

# BALINIT® Diamond: A world of Excellence

**oerlikon**  
balzers

HVM Graphene+ 2014 Conference

*Oxford, UK 15*

[www.hvm-uk.com](http://www.hvm-uk.com)

*John Bexkens, Product Manager Diamond Coatings*  
*Toby Middlemiss, Product Manager Components*



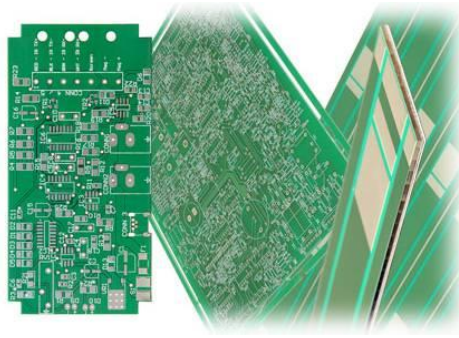
# Agenda

- 1** Applications range BALINIT® Diamond
- 2** BALINIT® Diamond coating & technology
- 3** Focus on Carbon fiber reinforced plastics machining
- 4** Center of Competence in Luxembourg
- 5** Balzers Carbon Coatings Portfolio
- 6** Racing Applications
- 7** Automotive Applications
- 8** High End Deco Applications

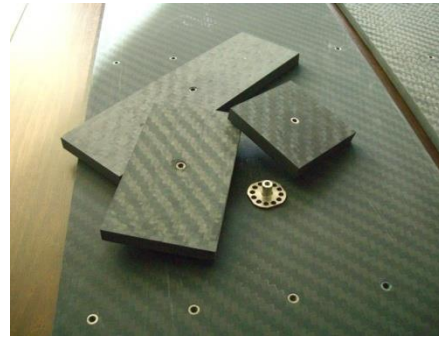
# Application range BALINIT<sup>®</sup> DIAMOND



**Graphite  
Moulds  
manufacturing**



**PCB  
Electronics**



**Composites & MMC's  
Aerospace  
Automotive  
home appliances  
Wind power**



**AI based materials  
Automotive,...  
Aerospace**



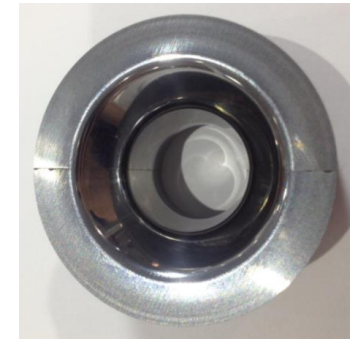
**Ceramics (greens, sintered)  
Dental, machinery**



