PLATIT®

Compendium 2012

49th Edition

QUAD Coatings4®

TripleCoatings3®

Think Twice.
Go Triple. Even QUAD.

PLATIT COMPENDIUM 2012

Content

PLATIT is a Member of the BCI Group

The Spirit of a Family

60 years of experience in coating business give us the competence to develop, produce and install genuine Turnkey Coating Systems.

The new PLATIT building in Selzach / SO, Switzerland
Operational Headquarters & Project Engineering & R&D & Test Center & Logistics & Marketing

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PLANAR building in Riaz / FR, Switzerland
Production & Service of PL1001/PL2001

PIVOT building in Sumperk, Czech Republic
Production & R&D & Test Center & Service for PL70, π80, π111, π311

The 10 Commandments for PLATIT

Core competence: Development and production of high-tech PVD coating equipment & coatings

1. **Independence from large enterprises**
   Main marketing targets: SME companies
2. **Headquarters in Switzerland**
   Tradition, image, infrastructure, financing and tax system
3. **World wide distributed intelligence**
   Global cooperation with institutes, suppliers, coaters and users
4. **Balanced distribution of sales**
   More than 340 installations in 36 countries
5. **Flat, lean company structure**
   No hierarchies, focus on development, not on logistics
6. **Team spirit**
   Innovation and performance count, not origins and ties
7. **Blue Ocean Strategy**
   Products and markets ahead of and without competition
   - min. 1 new coating every year
   - new coating unit every 2nd year
8. **Win-Win with customers**
   Not discount but price/performance decides competitiveness
9. **No job coating**
   Avoiding competition between customers and PLATIT
10. **Turnkey Systems**
    For integration into the production

BCI Group

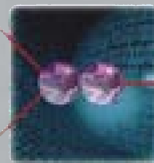
PLATIT is a member of the BCI Group, a family holding company that emerged from W. BLÖSCH AG. The presidents, Erich and Peter Blösch, are the sons of Walter Blösch, who founded the company in 1947. Headquartered in Grenchen, Switzerland, the group has over 300 employees worldwide.

BLÖSCH, Liss, SEDECAL, and Vilab, all focused on surface treatment, are also included in the BCI Group.

What started out as a supplier to the Swiss watch industry is now a powerhouse for high-tech functional and decorative coatings.

Erich and Peter Blösch, Presidents


Dr. Tibor Cselle, CEO, PLATIT AG

2002 —  Acquisition of Vilab AG in 1997. Vilab PCT (Profitcenter Technology) develops special coatings for the optical and watch industry.

Vilab

1995 — BCI: Innovative coatings for the watch industry:

1987 — PLATIT® — Start of the PLATIT project.

1985 — 
New construction for the production of hard coatings.

2001

2000 — i

1992 — 

LISS

1957 — Liss AG is founded for the production of watch dials and jewelery. First plant for the electroplating of precious metals is built.

BLÖSCH

1947 — W. BLÖSCH AG is founded by Walter Blösch for heavy gold plating of watch cases and jewelry.

PLATIT®

nACo® - nACRo®

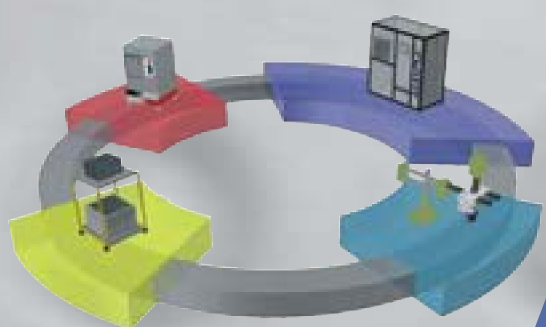
First nanocomposite coatings in industrial production.

2003

π^{80}

Research in nano-structured coatings leads to the introduction of the revolutionary π^{80} coating unit with LARC® technology.

PIVOT – PLATIT establishes PIVOT in a joint venture with SHM in the Czech Republic.



Development of turnkey systems for flexible coating, based on the *i*PL50 coating unit.

PLATIT AG was founded. Assembly of first PLATIT hard coating equipment.

2008 – π^{80+}

2007 – **200**

200th PLATIT machine installed.

TripleCoatings³®

2006 – ***nACVIc®*** 1st generation DLC-coatings based on Nanocomposites

π^{300}

2005 – The combination of LARC® and CERC® technology allows enormously high productivity and flexibility.

2004 – **100**

100th PLATIT machine installed.

PL1001 COMPACT

Introduction of the plug & play workhorse for conventional coatings.

Developments in 2009

Nanosphere

Dedicated coating for hobbing
(LMT-PLATIT patent)

2009

260

260th PLATIT machine installed.

The new generation of compact units as a base of turnkey systems for SMEs.

π111+OXI

π111+DLC

π111

OXI

π80+OXI **π300+OXI**

π80 and π300 can be upgraded to deposite OXI-coatings.

nACoX3® Oxides / Oxinitrides as **TripleCoatings3®**

DLC²

π80+DLC

π300+DLC

PL1001+DLC

All standard machines can be upgraded to deposite DLC² coatings.

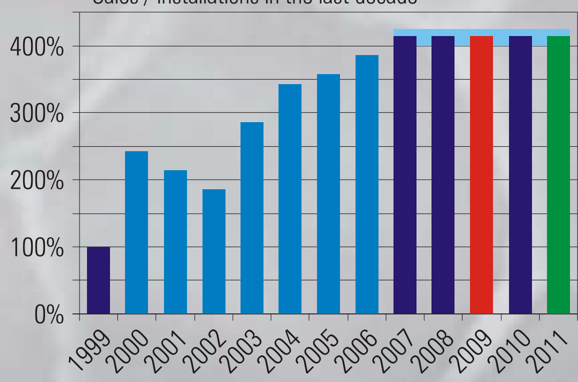
Fi-Vlc2® 2nd generation of Diamond Like Carbons as **TripleCoatings3®**

PLATIT®

Developments in 2010/11

The crisis hasn't stopped PLATIT and its developments, on the contrary:

Sales / Installations in the last decade



320

320th PLATIT machine installed.

LARC GD®

π311 +OXI

π311 +DLC

π311

Due to the possible upgrades for all standard machines, all users can participate in the benefits of the new technologies.

2010/11

PLATIT works with its partners, users and customers according to the **open source** philosophy:

- We deliver **turnkey systems** including coating, cleaning, edge preparation, handling and quality control.
- Beside their deliveries we are ready to share our **know how**, the **technology**; how to work with these systems.
- All coating units are open, the users can go deep into the **"source" of the technology**. Therefore the users are able to develop their own coatings and brands.

PLATIT® openSource

PLATIT Coating Systems in 36 Countries of the World

Europe

- Austria
- Belarus
- Bulgaria
- Czech Republic
- Denmark
- Estland
- France
- Finland
- Germany
- Netherlands
- Hungary
- Italy
- Norway
- Russia
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- United Kingdom

Asia

- China
- Hong Kong
- India
- Israel
- Japan
- Pakistan
- Singapore
- South Korea
- Taiwan
- Thailand
- Turkey
- United Arab Emirates

Americas

- Brazil
- Canada
- Mexico
- USA

Coating Advantages

PLATIT develops and produces coating equipment for plasma-generating PVD (Physical Vapor Deposition). Our products are based on:

- *conventional cathodic ARC technology (PL 70, PL1001, PL 2001), and*
- *the unique LARC® (LAteral Rotating Cathodes) and CERC® (CEntral Rotating Cathodes) technologies for the π series of units.*

We hold a significant number of patents related to coatings, coating techno-logies, and processes.

PLATIT coatings offer the highest standard of modern coating technology for tool steels (cold / hot work steel, high speed steel; HSS, HSCO, M42, ...) and tungsten carbides (WC). All work pieces can be coated with a programmable coating thickness between 1 and 18 µm. All batches are coated with high uniformity, ensuring the repeatability of the coating quality.

Cutting

The PLATIT hard coatings reduce the abrasive, adhesive and crater wear on the tools for conventional wet, dry and high speed machining. Modern coating technology reduces ARC droplets and the friction between chip and tool.

All carbide tipped tooling must be manufactured with brazing material that contains no cadmium and no zinc. Cadmium and zinc are not stable under the high vacuum at the coating process temperatures. Braze outgassing will ruin the strength of the joint, contaminate the tooling surface and the vacuum chamber.

Punching

PLATIT technology ensures an increase in tool life through the reduction of friction on punches, molds and dies.

Forming

For forming applications such as extrusion, molding, deep-drawing, coining, PLATIT hard coatings reduce friction, wear, built-up edges and striation. Repolishing of functional surfaces is not necessary in most cases.

Injection Molding

The PLATIT hard coatings increase productivity for plastic forming and forming machine components with better release and lower wear. Low roughness and excellent surface texture improve part release and influence injection forces in the mold to allow shorter cycle times. For parts with a mirror finish, repolishing after coating is recommended. Due to physical limitations, deep holes and slots are seldom coatable.

Tribology

PLATIT hard coatings solve tribological problems with machine components that can be coated at temperatures of 200-600°C. Due to the hardness (up to 45 GPa), abrasive wear is reduced. This leads to higher reliability for dry operations, and environmentally damaging lubricants can be replaced.

Basic Application Fields

Cutting

Punching

Injection Molding

Forming

Tribology

Flexible Coating

Application Oriented

Different objects (e.g. tools) are not coated with one universal coating, but in separate batches with the optimal coating for their individual applications.

