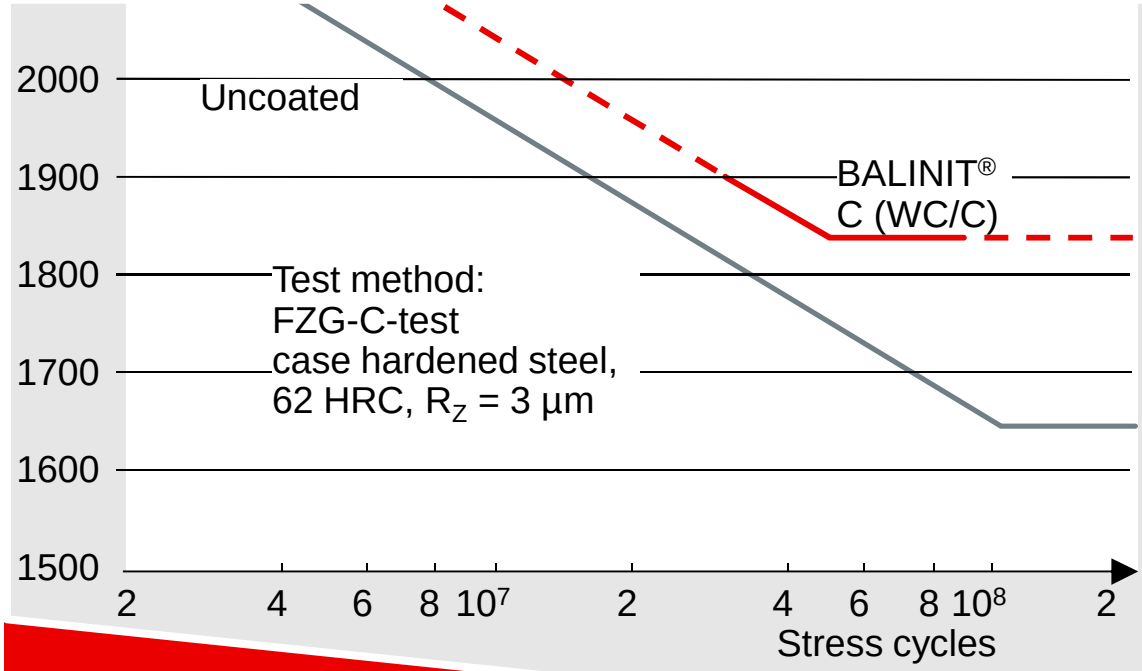
BALINIT® C



BALINIT® C (WC/C) increases load carrying capacity (fatigue endurance limit) of case hardened gears by 10 - 15%. The reason is the reduced hertzian stress due to lowering of the friction and running in of the coating.

BALINIT® coatings for Fuel Pumps (axial piston pumps)

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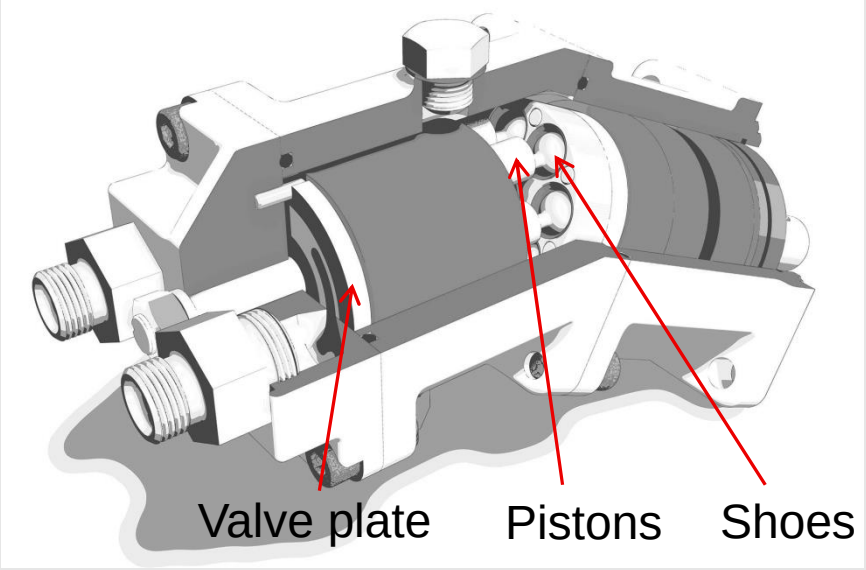
BALINIT® A (TiN), BALINIT® DLC

- The replacement of bronze shoes by steel shoes coated with WC/C results in lower wear and higher load carrying capacity.
- Coating of valve plate for increased wear resistance, durability and reduced friction



Benefit

BALINIT® A (TiN) and BALINIT® DLC coatings offer excellent wear resistance.

BALINIT® coatings for Aerospace
Turbine bearing

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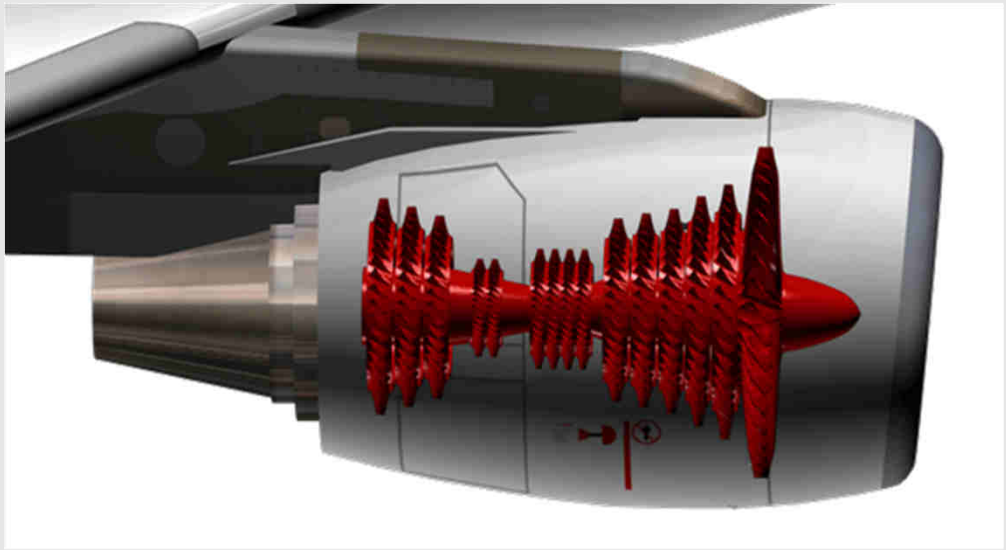
BALINIT® A



Benefit

BALINIT® A (TiN) coated ring boards prevent wear and spark formation in case of cage contact under extreme conditions.