**Wood Industry**



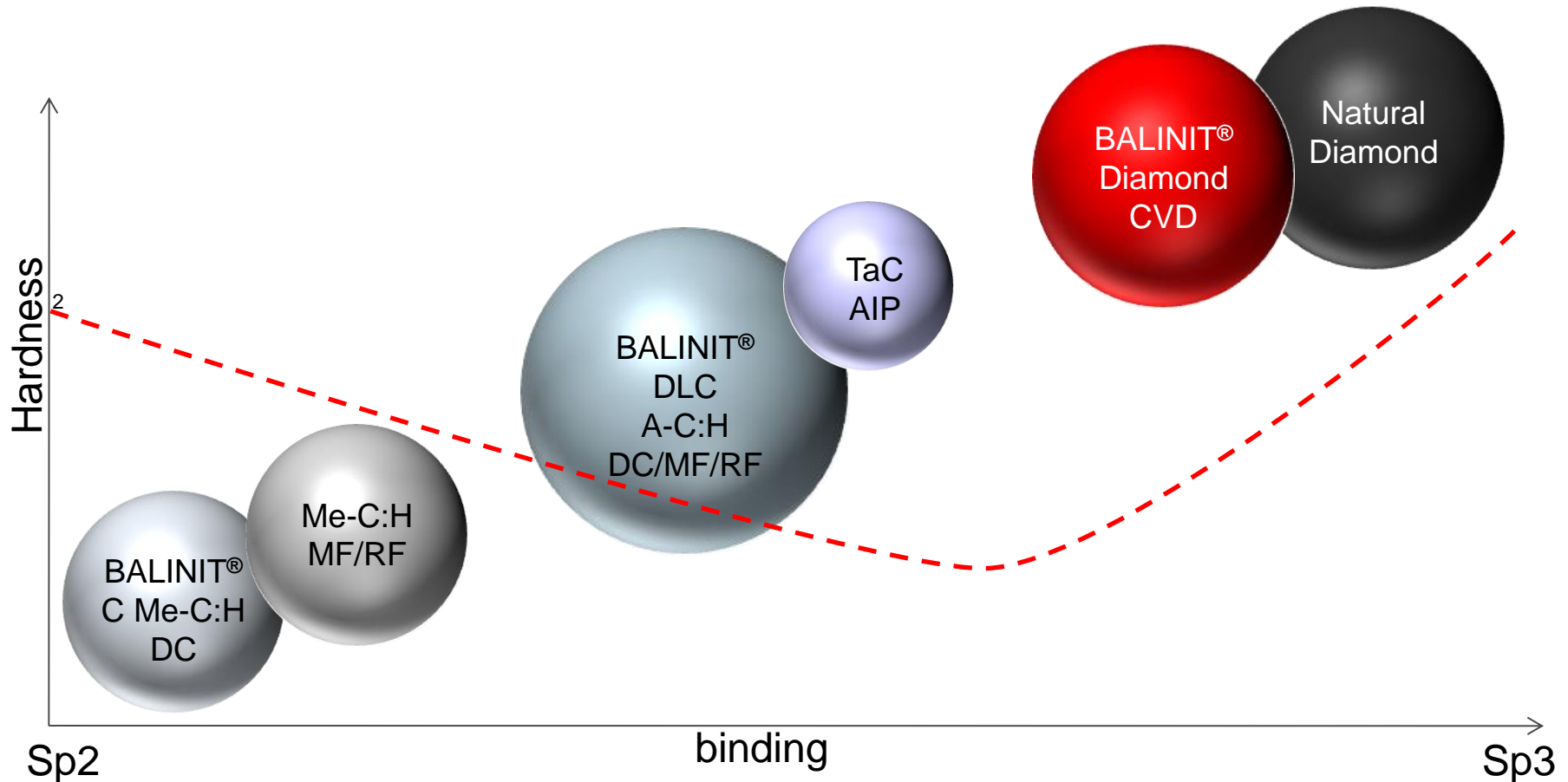
**Watch – Non ferrous  
materials**



**Dies**

# Carbon based coatings

Diamond is the hardest material known on earth



# The way to highly productive cutting tools

## Crucial factors

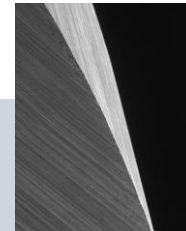
Cutting material



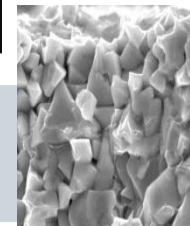
Tool design and geometry



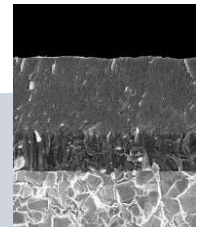
Tool surface / edge preparation



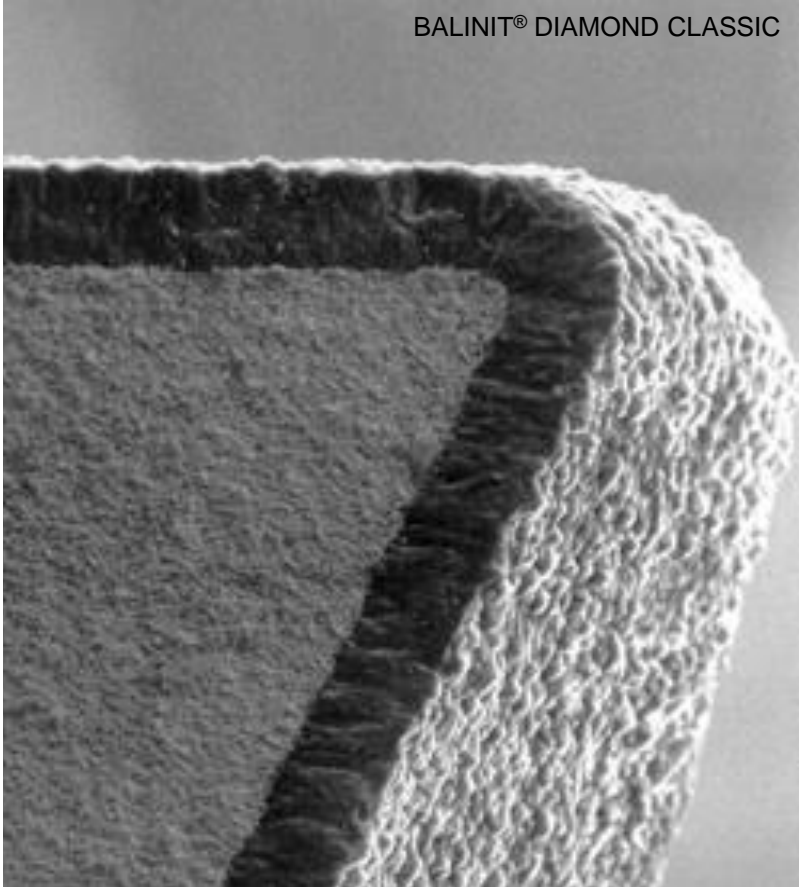
Tuned chemical pretreatment



Coating



# BALINIT<sup>®</sup> DIAMOND Coating Properties

	PA-CVD	CVD	BALINIT <sup>®</sup> DIAMOND CLASSIC
Composition	ta-C	C (sp <sup>3</sup> )	
Depositiontemp.	< 100°C	800 – 850°C	