User Oriented

Large and small part quantities can be coated according to the customer's specifications.
Users can create new coating brands to coat special parts for highest performance and their own marketing.

Highly Reproducible

All customer-dedicated batches can be repeated with the same exact parameters and under the same conditions.

Fast

The collection of similar pieces to be coated in one batch can be minimized. No waiting times.

Economical

The system's payback is ensured even at just a few batches per day, since coating times are much shorter than with conventional units.

Large Volume Coating

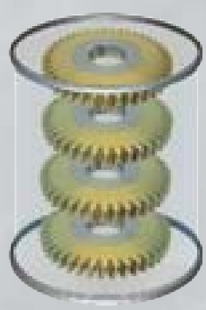
Standard Coating for All Pieces

In industrial mass coating, different types of substrates are often coated together. While high volumes may raise profitability, coating performance often suffers. Also, process times are typically much longer than with smaller quantities.

The π^{300} and PL1001 units make traditional high-volume coating flexible. They offer high-quality coatings and short cycle times. Different substrate types and sizes can be mixed without sacrificing coating quality.

Dedicated Coating

The PL70, π^{80}, π^{111}, and π^{300} units make specially tailored coatings possible and economical, even for small and medium-sized batches.



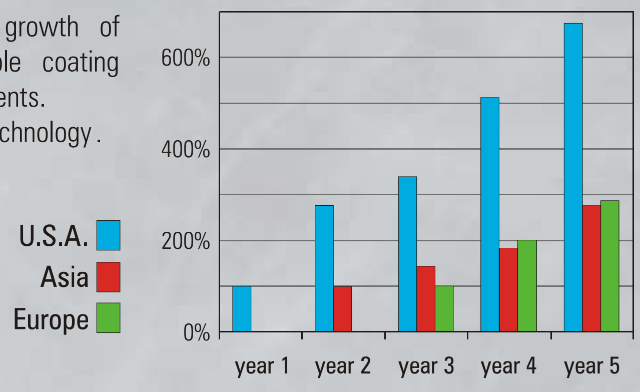
Dedicated TiN
for milling cutters

Dedicated TiAlN
for end mills

Dedicated TiCN
for punches and dies

Flexible Coating Growth

This chart shows the growth of turnover in three flexible coating centers on different continents.
They are all using PLATIT technology .



Integrated Coating

The PL70, π^{80}, π^{111}, and π^{300} units are suitable for integration into the manufacturing process. This creates the opportunity to

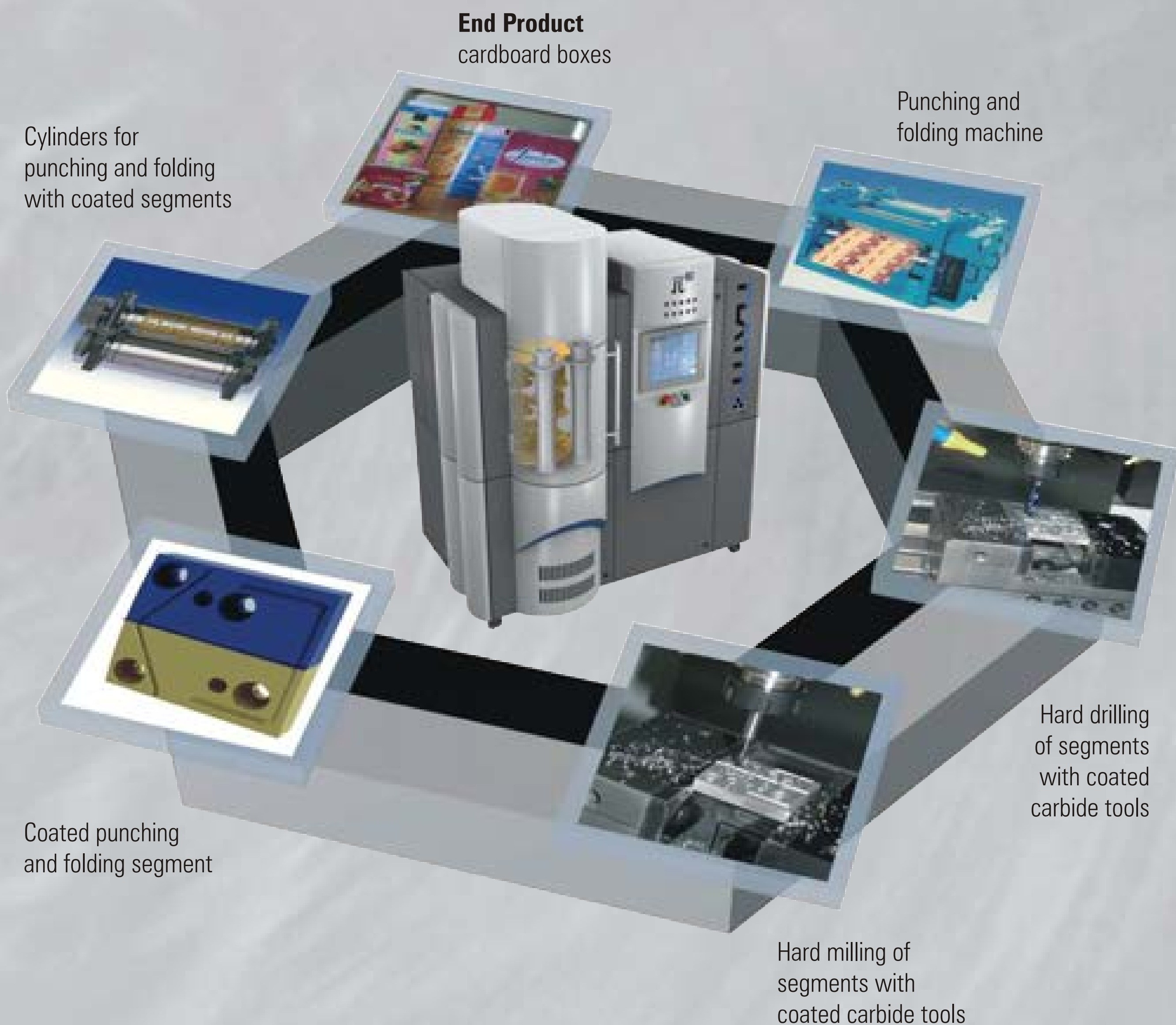
- generate new coatings (such as nanocomposites) and coating brands
- reduce logistics, transport, and storage costs
- operate with own pretreatments, tool geometries and keep them confidential
- manage the quality and timeline for entire production internally
- create earnings through coating

Insourcing the coating process does not require more staff than that for logistics, packaging, shipping and cooperating with the job coater. The break-even of PLATIT coating systems is typically achieved in less than 2 years.

With the high flexibility of the PLATIT units, coatings can be applied

- for the cutting and forming tools used in production and
- for own products, including machine parts

The example below is taken from Madern, Vlaardingen, NL



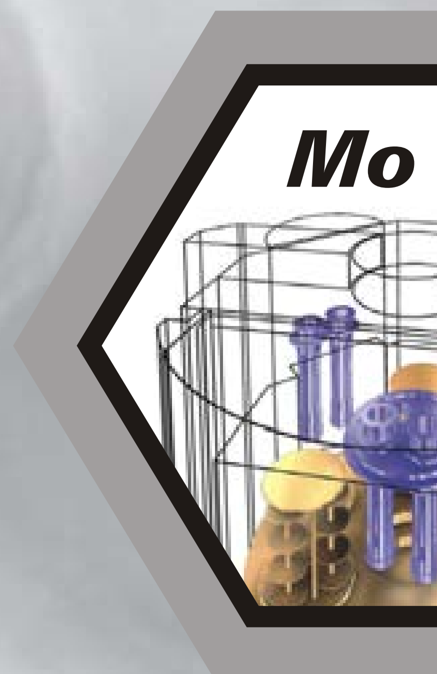
MoDeC® Innovations

PLATIT's coating concept - Modular Dedicated Coating - allows the configuration of the number of cathodes, type, and position according to the coating task. MoDeC® is the driving force behind PLATIT innovations. New coatings and units are developed with this principle in mind.

$\pi^{80} - \pi^{80+}$

LARC® technology: LAteral Rotating Cathodes

- The first industrial compact coating unit for nanocomposite coatings
- Coatable volume: ø300x400 mm



PL70

- Easy-to-Start coating unit with 1 linear planar ARC-Cathode
- Fully upgradeable to π^{80} and π^{80+}
- Coatable volume: ø300x400 mm

PL1001 COMPACT

High volume coating unit with 4 linear planar cathodes:

- For conventional coatings
- The "workhorse" for coating centers
- For selected TripleCoatings3®
- Coatable volume: ø700 x 700 mm

PLATIT's entire product line consists of "compact" coating units. These units come in one piece, with the coating chamber in the same cabinet as the electronics. This eliminates the need of costly and time consuming on-site assembly.
Since 2009 all new standard units are upgradeable for the deposition of 2nd generation DLC^2 coatings.