BALINIT® coatings for Aerospace Landing Gear Components

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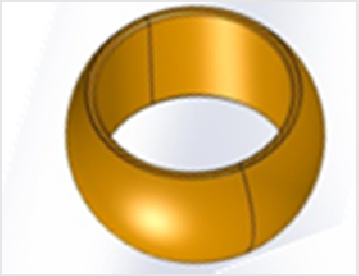
Chrome replacement



Benefit

BALINIT® A (TiN) coated bearing bush running against BALINIT® CNI (CrN) coated housing is an excellent protection against fretting.

BALINIT® coatings for Aerospace Fasteners and Bushes

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BALINIT® C for Chrome replacement

Benefit

BALINIT® C (WC/C) coated pin against fretting wear

BALINIT® coatings for Aerospace Hydraulic Actuators

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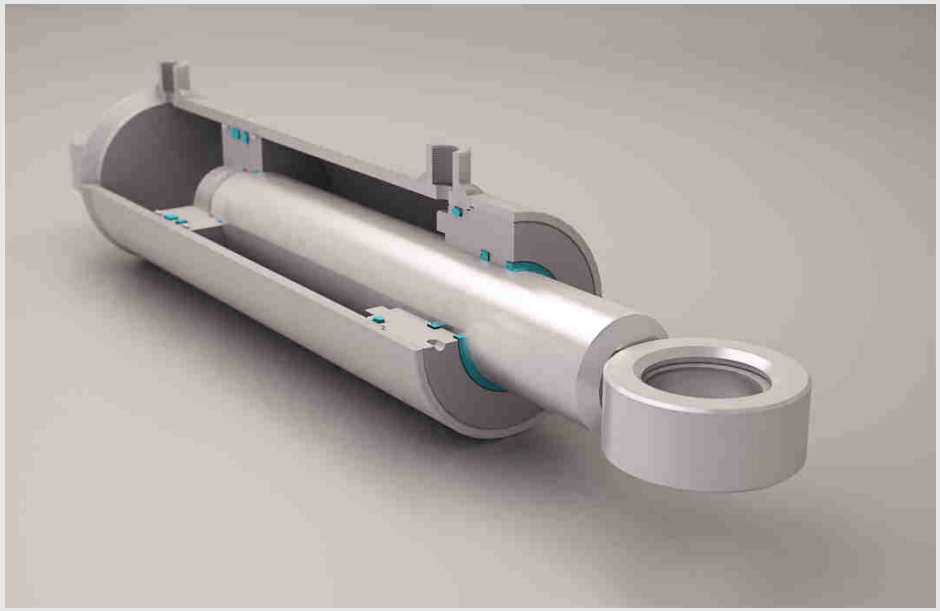
BALINIT® DLC



Benefit

BALINIT® DLC coating on piston rods for chrome replacement offers reduced friction and extends seal life.

BALINIT® coatings for Aerospace sliding sheet pivot – flap track fairing

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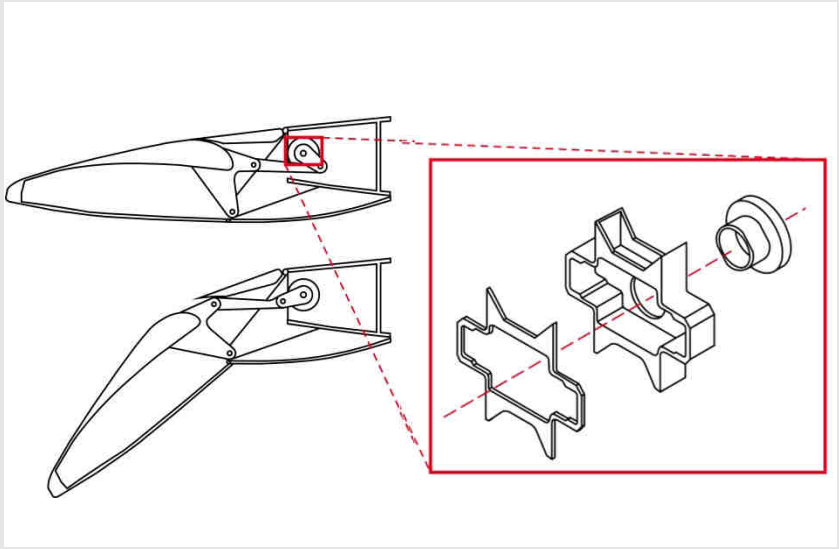
BALINIT® C