Max. temp of use	500°C	600°C	
Coeff. of friction (against Al, dry)	0.08–0.12	0.1	
Microhardness (Hv)	> 5000	10000	
Coating Thickness	0,5 – 1 (µm)	6 <sup>+2</sup> (µm)	
Colour	black rainbow	grey	



## BALINIT<sup>®</sup> DIAMOND technology:



### Unique Balzers patented technology (Classic)

- For graphite machining
- High wear resistance coating
- Improved life time of carbide tools
- Standard thickness  $6^{+2} \mu$
- Special thickness such as  $8\mu$ ,  $10\mu$  on request

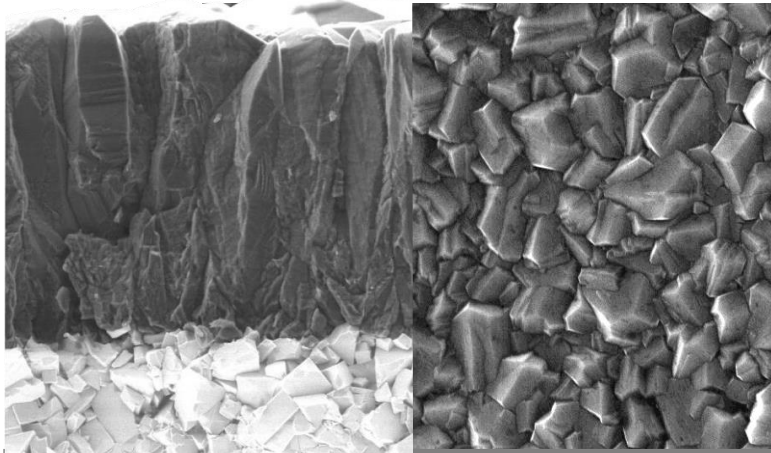


### Hot filament technology (Plus)

- For high demanding applications
- Tight tolerances
- Smooth coating
- Standard thickness  $6^{+2} \mu$
- Special thickness such as  $8\mu$  or  $12\mu$  on request