π111

LARC® technology: LAteral Rotating Cathodes
- The new generation of the first industrial coating unit for Nanocomposite coatings
- The heart of turnkey coating systems for SMEs
- Selected Triple**Coatings3®**
- Coatable volume: ø355x460 mm

π311

LARC® + CERC® technology
(CEntral Rotating Cathodes)
- Medium size compact coating unit
- For conventional and Nanocomposite coatings
- All Triple**Coatings3®**
- Selected QUAD**Coatings4®**
- Coatable volume: ø485x440 mm

π411

LARC® + CERC® technology
- High performance compact coating unit
- All 4 cathodes deposit simultaneously
- For conventional and Nanocomposite coatings
- All Triple**Coatings3®** and QUAD**Coatings4®**
- Coatable volume: ø500x460 mm

PLATIT PL70
Upgradeable to π^{80+}

General Information

- 1-linear-cathode compact hardcoating unit
- Based on PLATIT planar-cathodic ARC-technology
- Coating on tool steels (TS) above 230 °C, high speed steels (HSS) and on tungsten carbide (WC) between 350 - 550°C
- The easy-to-start coating unit
- Fully upgradeable to π^{80+}

Hard Coatings

- Monoblock and gradient coatings
- Main standard coatings: TiN, TiCN-grey
- See available standard coatings on page 114

Hardware

- Foot print: W1870 x D1320 x H2155 mm
- Vacuum chamber with internal sizes of: W400 x D380 x H520 mm
- Usable plasma volume: Ø300 x H400 mm
- Max. load: 50 kg
- System with turbo molecular pump
- Ionic plasma cleaning:
  - Etching with gas (Ar/H2): glow discharge
  - Metal ion etching (Ti, Cr)
- DC BIAS supply
- Only high quality, brand-name components
- Electrical connection: 3x400V, 80A external fuse 50-60 Hz, 15 kW

Electronics and Software

- Industrial PLC (programmable logic control) system
- Industrial PC system
- Control system with touch-screen menu driven concept
- Manual and automatic process control
- Data logging and real-time viewing of process parameters
- Remote diagnostics
- No programming knowledge is required for process control
- Operator's manual on CD-ROM

Cycle Times

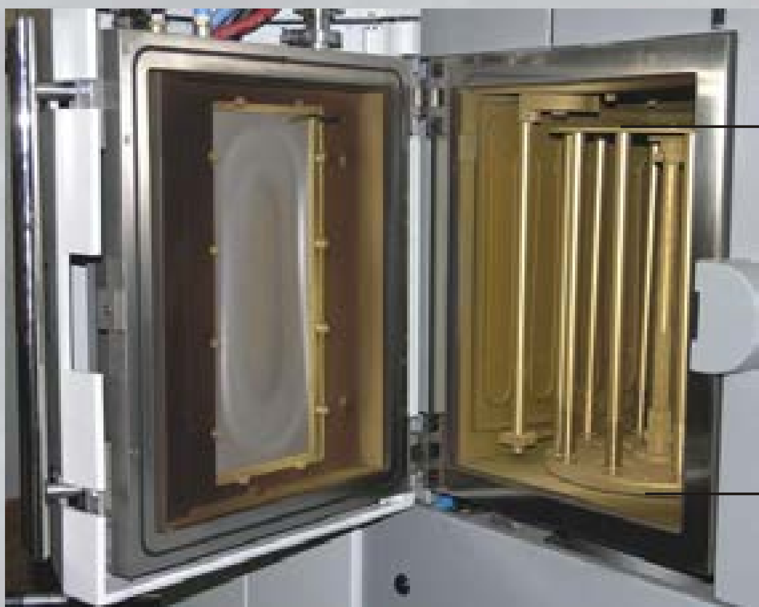
At continuous operation for coating tools, with standard thicknesses for:

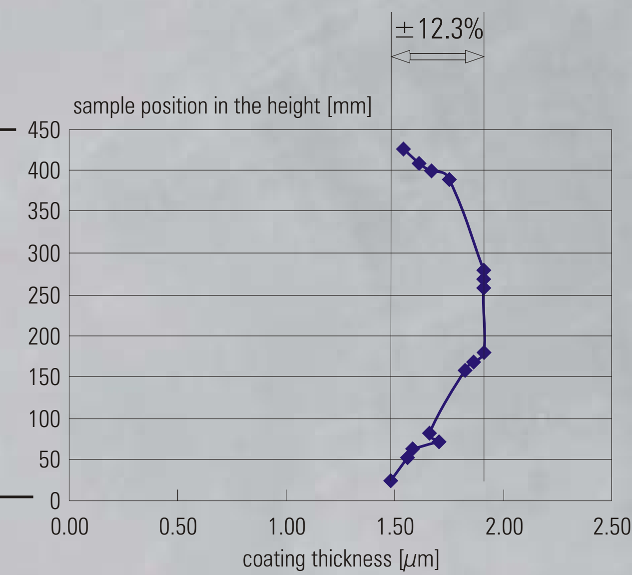
- Shank tools (2 μm): ø 10 x 70 mm, 162 pcs: 3.25 h
- Inserts (3 μm): ø 20 x 6 mm, 1260 pcs: 3.5 h
- Hobs (4 μm): ø 80 x 180 mm, 6 pcs: 5.25 h

PL70 Features

Thickness Distribution

The PL70 maintains an excellent thickness distribution from chamber height 25 mm to 425 mm. Typically it remains between ±12.5%.





For homogeneus batches.

Average thickness: 1.7 um – Max=1.91 um – Min=1.49um – Max. scatter = 0.42um: ±12.3%
Application: Coating small mold and dies with TiN - Measured by BYD, Shenzen, China

Convertibility to π^{80} or π^{80+}

The PL70 can be converted to a π^{80} or π^{80+} unit. To perform the conversion, the coating door containing the cathodes as well as the face plates are exchanged, the electronics hardware is extended, and new control software is installed.

Its low costs and the ability to upgrade makes the PL70 the optimal choice for coating start-ups. Also, it can be used as a second machine alongside bigger coating units, for applying conventional coatings only.

PLATIT π^{80} and π^{80+}

General Information

- Compact hardcoating unit
- Based on PLATIT LARC® technology (LAteral Rotating Cathodes)
- Coating on tool steels (TS) above 230 °C, high speed steels (HSS) 350 - 500 °C and on tungsten carbide (WC) between 350 - 550 °C

Hard Coatings

- Monolayers, Multilayers, Nanogradients, Nanolayers, Nanocomposites, and their combinations
- Main standard coatings: TiN, AlTiN-G, nACo®
- See available standard coatings on page 114
- Available Triple**Coatings^3®**: AlCrN^3®

Hardware

- Foot print: W1870 x D1320 x H2155 mm
- Vacuum chamber with internal sizes of: W400 x D380 x H520 mm
- Usable plasma volume: Ø300 x H400 mm
- Max. load: 50 kg
- System with turbo molecular pump
- Revolutionary rotating (tubular) cathode system with 2 LARC® cathodes:
  - LARC® target size: Ø96 x H510 mm
  - Magnetic Coil Confinement (MACC) for ARC control
  - Double wall, stainless steel, water cooled chamber and cathodes
  - Changing time for skilled operator: approx. 15 min / evaporator
- VIRTUAL SHUTTER®
- Ionic plasma cleaning:
  - etching with gas (Ar/H2), ion bombardment, and glow discharge (Ti, Cr)
- DC BIAS supply
- With air conditioning unit on top of electric cabinet
- 4 (+1) gas channels, 4 MFC controlled
- Electrical connection: 3x400V, 100A external fuse 50-60 Hz, 20 kW

Electronics and Software

- Industrial PC and PLC system
- Control system with touch-screen menu driven concept
- Manual and automatic process control
- Data logging and real-time viewing of process parameters
- Remote diagnostics
- No programming knowledge is required for process control
- Operator's manual on CD-ROM

Cycle Times

At continuous operation for coating tools, with standard thicknesses for:

- Shank tools (2 μm): ø 10 x 70 mm, 162 pcs: 3.5 h
- Inserts (3 μm): ø 20 x 6 mm, 1260 pcs: 3.75 h
- Hobs (4 μm): ø 80 x 180 mm, 6 pcs: 5.5 h

π^{80+} Additional Hardware

- TUBE SHUTTERS®
- Pulsed BIAS supply (350 kHz)
- Dust filter for heaters (7.5 kW)

The 6 π Advantages & Double Shuttering

1. Low target costs due to the cylindrical rotating cathodes
- Large effective target surface; $d * \pi * h$
- Consistent target erosion
- Maximum target life; ~200 batches
- Low target costs/tool; ~0.07 CHF/tool

2. Optimum adhesion with VIRTUAL SHUTTER® and TUBE SHUTTER® due to:
- Turnable magnetic field
  - to the back for fast target cleaning
  - to the substrates for deposition
- Permanent presence of pure Ti or Cr target

3. Smooth coating surface with minimized droplets due to:
- VIRTUAL SHUTTER® and TUBE SHUTTER®
- Fast (double) ARC track motion
- Special heaters with dust filter

4. High hardness with the Nanocomposite coatings due to:
- Segregation into 2 phases, e.g. (nc-TiAlN)/(a-SiN)
- 2 targets very close to each other