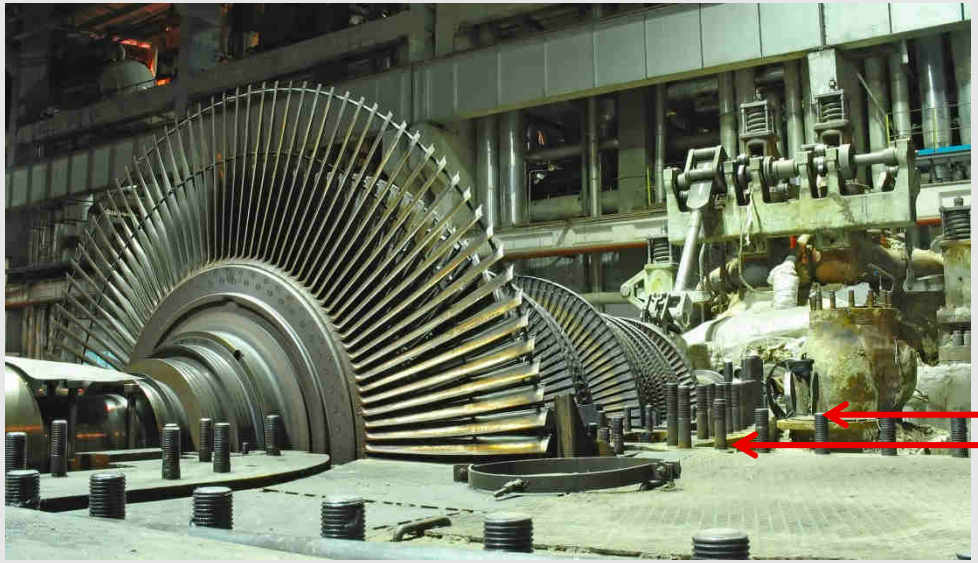


Benefit

BALINIT® C coated «sliding sheet» acts as anti-fretting inlay.

BALINIT® coatings on Studs – Chrome replacement

BALINIT® D (CrN)



studs

Hard Chrome replacement and improvement on fretting wear resistance for connecting studs with a 10 micron protective coating.

BALINIT® surface solutions for compressor blades in turbines – new erosion coating

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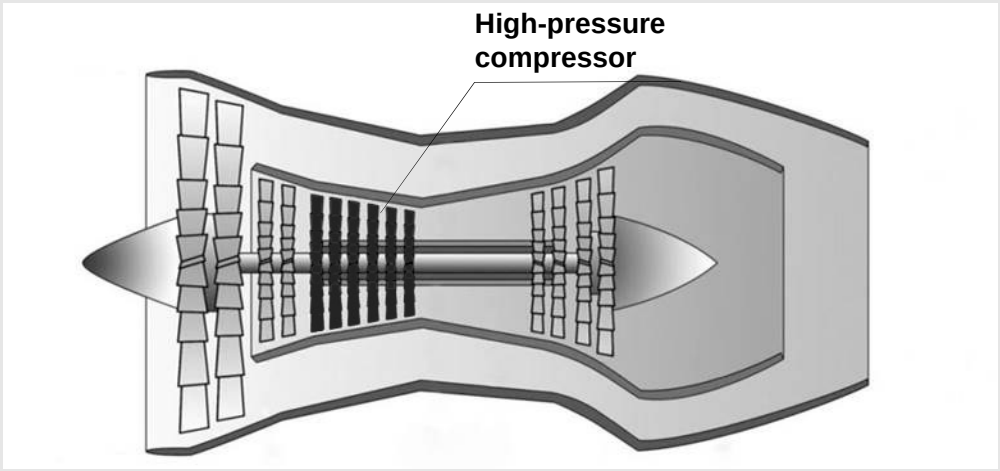
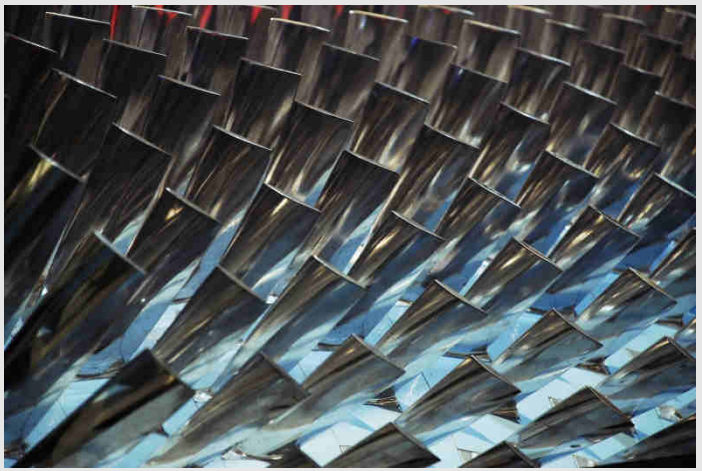
BALINIT® TURBINE PRO - New anti-erosion coating





Benefit

BALINIT® erosion resistant turbine coatings allow longer maintenance cycles and fuel efficiency.

Coating Properties

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	BALINIT® TURBINE PRO	BALINIT® C		BALINIT® DLC	BALINIT® CNI	BALINIT® DLC STAR	BALINIT® A	BALINIT® ALCRONA PRO
Coating material	TiAlN	a-C:H:Me (W)		a-C:H	CrN	a-C:H + CrN	TiN	AlCrN
Coating type		C1000	C1500					
Typical Microhardness (HK 0.01)*	3,300	1,000	1,500	> 2,000	1,750	> 2,000	2,300	3,200
Typical coating thicknesses (µm)	5 - 35	1 - 4		0.5 - 3	1 - 4	2 - 5	1 - 4	1 - 4
Coeff. of friction against steel (dry)*	0.4	0.1 - 0.2		0.1 - 0.2	0.5	0.1	0.4	0.4
Coating temperature (°C)	< 500	(~160) < 250		< 250	< 250	< 250	< 500	< 500
Resistance to oxidation (°C)	900	~350		~350	700	350	600	1100

* depending on application and test conditions / ** no reliable results available