# BALINIT® DIAMOND

## CLASSIC



Coating properties

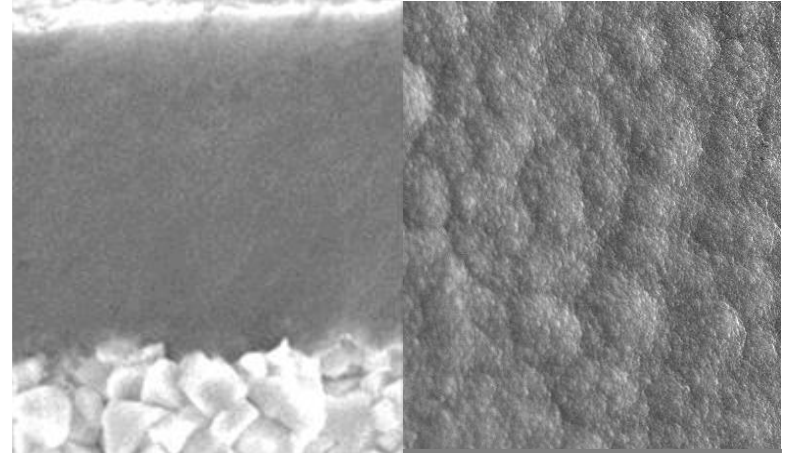
Structure crystalline ( 1-2  $\mu\text{m}$ )

- +++ abrasive wear resistance
- ++ coefficient of friction (against Al)
- ++ precision

### Main Applications

- Graphite for EDM electrodes (moulds)
- Ceramics
- Platinum

## PLUS



Coating properties

**nanocrystalline ( 30 – 40 nm)**

- +++ precision
- +++ coefficient of friction (against Al)
- ++ abrasive wear resistance

### Main Applications

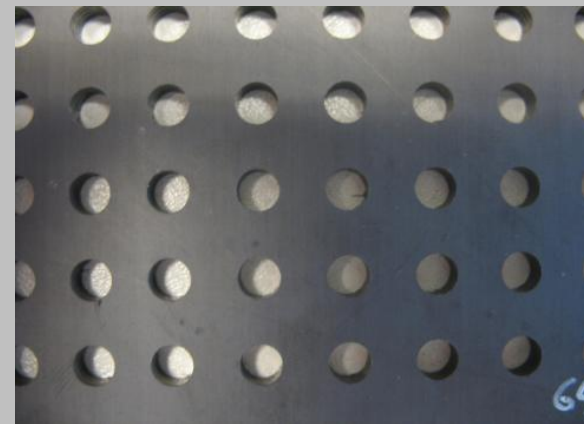
- **Composites / Carbon fiber reinforced plastics (CFRP)**
- Highly abrasive Aluminium (Si>9%)
- PCB (printed circuit board)



# Machining of CFRP: BALINIT® DIAMOND PLUS



- Balinit® Diamond Plus enables low wear of the tool, high process stability, high accuracy and excellent surface finish when machining CFRP materials
- Many applications running today and qualified by Airbus



*Fig: CFRP test plate for drilling sampling/qualification  
No delamination, high hole quality and accuracy  
thanks Balinit® Diamond Plus*

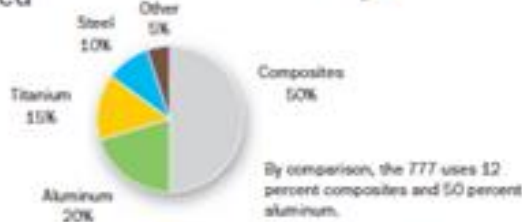
# Aerospace: New Generation aeroplanes with 50% CFRP (vol.%) (787 Dreamliner, A350 XWB, A380)