5. High deposition rate due to:
- High ionized plasma with
- High magnetic field intensity
- Typically 2 - 8 μm/hour

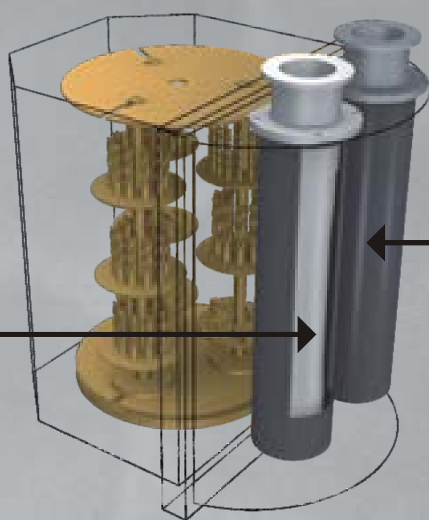
6. Programmable stoichiometry due to:
- Minimum distance between 2 targets

Deposition of:
- Nanocomposites
- Multi- and Nanolayers, gradient coatings
- Without changing the not alloyed targets; Ti, Cr, Al, Al(Si), Zr

VIRTUAL SHUTTER®

Target cleaning before coating

- TUBE SHUTTER® is closed
  - to protect the substrates from dust of the previous process
- ARC is burning towards the back
  - VIRTUAL SHUTTER® is on
- ARC works as getter pump and substantially improves vacuum
- Target is cleaned before deposition
  - without contaminating the substrates



TUBE SHUTTER®

Deposition (coating)

- TUBE SHUTTER® is open
- ARC is burning towards the substrates
  - VIRTUAL SHUTTER® is off
- Smooth deposition with clean target

Advantages of the double shutters
- Adhesion layer is always deposited with clean targets
- Shuttering of all cathode types possible
- Simple handling, setting and maintenance of the shields and ceramic insulators
- Higher ARC current -> higher deposition rate possible (~+20-30%)

PLATIT π111

General Information

- Compact hardcoating unit
- Based on PLATIT LARC® technology (LAteral Rotating Cathodes)
- Coating on tool steels (TS) above 230 °C, high speed steels (HSS) 350 - 500 °C and on tungsten carbide (WC) between 350 - 550 °C

Hard Coatings

- Monolayers, Multilayers, Nanogradients, Nanolayers, Nanocomposites, and their combinations
- Main standard coatings: TiN, AlTiN-G, nACo®
- See available standard coatings on page 114
- Selected TripleCoatings3® available

Hardware

- Foot print: W1890 x D1500 x H2120 mm
- Vacuum chamber with internal sizes of: W450 x D320(460) x H615 mm
- Max. size of coatable parts: Ø355 x H500 mm
- Usable plasma volume: Ø355 x H460 mm
- Max. load: 100 kg
- Turbo molecular pump
- Revolutionary rotating (tubular) cathode system with 2 LARC® cathodes:
  - LARC® target size: Ø96 x 510 mm
  - Magnetic Coil Confinement (MACC) for ARC control
  - Double wall, stainless steel, water cooled chamber and cathodes
  - Changing time for skilled operator: approx. 15 min / cathode
- VIRTUAL SHUTTER® and TUBE SHUTTER®
- LGD®: LARC® Glow Discharge
- Ionic plasma cleaning:
  - etching with gas (Ar/H_2); glow discharge,
  - metal ion etching (Ti, Cr)
- Pulsed BIAS supply (350 kHz)
- Air conditioning for the electric cabinet
- 5 (+1) gas channels, 5 MFC controlled
- Special dust filters for heaters (10 kW)
- Electrical connection: 3x400V, 100A external fuse 50-60 Hz, 30 kW

Electronics and Software

- Industrial PC and PLC system
- Enhanced operating software
- Control system with touch-screen menu driven concept
- Manual and automatic process control
- Data logging and real-time viewing of process parameters
- Remote diagnostics
- No programming knowledge is required for process control
- Operator's manual on CD-ROM
- Upgradeable to π111+DLC and π111+OXI on user's place

Cycle Times

At continuous operation for coating tools, with standard thicknesses for:

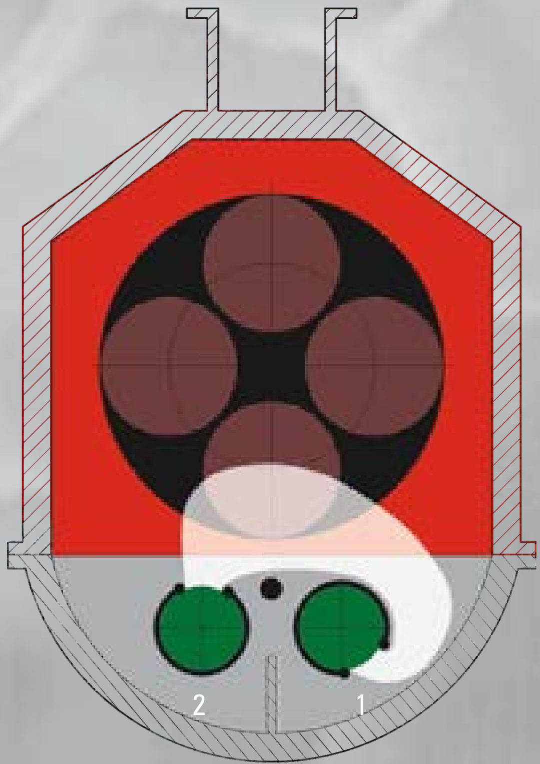
- Shank tools (2 µm): ø 10 x 70 mm, 288 pcs: 3.5 h
- Inserts (3 µm): ø 20 x 6 mm, 1680 pcs: 3.75 h
- Hobs (4 µm): ø 80 x 180 mm, 20 pcs: 5.5 h

Comparison to π80

- >50% higher, optimized coatable volume
  - at practically same foot print and
  - at same process (cycle) time
- TUBE SHUTTER® to protect both cathodes from contamination
- Dust filter for heaters
- Carousel drive with high loadability (>150kg)
- Prepared for easy upgrade to DLC^2- and OXI-units and -coatings
- Extremly homogenous thickness distribution
- LARC® - Glow discharge
- 4 Standard TripleCoatings3® available

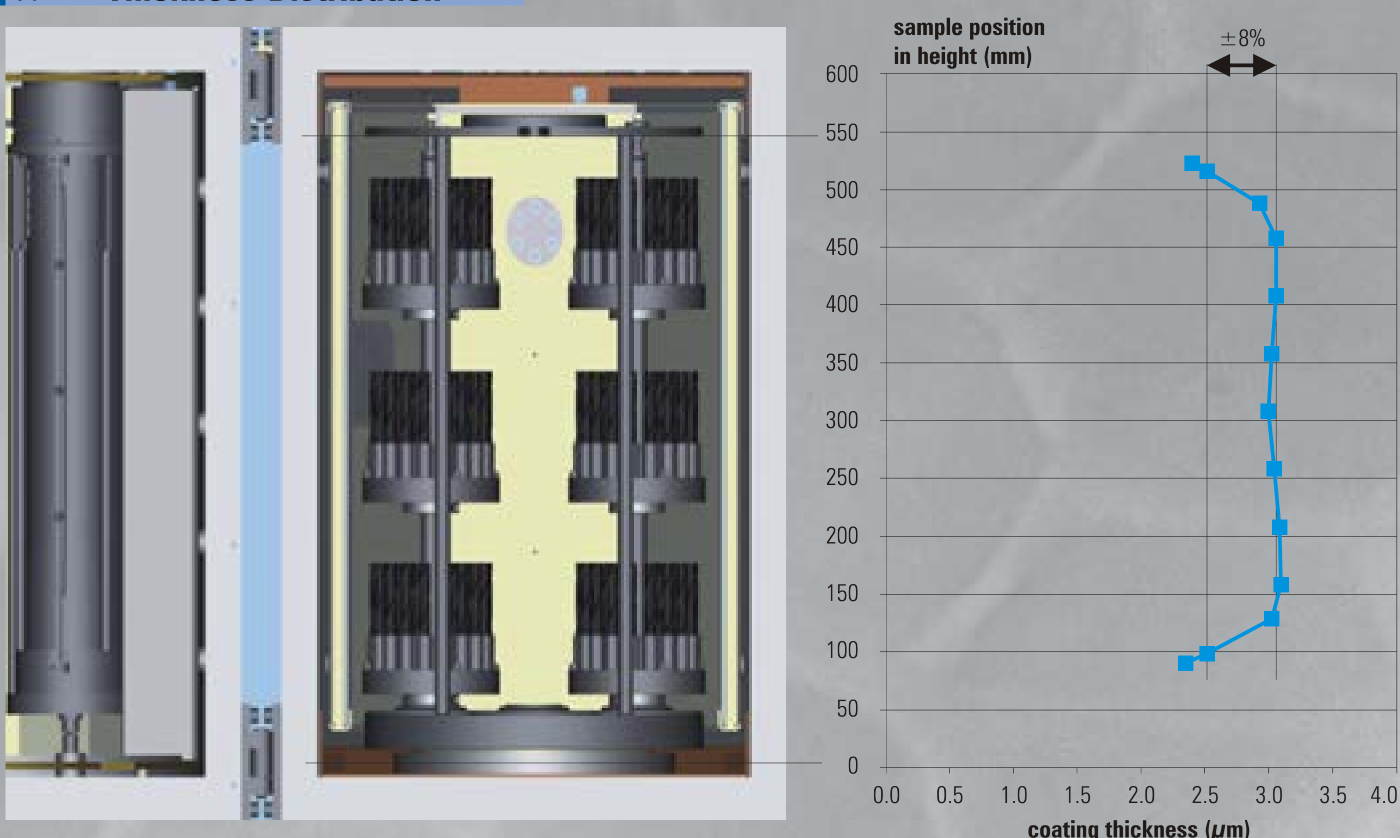
LGD® and Thickness Distribution

LARC GD® LARC® Glow Discharge



- LARC GD® is a new patented methode, that only works with the LARC cathodes in combination with the VIRTUAL SHUTTER® and TUBE SHUTTER®
- LARC GD® generates a highly efficient argon etching for special subtrates with difficult surfaces (e.g. hobs, mold and dies)
- The electron stream between the cathodes 1 and 2 creates high ion density plasma, which "cleans" even surfaces of complicated subtrates
- Pulsing of LGD source ensures high LGD-process stability and suppresses micro-arcs (hard-arcs) generation

π[111] Thickness Distribution



Valid for homogeneus batches in symetrical carousels.