Coating materials – a versatile toolbox

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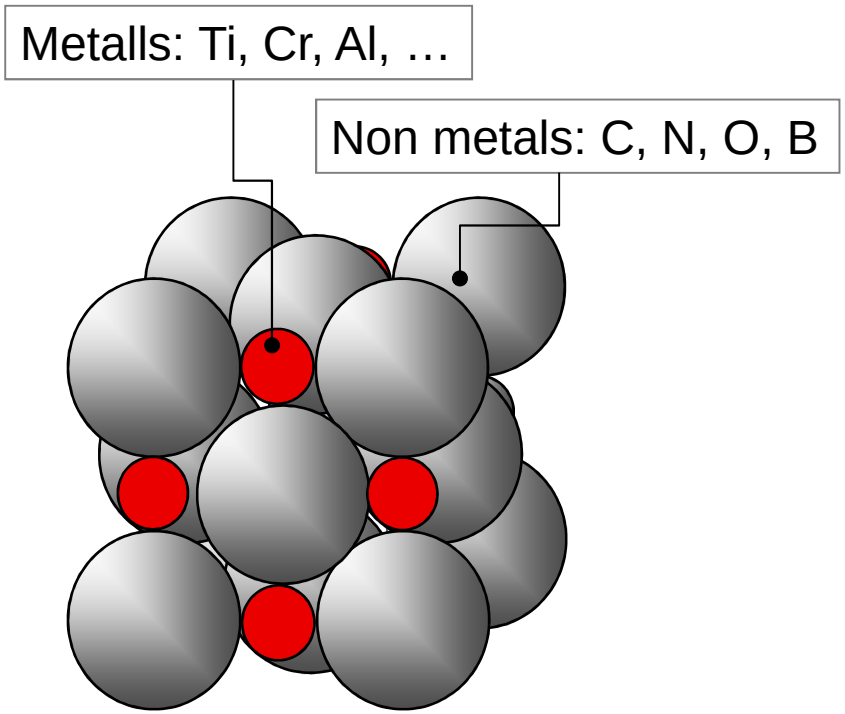
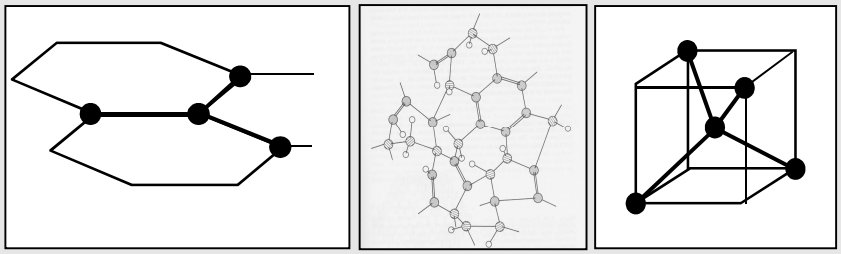
Nitrides/Carbides



High hardness (erosion and wear resistance) and **oxidation resistance**.

Carbon based coatings



Graphite sp^2

DLC sp^2 und sp^3

Diamond sp^3

Nitride coatings like TiN or CrN have a crystalline structure, while carbon coatings (WC/C or DLC) consist of an amorphous carbon-hydrogen network with graphite – and diamond bondings between the carbon atoms.
This structure combine in an unique way **low friction** and **high hardness**.