## Materials used in 787 body

- Fiberglass
- Aluminum
- Carbon laminate composite
- Carbon sandwich composite



## Total materials used By weight



## Boeing 777



Primary/Secondary structure  
CFRP usage : Approx. 10t

## Boeing 787



Primary/Secondary structure  
CFRP usage: Approx. 35t

## Airbus A320



Primary/Secondary structure  
CFRP usage: Approx. 2t

## Airbus A380



Primary/Secondary structure  
CFRP usage: Approx. 35t

Source: Airbus, Sandvik, Toray

# Trends for CFRP in automotive industry to follow the aerospace trend ?



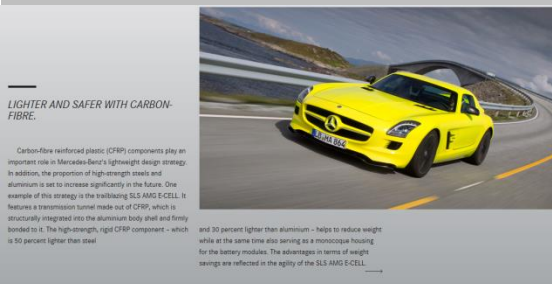
BMW :  
Joint venture with SGL (51%)

i3: Launch 2013

i8: Launch planned 2014

- Light weight construction: CFRP
- Electrical engine

Mercedes, Daimler  
Cooperation with Toray (Japan)



Audi  
Cooperation with Voith



Volkswagen  
Partnership with SGL (bought 8.18% of shares of SGL)

Jan 2011, 1Liter car presented with a Carbon Carosserie, productioncosts dropped from 35K€ down to 5K€

Source: BMW, Mercedes, VW, Carbon Composites Fachtagung 2013

# Oerlikon Balzers Luxembourg

## World wide center of competence for Balinit®Diamond & ta-C



### Oerlikon Balzers Diamond Coating Luxembourg

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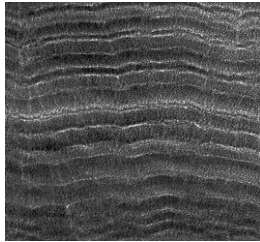
This center is NADCAP\* accredited since 2007

\*NADCAP is the quality standard to fulfill the requirements of the aerospace industry.

## BALINIT® C (WC/C)

### a-C:H:Me

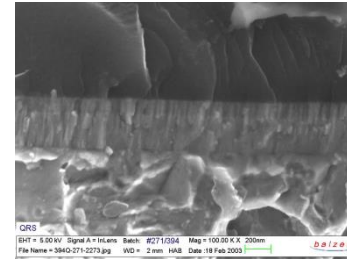
- very good adhesion
- high elasticity
- moderate hardness (1'000 / 1'500 HV)



## BALINIT® DLC

### a-C:H

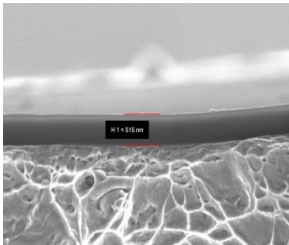
- high wear resistance
- higher hardness (>2'500 HV)
- low friction



## BALINIT® HARD CARBON

### ta-C

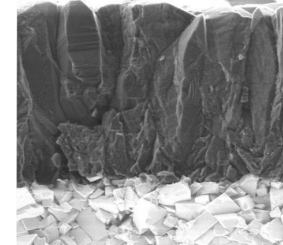
- hydrogen-free
- high hardness (5'000 HV)
- Temperature resistance up to 450°C