PLATIT π311

Fully compatible to π300

General Information

- Compact hardcoating unit
- Based on PLATIT LARC® and CERC® technologies (LAteral Rotating Cathodes and CEntral Rotating Cathodes)
- Coating on tool steels (TS) above 230 °C, high speed steels (HSS) 350 - 500 °C and on tungsten carbide (WC) between 350 - 550 °C
- Reconfigurable by the user into different cathode setups:
  A: 3 LARC® cathodes and one CERC® cathode
  B: 3 LARC® cathodes

Coatings

- Monolayers, Multilayers, Nanogradients, Nanolayers, Nanocomposites, TripleCoatings^{3}® and their combinations
- Main standard coatings: TiN, AlTiN-G, nACo®
- See all 21 standard coatings on page 114
- All TripleCoatings^{3}® available
- Selected QuadCoatings^{4}® available

TripleCoatings^{3}®

Hardware

- Foot print: W2350 x D1660 x H2300 mm
- Vacuum chamber, internal sizes: W580 x D566 x H580 mm
- Max. size of coatable parts: Ø485 x H480 mm
- Usable plasma volume: Ø485 x H440 mm
- Max. load: 150 kg
- System with turbo molecular pump
- Revolutionary rotating (tubular) cathode system with 3 LARC® / CERC® cathodes:
  - Magnetic Coil Confinement (MACC) for ARC control
  - Changing time for skilled operator: approx. 15-30 min/cathode
- VIRTUAL SHUTTER® and TUBE SHUTTER® for all LARC® cathodes
- LGD®: LARC® Glow Discharge
- Ionic plasma cleaning:
  - etching with gas (Ar/H_2); glow discharge,
  - metal ion etching (Ti, Cr)
- Pulsed BIAS supply (350 kHz)
- 6 (+1) gas channels, 6 MFC controlled
- Special dust filters for heaters (20 kW)
- Electrical connection: 3x400V, 100A, 50-60 Hz
  In π311-13 mode: max. 45 kW
  In π311-03 mode: max. 40 kW
- Upgradeable to π311+DLC and π311+OXI on user's place

Electronics and Software

- Industrial PC and PLC systems
- Control system with touch-screen menu driven concept
- Manual and automatic process control
- Data logging and real-time viewing of process parameters
- Remote diagnostics
- No programming knowledge is required for process control
- Operator's manual on CD-ROM

Cycle Times

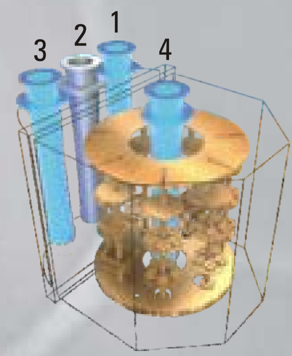
At continuous operation for coating tools, with standard thicknesses for:

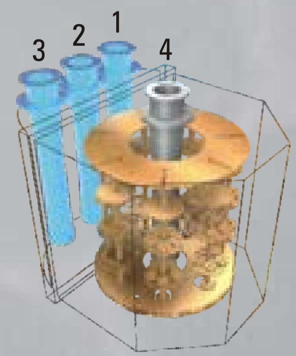
• Shank tools (2 µm):	ø 10 x 70 mm,	504 pcs:	4.0 h
• Inserts (3 µm):	ø 20 x 6 mm,	2940 pcs:	4.25 h
• Hobs (4 µm):	ø 80 x 180 mm,	28 pcs:	6.0 h

π311 Configurations

A: π311-13 Configuration

3x LARC®: LAteral Rotating Cathodes
Target size: Ø96 x 510 mm
1x CERC®: CEntral Rotating Cathode
Target size: Ø110 x 510 mm





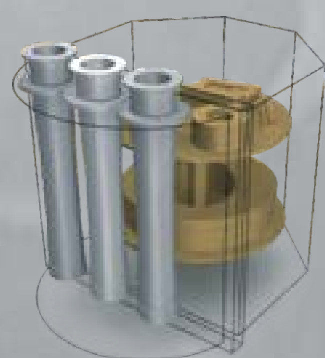
Usable plasma volume: Ø485 - Ø185 mm x H440 mm
Highest productivity for coating of cutting shank tools and inserts.

3 cathodes in action at the same time:
Free programmable switching between cathode 2 and 4; between operation mode π311-13 and operation mode π311-03, even during deposition process.

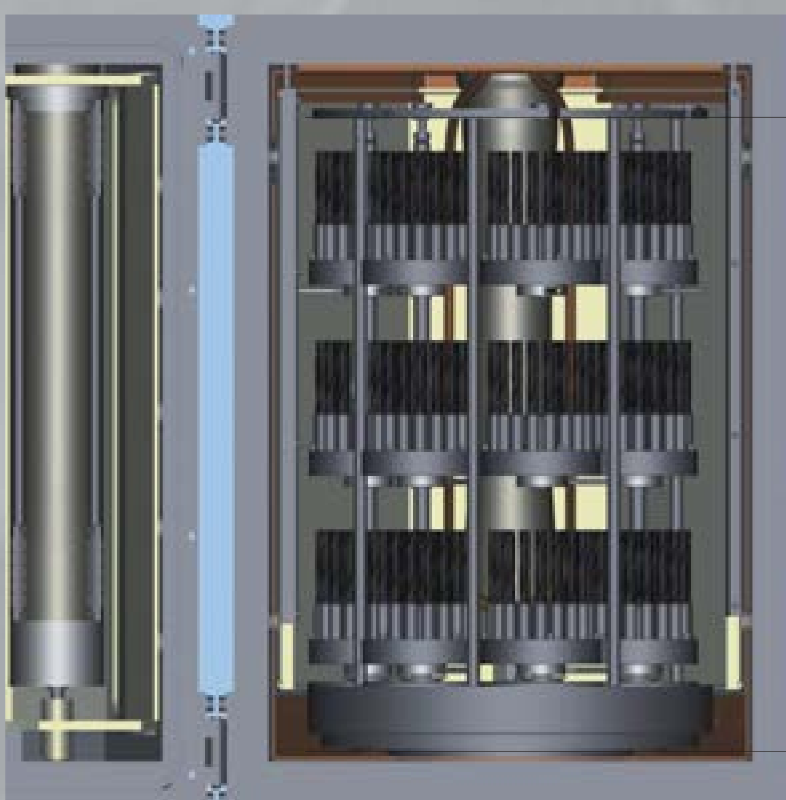
B: π311-03 Configuration

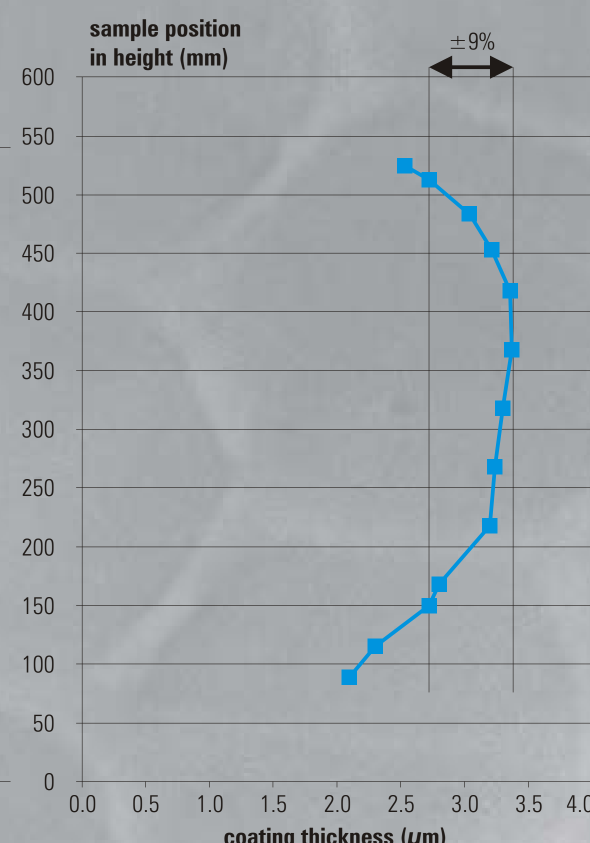
3x LARC®: LAteral Rotating Cathodes
Target size: Ø96 x 510 mm
No CERC®: CEntral Rotating Cathode

Usable plasma volume: Ø485 x H 440 mm
For coating large-volume work pieces, especially molds and dies as well as machine parts.