BALINIT® C and BALINIT® DLC

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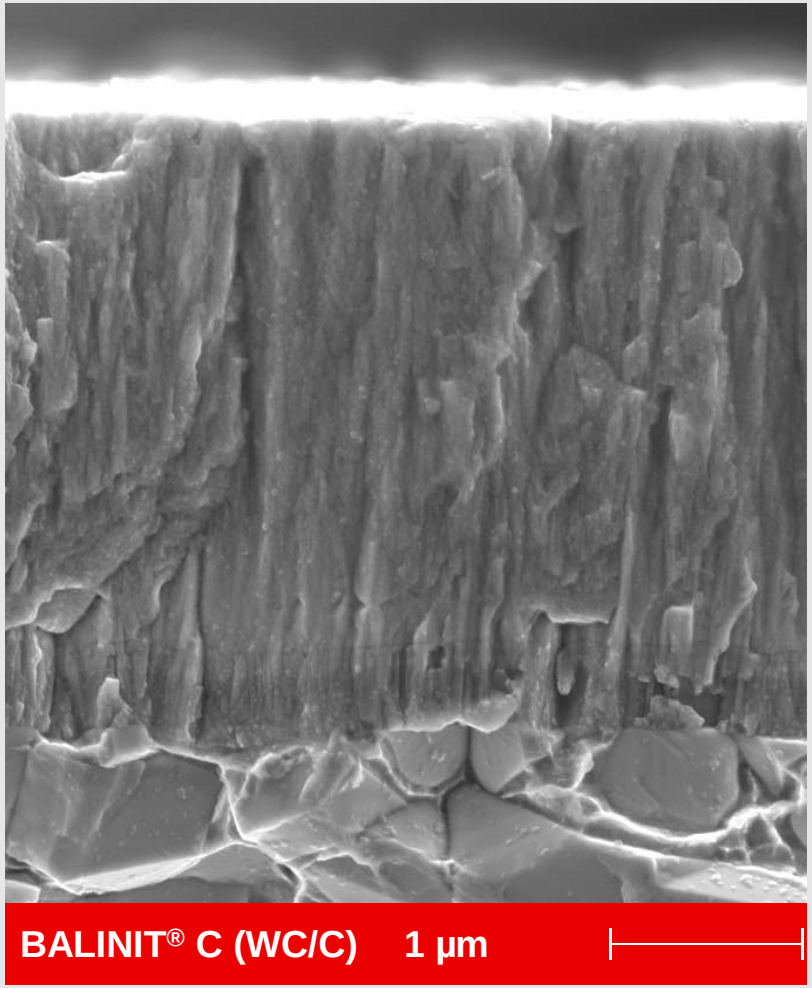
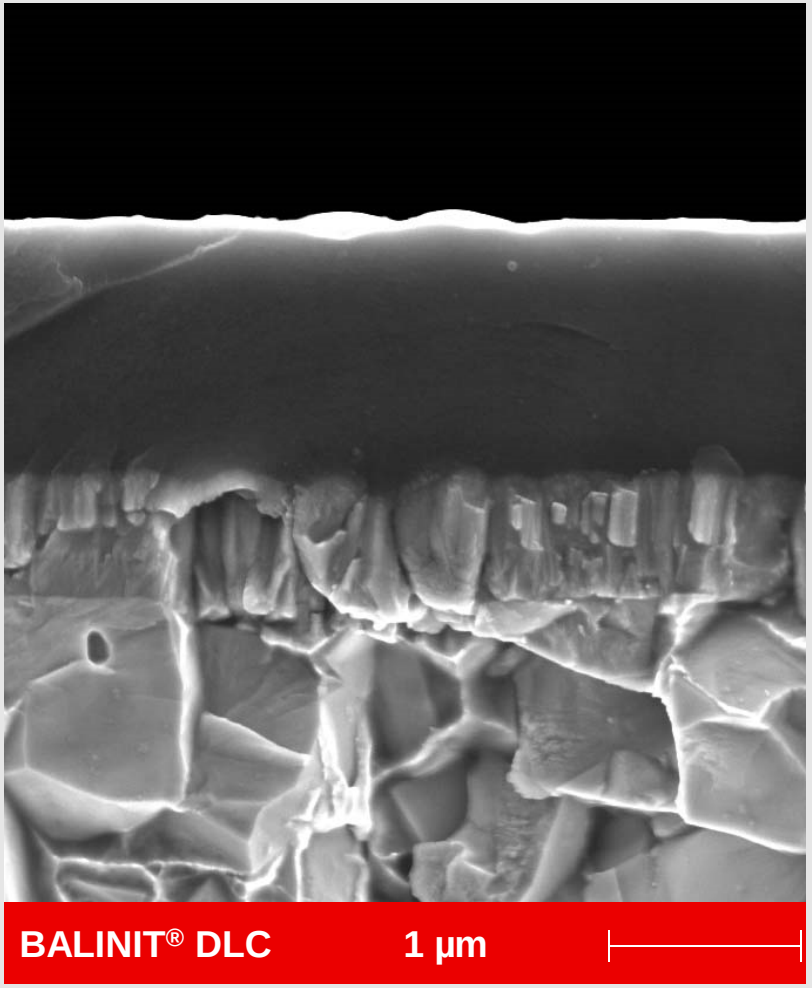
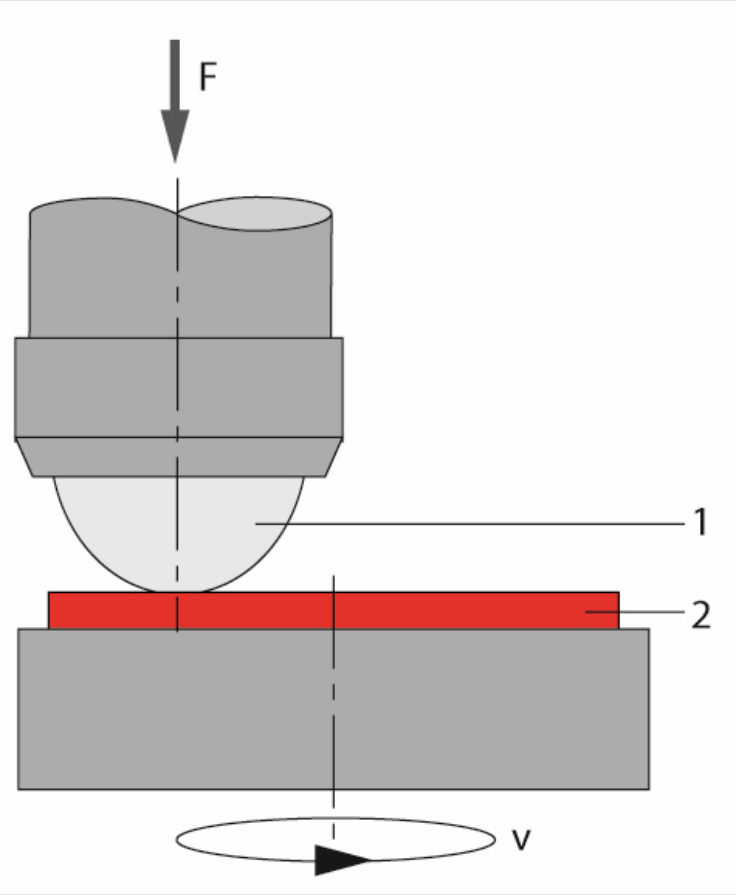


BALINIT® C (WC/C) 1 µm



BALINIT® DLC 1 µm

Sliding wear test



Experimental method:

1. Ball, non rotating, diameter 3mm, AISI 52100 (DIN 1.3505), 60 HRC

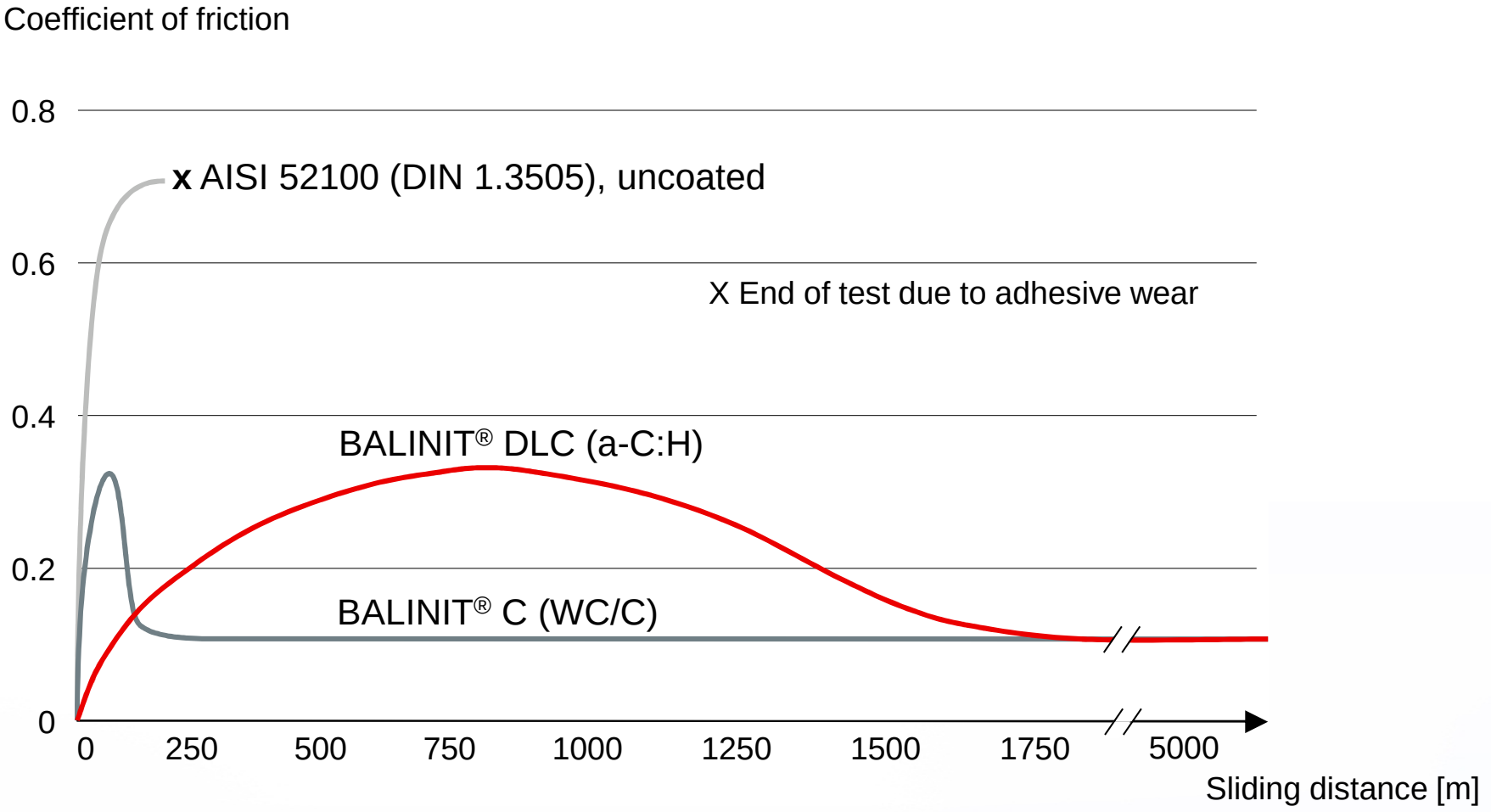
2. Test ring: AISI 52100 (DIN 1.3505), 60 HRC Abrasive-blasted or polished, N4, coated

Test conditions:

F = 30 N
v = 0.3 m/s
dry contact

The key property against seizure at poor lubricating condition is the coefficient of friction. It is measured with a pin on disc test under dry running condition.