## BALINIT® DIAMOND

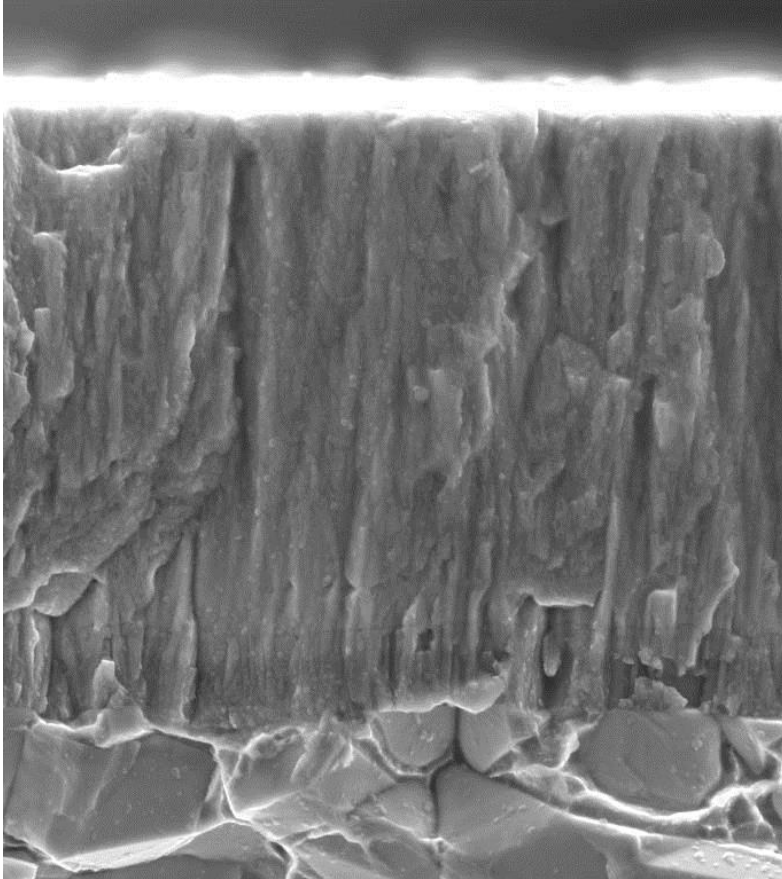
### PCD / NCD

- max. wear resistance
- max. hardness (10'000 HV)
- Temperature resistance up to 800°C



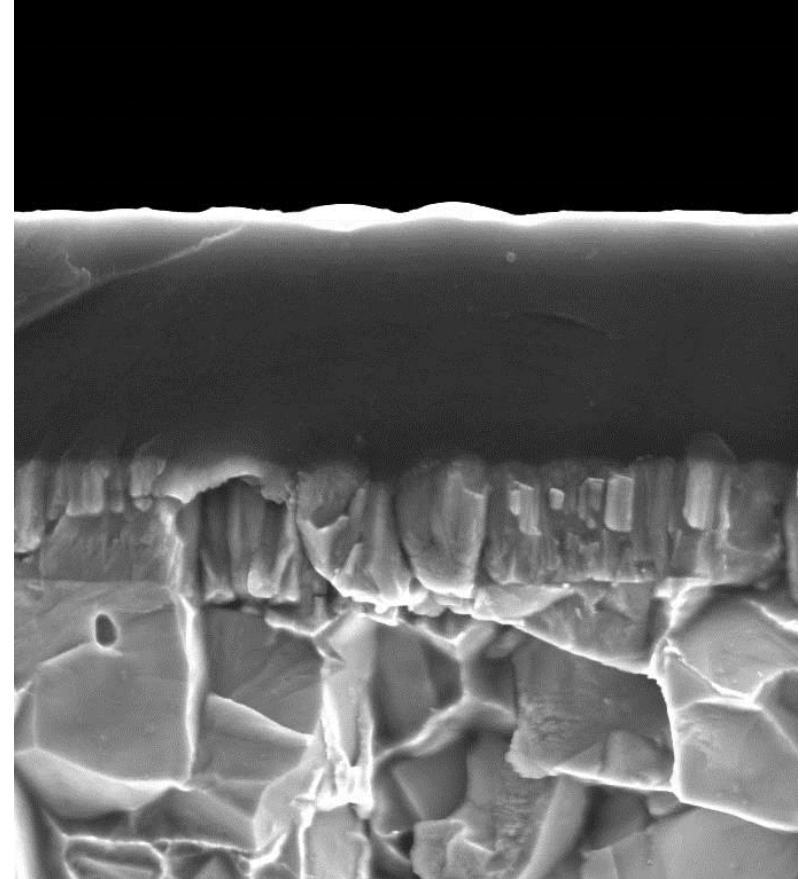


# BALINIT<sup>®</sup> C and BALINIT<sup>®</sup> DLC



BALINIT<sup>®</sup> C (WC/C)