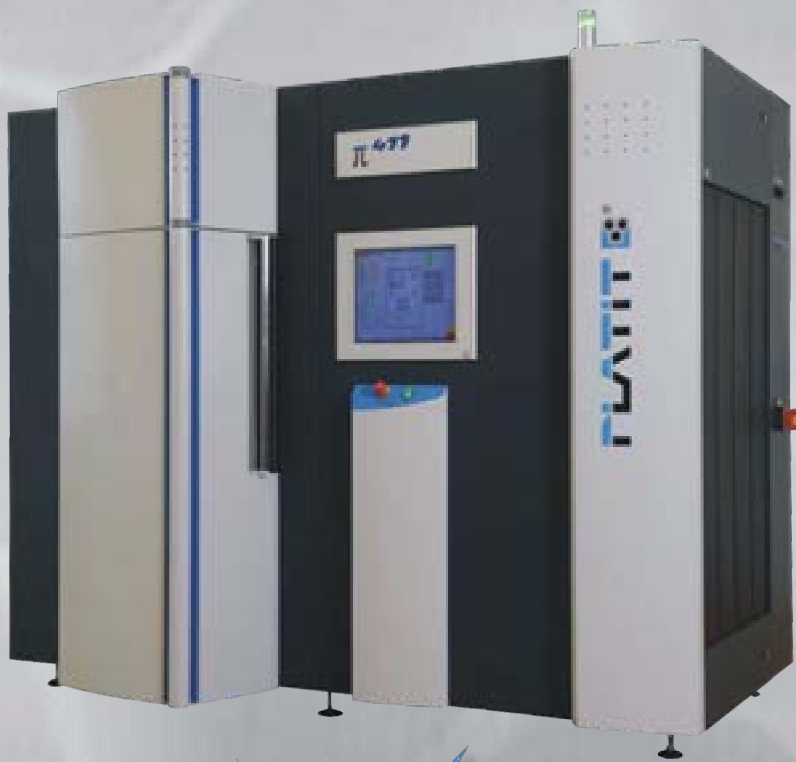
π311 Thickness Distribution





Valid for homogeneus batches in symetrical carousels.

PLATIT π411



General Information

- Compact hardcoating unit
- Based on PLATIT LARC® and CERC® technologies (LAteral Rotating Cathodes and CEntral Rotating Cathodes)
- Coating on tool steels (TS) above 230 °C, high speed steels (HSS) 350 - 500 °C and on tungsten carbide (WC) between 350 - 550 °C
- Reconfigurable by the user into different cathode setups:
  A: 3 LARC® cathodes and 1 CERC® cathode
  B: 3 LARC® cathodes

Coatings

- Monolayers, Multilayers, Nanogradients, Nanolayers, Nanocomposites, TripleCoatings3®, QuadCoatings4® and their combinations
- Main standard coatings: TiN, AlTiN-G, nACo®
- See all 21 standard coatings on page 114
- All TripleCoatings3® available
- All QuadCoatings4® available

Hardware

- Foot print: W2720 x D1721 x H2149 mm
- Vacuum chamber, internal sizes: W650 x D670 x H675 mm
- Max. size of coatable parts: Ø500 x H500 mm
- Usable plasma volume: Ø500 x H460 mm
- Max. load: 200 kg
- System with turbo molecular pump
- Revolutionary rotating (tubular) cathode system with 3 LARC® / CERC® cathodes:
  - Magnetic Coil Confinement (MACC) for ARC control
  - LARC®: Up to 200A ARC current
  - CERC®: Up to 300A ARC current
  - Changing time for skilled operator: approx. 15-30 min/cathode
- VIRTUAL SHUTTER® and TUBE SHUTTER® for all LARC® cathodes
- Ionic plasma cleaning:
  - etching with gas (Ar/H_2); glow discharge
  - metal ion etching (Ti, Cr)
- LGD®: LARC® Glow Discharge
- Pulsed BIAS supply (350 kHz)
- 6 (+1) gas channels, 6 MFC controlled
- Special dust filters for heaters (24 kW)
- Electrical connection: 3x400 V, 100 A, 50-60 Hz
  Total power consumption: < 76 kW

QUADCoatings4®

Electronics and Software

- Industrial PC and PLC systems
- Enhanced operating software
- Control system with touch-screen menu driven concept
- Manual and automatic process control
- Data logging and real-time viewing of process parameters
- Remote diagnostics
- No programming knowledge is required for process control
- Operator's manual on CD-ROM

Cycle Times

At continuous operation for coating tools, with standard thicknesses for:

• Shank tools (2 μm):	ø 10 x 70 mm,	504 pcs:	3.5 h
• Inserts (3 μm):	ø 20 x 6 mm,	2940 pcs:	4.0 h
• Hobs (4 μm):	ø 80 x 180 mm,	14 pcs:	5.5 h

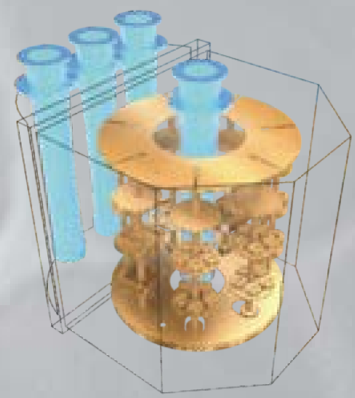
PLATIT®

π^{411}-POWER Coating Unit

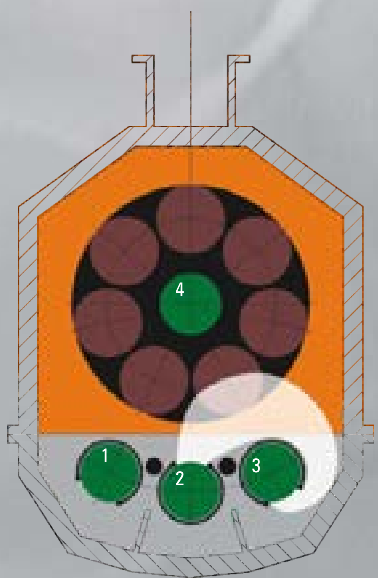
4 Cathodes Run Simultaneously

3x LARC®: LAteral Rotating Cathodes
Target size: Ø96 x 510 mm
1x CERC®: CEntral Rotating Cathode
Target size: Ø110 x 510 mm

Usable plasma volume: Ø500 mm x H460 mm
Highest productivity for coating of cutting shank tools, inserts, and hobs.



LARC GD® LARC® Glow Discharge



- LARC GD® is a new patented methode, that only works with the LARC cathodes in combination with the VIRTUAL SHUTTER® and TUBE SHUTTER®
- LARC GD® generates a highly efficient argon etching for special subtrates with difficult surfaces (e.g. hobs, mold and dies)
- The electron stream between the cathodes 1 (or 3) and 2 creates high ion density plasma, which "cleans" even surfaces of complicated subtrates
- Pulsing of LGD source ensures high LGD-process stability and suppresses micro-arcs (hard-arcs) generation

High Loadability, Robust, and Easy Change of Loads

PLATIT PL1001 COMPACT

General Information

- High capacity hardcoating unit
- Based on PLATIT planar-cathodic-ARC-technology
- Coatings on HSS and WC ($T \leq 500°C$)

Hard Coatings

- Monolayers, Multilayers, and Nanolayers
- Main standard coatings: TiN, TiCN-grey, AlTiN-G
- See available standard coatings on page 114
- Available TripleCoatings$^{3®}$: AlTiCrN$^{3®}$

Hardware

- Foot print: W3880 x D1950 x H2220 mm
- Internal chamber size: W1000 x D1000 x H1100 mm
- Usable plasma volume: Ø700-H700 mm
- Max. load: 400 kg
- Standard BIAS: 15kW DC, 1000V,
  optional: 20 kW, 250 kHz, 700V
- Double wall, stainless steel, water cooled chamber
- Front door loading, excellent access
- 4 PLATIT cathodes with quick-exchange system
- Storage of 4 spare cathodes inside the cabinet
- Electrical connection: 3x400 V, 50-60 Hz, 95 kW
- Modular carousel system with 2, 4, 8, and 12
  as well as 3, 6, and 9 satellites

Electronics and Software

- Industrial PLC (programmable logic) system
- Industrial PC system
- Touch-screen operated
- Complete menu driven processes
- Easy diagnostic and help functionality
- Remote diagnostics
- No programming knowledge is required for process control
- Operator's manual on CD-ROM

Cycle Times

At continuous operation for coating tools, with standard thicknesses for:

• Shank tools (2 μm):	ø10 x 72 mm,	864 pcs:	6.25 h
• Inserts (3 μm):	ø20 x 6 mm,	4224 pcs:	6.5 h
• Hobs (4 μm):	ø80 x 180 mm,	36 pcs:	7.0 h

With easy loading,
different tool types and sizes
can be mixed and coated
in one batch.