Dry running properties of BALINIT® carbon coatings



Structure of the BALINIT® C – Coating feature: high hardness & low COF

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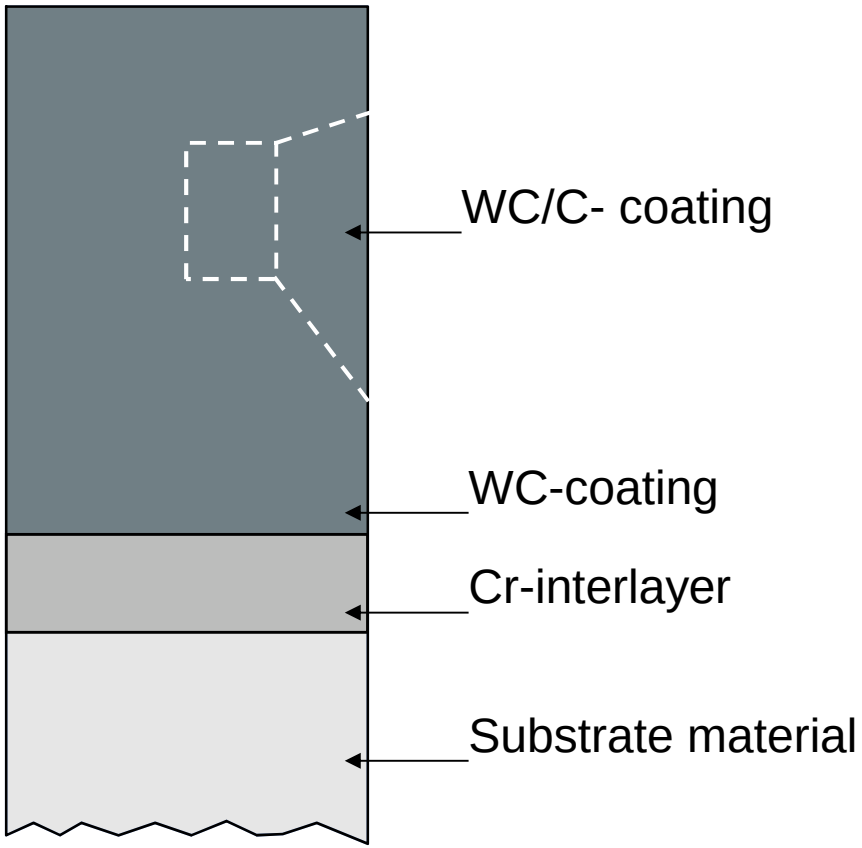
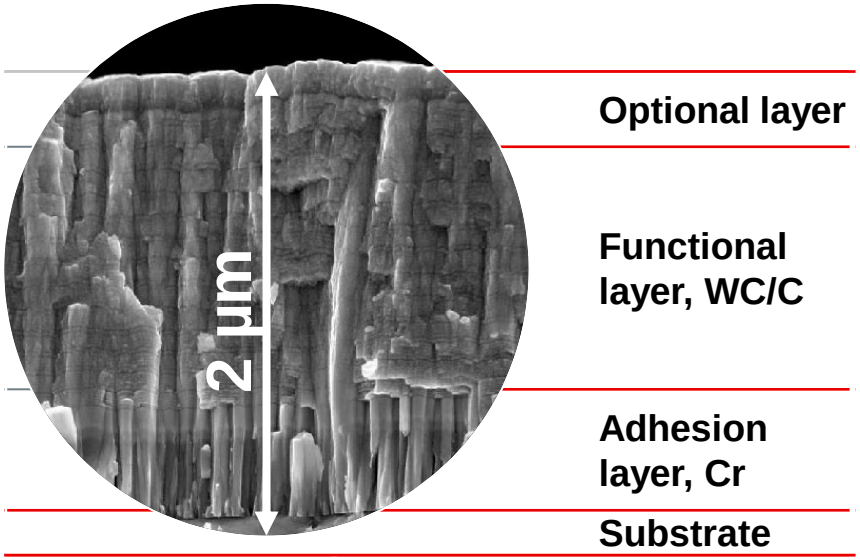
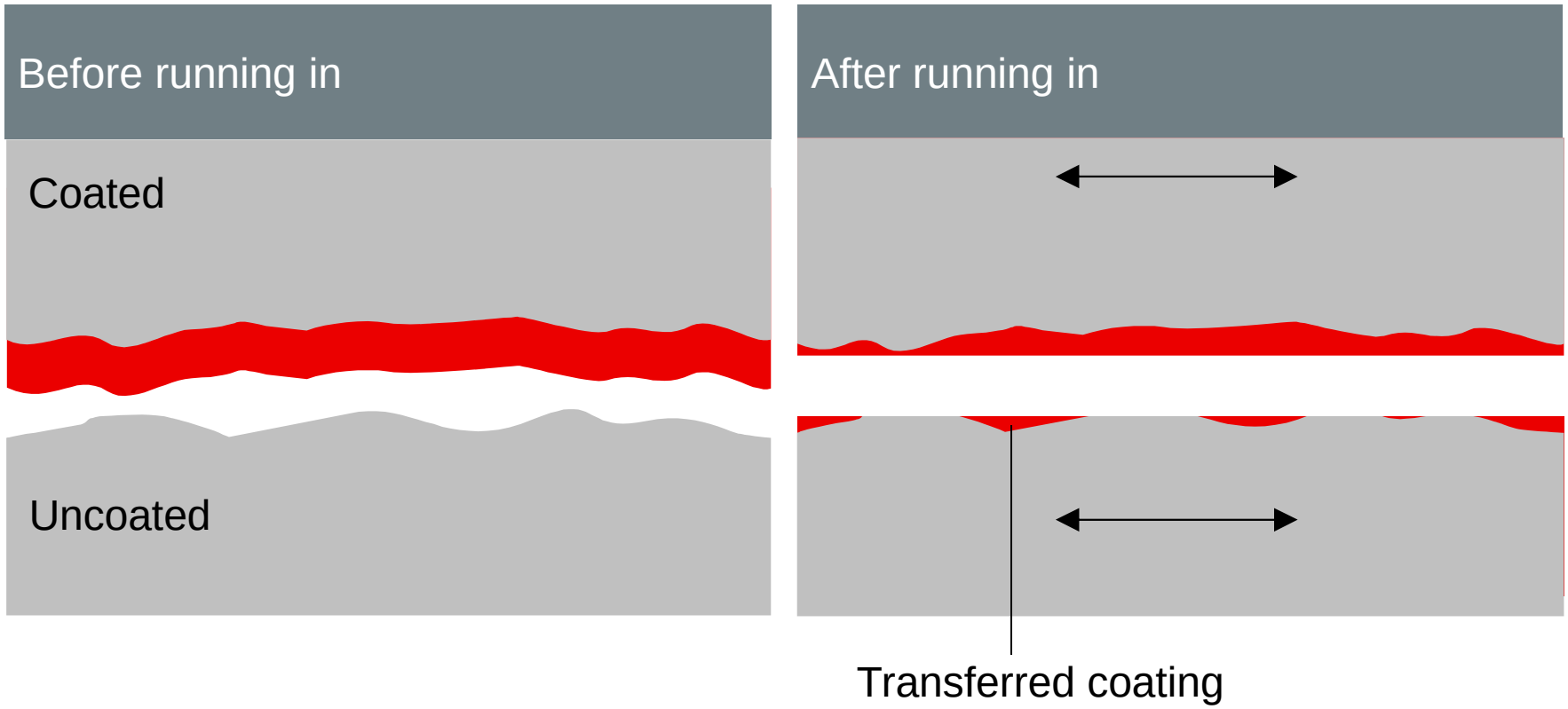
Total coating structure



WC/C-Section



Running in behaviour of BALINIT® C (WC/C)



BALINIT® C (WC/C) shows excellent running in behaviour.

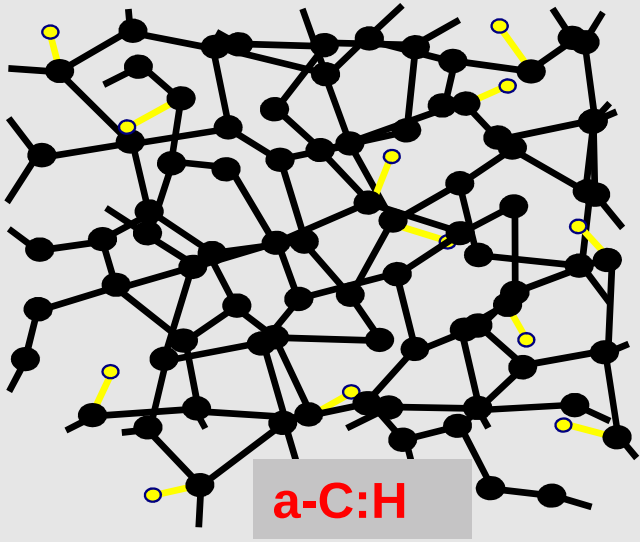
Oerlikon Balzers DLC coating families

Hard amorphous carbon thin film

DLC

- very hard
- electrically insulating
- wear resistant

Comprises C, H (a-C:H)
Carbon in sp^3 bonding => "Diamond-like" properties
DLC is a family of coatings (doped / undoped)