1 µm



BALINIT<sup>®</sup> DLC

1 µm

# Racing components

Surfaces of racing components are subjected to extreme loads. Reliability and performance are key for success. Coatings with high wear resistance and low friction are required.

Many sliding components are coated with BALINIT<sup>®</sup> DLC, BALINIT<sup>®</sup> C (WC/C) or BALINIT<sup>®</sup> CNI (CrN). The reduced friction results in higher top speeds, increased wear resistance results in higher reliability.



# Coatings for automotive and precision components



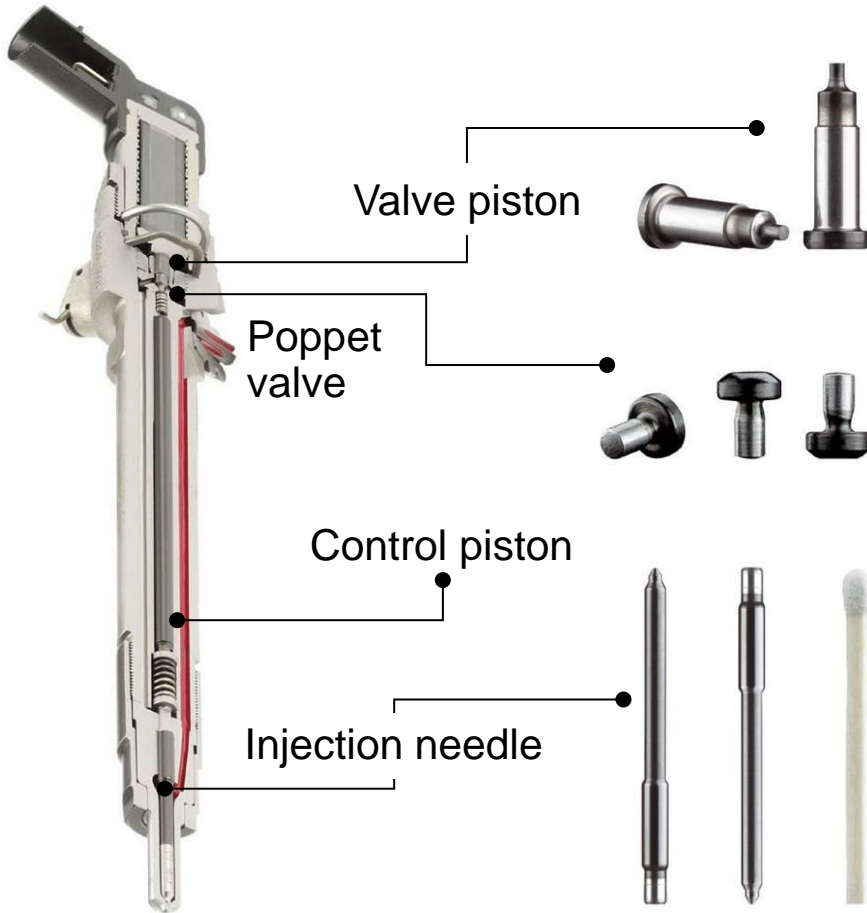
**Wrist pins**

**Injection system**

**Rocker arm**

# Performance increase by BALINIT®

## Diesel injector with piezo technology



Components of the injector out of a Common-Rail diesel injection system are coated with performance increasing carbon coatings in mass-production

BALINIT® DLC-coated injection needles are dimensionally stable even in long-term usage, thus ensuring the leak tightness of the system. The good sliding properties guarantee a precise flow of the diesel fuel