DLC- and OXI-Machines

π80 +DLC

π311 +DLC +OXI

π111 +DLC

PL1001 +DLC

π411 +OXI

DLC-Machines	OXI-Machines
VIRTUAL SHUTTER®	
to clean the targets to the rear before depostion	
TUBE SHUTTER®	
to protect the targets against contamination during the process	
Pulsed BIAS supply 350 kHz	
to enable deposition of non-conductive layers, to avoid ion overload, over-etching	
Special heaters with dust filter	
to avoid contamination of the substrates by dust released from the heaters	
Additional gas channel regulated by mass flow controller	
for acetylene	for N/O mixture
Special gas line for Si containing gas	Pulsed ARC supply optional
Combined PVD / PECVD process	PVD process at increased temperature

Dedicated Units

PL1001-DUO Compact

- Specially manufactured on request
- Based on PLATIT planar-cathodic-ARC-technology
- Coatings on HSS and WC (T ≤ 500°C)

Hardware

- Usable plasma volume: Ø575 x H700 mm
- 2 PLATIT cathodes with quick-exchange system fully compatible with the PL1001 COMPACT cathodes
- Low cost version of PL1001 COMPACT

PL2001 for saw blades

- Specially manufactured on request
- Extremely high capacity hardcoating unit for large tools and objects
- Based on PLATIT planar-cathodic-ARC-technology
- Coatings on HSS and WC (T ≤ 500°C)

Hardware

- Foot print: W3880 x D2350 x H2220 mm
- Internal chamber size: W1700 x D1700 x H1100 mm
- Usable plasma volume: Ø1200 x H700 mm
- Max. substrate load: 800 kg
- 4 PLATIT cathodes with quick-exchange system fully compatible with the PL1001 COMPACT cathodes
- Electrical connection: 3x400 V, 50-60 Hz, 110 kW
- Modular carousel system with 1, 2, 3, 4, 6, 8 satellites

π603

- Dedicated Coating Unit with 3 LARC and 1 planar cathodes for the deposition of saw bands
- Coatable volume: ø1400x200 mm

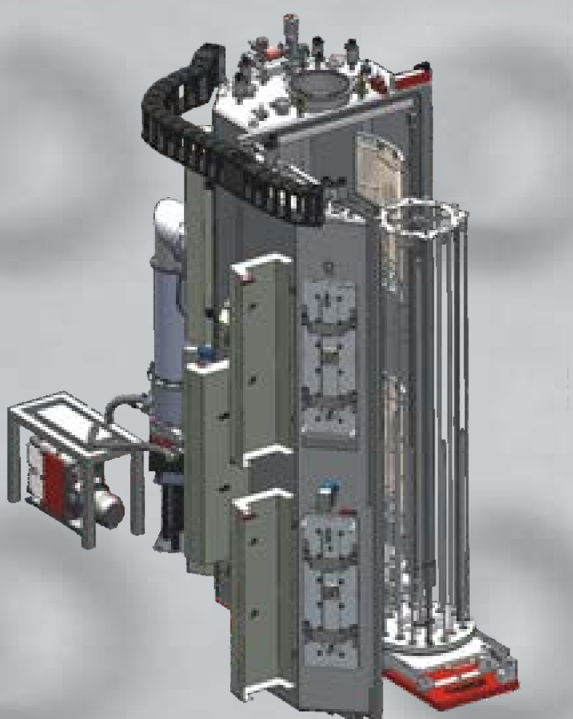
Dedicated Units for Broaches

PL1401-HUT for Broaches

- Specially manufactured on request
- Based on PLATIT planar-cathodic-ARC-technology
- After coating the first half, the broaches must be turned to coat the other half in a second batch

Hardware

- Usable plasma volume: Ø700 x H700 mm + Ø150 x H700 mm
- Max. length of broaches: 2000 mm
- Max. coatable lengths on broaches: 2 x 700 mm
- Max. substrate load: 400 kg
- 4 PLATIT cathodes with quick-exchange system fully compatible with the PL1001 COMPACT cathodes
- Modular carousel system with 1, 2, 3, 4, 6, 8 satellites



PL1901 for Extra Long Broaches

- Specially manufactured on request
- Based on PLATIT planar-cathodic-ARC-technology
- The extra long broaches are coated in 1 batch

Hardware

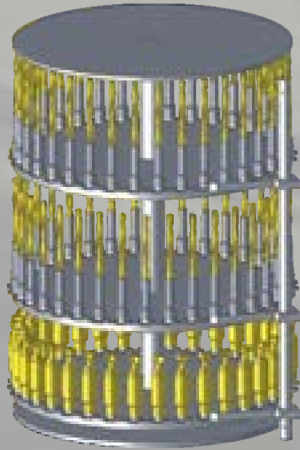
- Usable plasma: Ø700x700 - 1'900 mm
- Max. length of a broach: 2'300 mm
- Max. substrate load: 600 kg
- 6 PLATIT cathodes with quick-exchange system, fully compatible with the PL1001 compact cathodes
- Modular carussel system with 1,2,4,6,8 satellites
- The coating unit and the loading system are to be embeded into the special fundament of the work floor

Dedicated 1-Chamber Cleaning System for Broaches

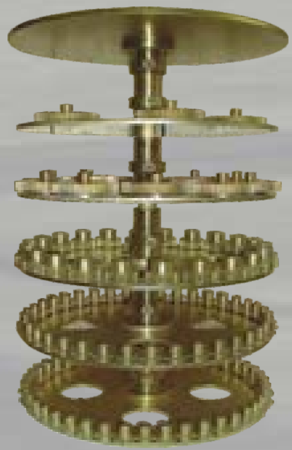
- Max. broach length: 2'500 mm
- Max. broach load: 600 kg
- Cyle time < 1h

Carousels for PL70 / π80 / π111

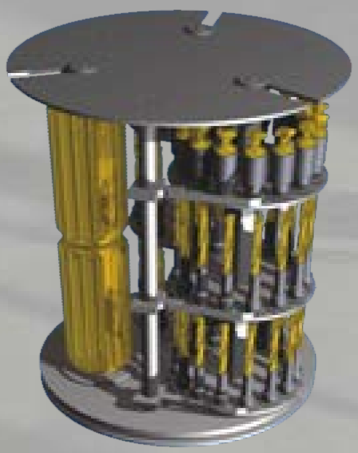
Carousel for single rotation
Dmax=355mm (π111)



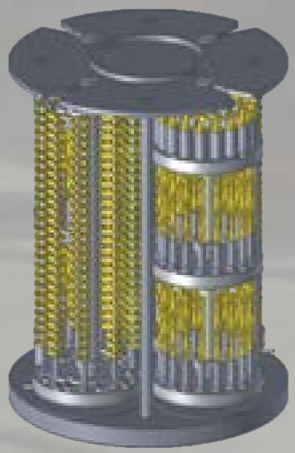
Carousel for double rotation
with kickers for every level



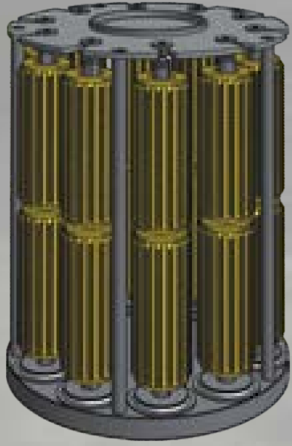
Plates for carousel
for double rotation



3 axis carousel for double
and triple rotation with and
without kickers
Dmax=162mm (π111)



4 axis carousel for continuous
triple rotation with gearboxes
without kickers
Dmax=143mm (π111)

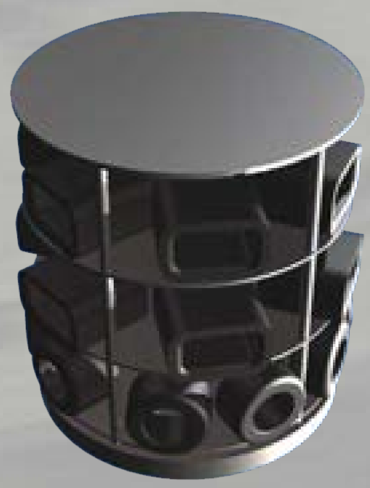


10 axis carousel for continuous
double rotation without kickers
Dmax=82mm (π111)

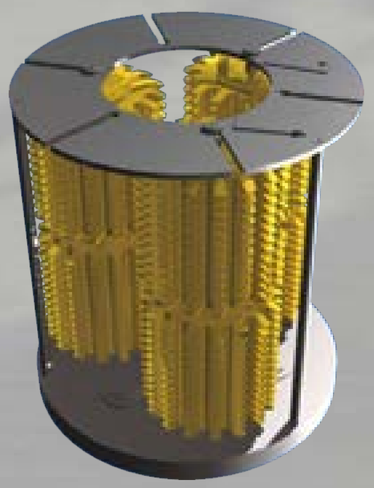
Batch coated with double rotation

Batch coated with triple rotation

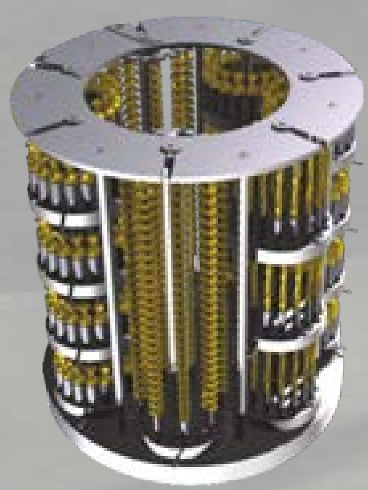
Mixed batch with double and triple rotation