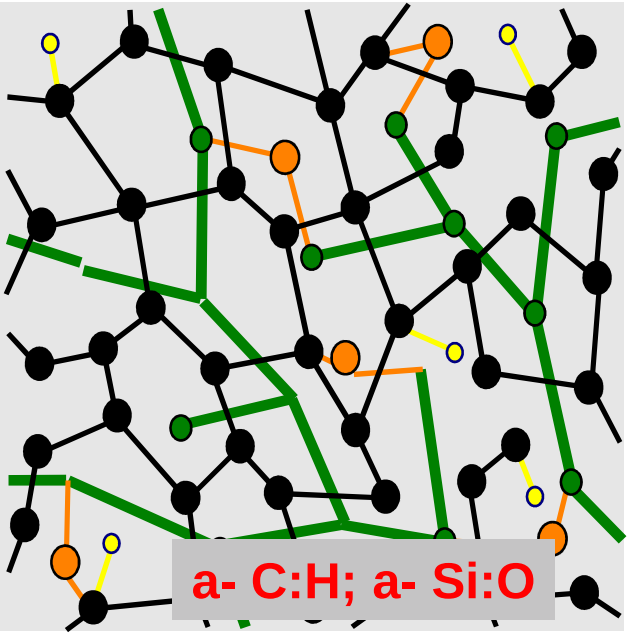


Hard amorphous carbon thin film

DYLYN

- very hard
- electrically insulating
- wear resistant
- lower friction
- low film stress

Comprises C, H, Si, O
a-C:H ~ "Diamond-like" properties
a-Si:O ~ enhances high temperature stability
DYLYN® is a family of coatings



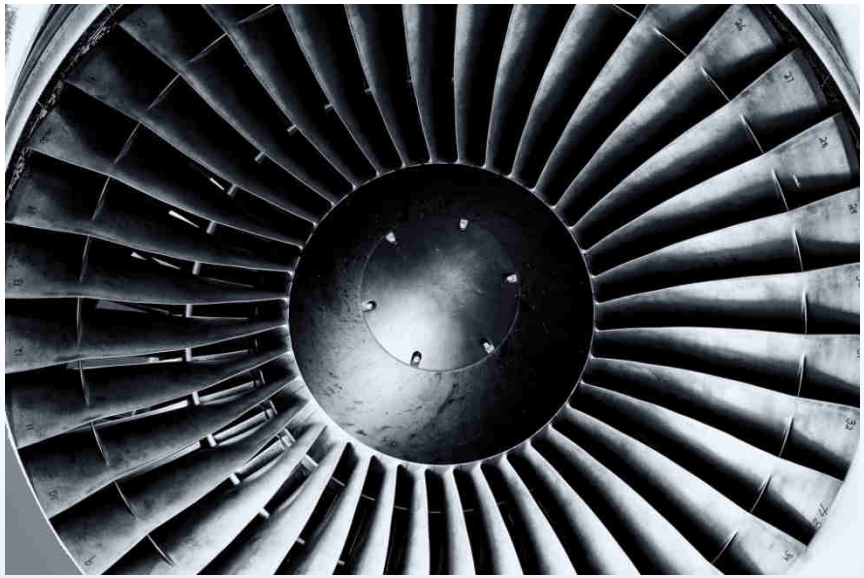
BALINIT® TURBINE PRO
Benefits

- BALINIT® TURBINE PRO: the new anti-erosion coating offers a new level in erosion and corrosion protection for turbine blades.

- 5 times more erosion protection than previous multilayer coatings on the market

- Minimal fatigue debit of around 5%

- Cavitation results in less than 0.1% mass loss on titanium substrates



Coating Properties

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Coating material	TiAlN	a-C:H:Me (W)		a-C:H	CrN	a-C:H + CrN	TiN	AlCrN
Coating type		C1000	C1500					
Typical Microhardness (HK 0.01)*	3,300	1,000	1,500	> 2,000	1,750	> 2,000	2,300	3,200
Typical coating thicknesses (µm)	5 - 35	1 - 4		0.5 - 3	1 - 4	2 - 5	1 - 4	1 - 4
Coeff. of friction against steel (dry)*	0.4	0.1 - 0.2		0.1 - 0.2	0.5	0.1	0.4	0.4
Coating temperature (°C)	< 500	(~160) < 250		< 250	< 250	< 250	< 500	< 500
Resistance to oxidation (°C)	900	~350		~350	700	350	600	1100

* depending on application and test conditions / ** no reliable results available

Competence in the heart of EU aerospace industry.

Aerospace coating specifications			
Customer	**Specification**	**Type of Coating**	**Group**
ROLLS ROYCE	RPS 673 (259, 367)	Ion Assissted deposition	
	RPS 51000	Degreasing	
AIRBUS	AIPS 0203003	TiN	EADS
	AIPS 0204007	WC/C	EADS
AIRCELLE	HPTR 0112	WC/C	Safran
ARTUS	ST-IG		Pacific Scientific
AIRBUS HELICOPTER	IFMA 856	WC/C	EADS
UTAS	212-002	WC/C	UTC
LATECOERE	DE-03	TiN	
LIEBHERR	MFT-360	WC/C	
	MFT-361	CrN	
MESSIER BUGATTI DOWTY	IFC 40-893-01-2	WC/C	Safran
NOVINTEC	ITN 380	WC/C	
NTN SNR	DAQ 01968	DLC	
RATIER FIGEAC	FN 144	WC/C	UTC
SKF AEROSPACE	MQS 13050	TiN-CrN-WC/C	
TECHSPACE	00R7030	WC/C	Safran
TURBOMECA	CCT-748	WC/C	Safran
IN-LHC	PG06-002	WC/C	Zodiac

Thank You.

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Close to you –
Anywhere in the world

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