BALINIT® C-coated valve pistons virtually show no wear even at extreme pressures

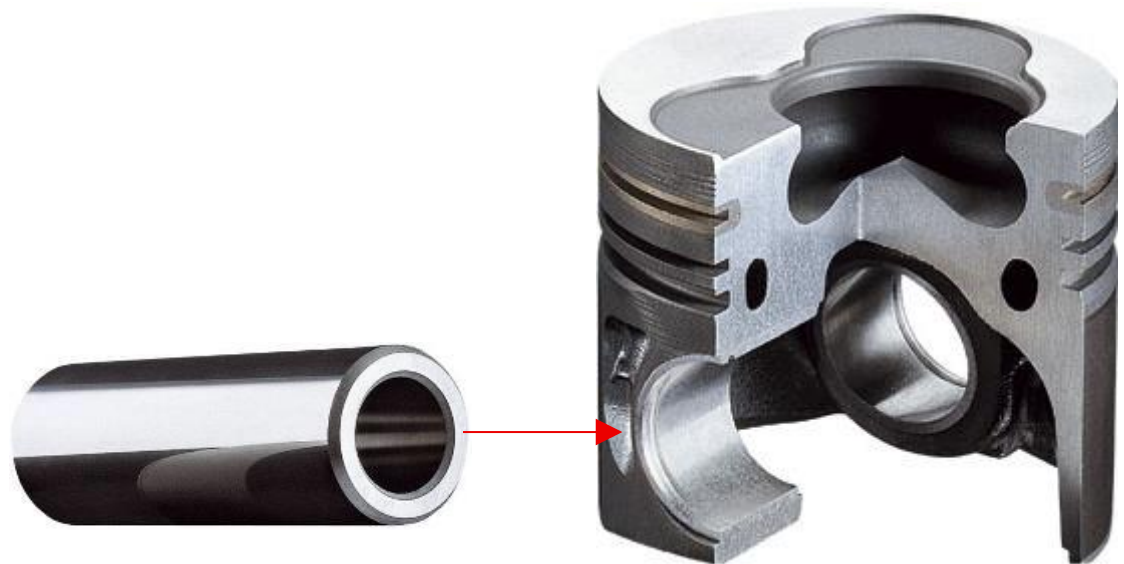
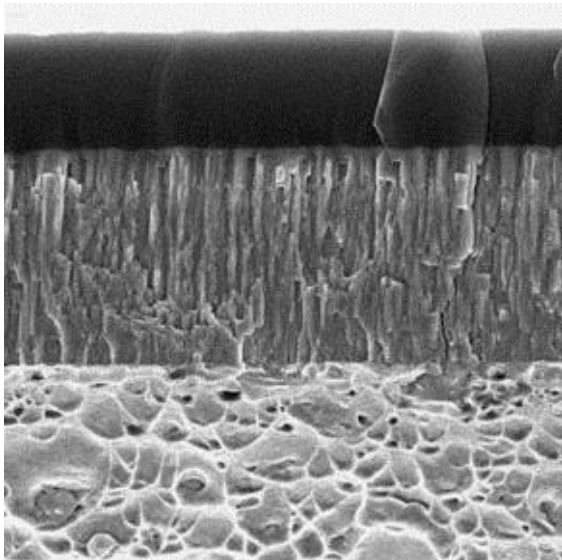
Image source:  
Continental



# Technological and economical success with BALINIT®

## Coating of wrist pins

- Improvement in economic efficiency of high quality DLC-coating with new coating system RS 90
- Mass production for suppliers of automotive industry





# High end deco applications

**Watches**



**Consumer Electronics**



**Automotive Interior**



**Pen & Office Tools**



**Sanitary Industry**



## Functional/decorative coatings for interior parts

- Dry running
- Longer service cycles
- Attractive coloration



## Decoration exterior parts

- Attractive colorations for metal and ceramic
- High scratch resistance
- High abrasion resistance
- Hypo-allergenic