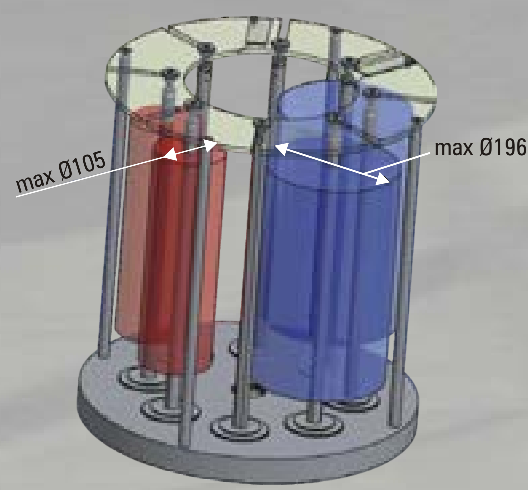
Single rotation carousel
Dmax-1=485mm



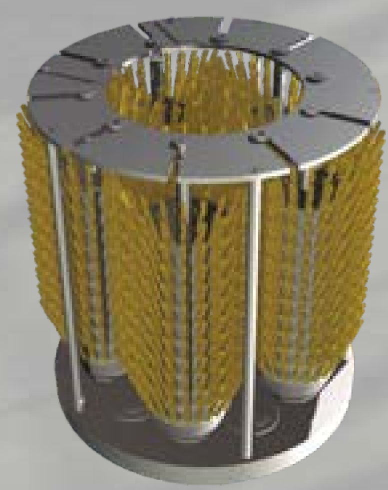
3 (6) axis carousel
Dmax-3=223mm - Dmax-6=129mm



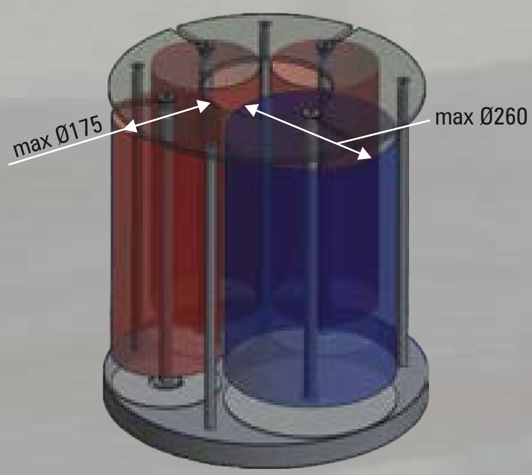
7 axis carousel
Dmax-7=143mm



4 (8) axis carousel
Dmax-4=196mm - Dmax-8=108mm



5 (10) axis carousel
Dmax-5=174mm - Dmax-10=94mm

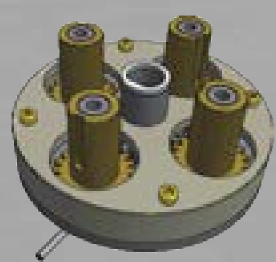
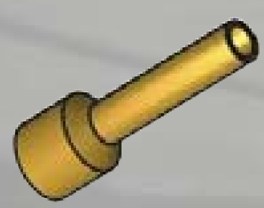


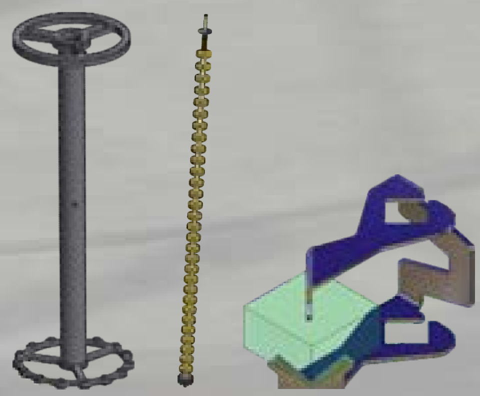
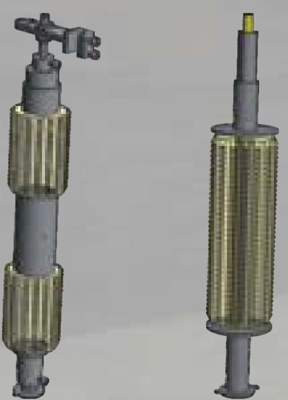
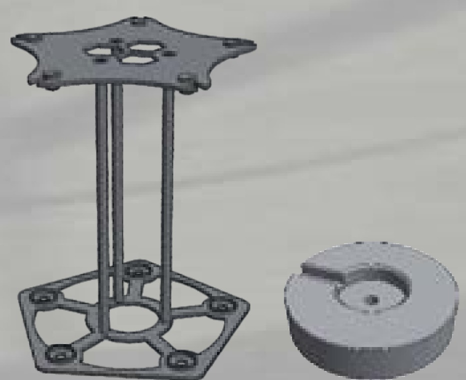
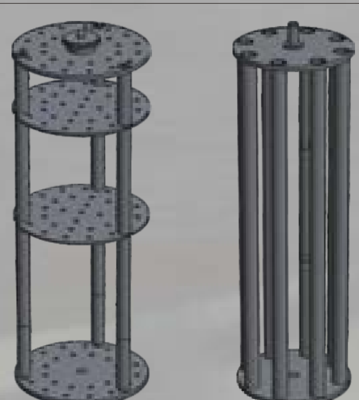
4 axis dedicated asymetric carousel
3xD1=175mm - 1xD2= 260mm

12 (6) axis carousel
Dmax-12=88mm - Dmax-6=133mm

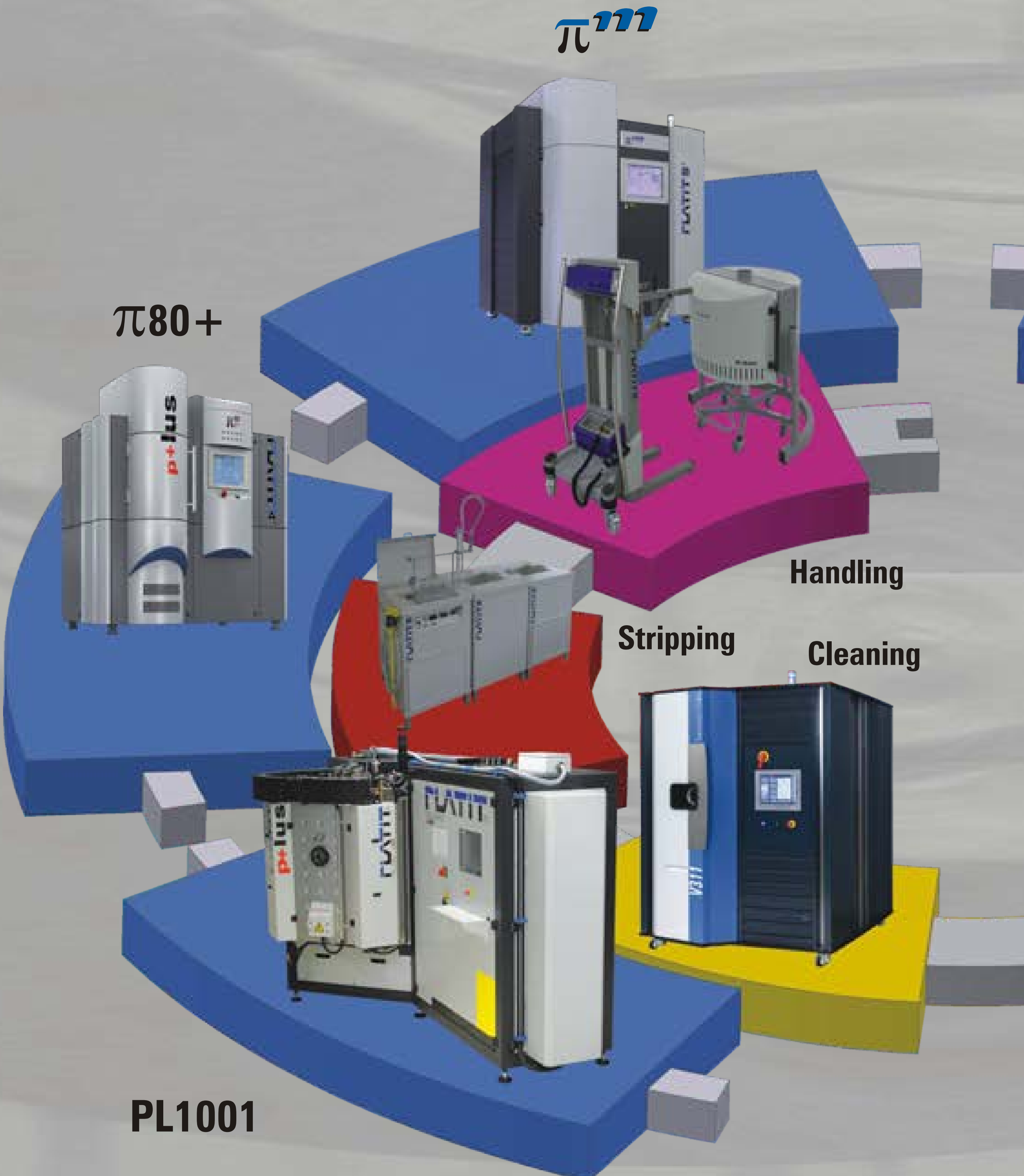
14 axis carousel
Dmax-14=87mm

Holders for Cutting Tools

Holders		Application
Plates with gears, as holders for sleeves		The gears are rotating stepwise, driven by kickers from the side. Plates and gears are available for the different standard diameters of shank tools in the range of d = 2.2 - 52 mm
Gearboxes for triple rotation for shank tools with shank diameter D and with gear postions #N		For special big shank tools D<=52 mm (2") - N= 4 Special sleeves are neccessary
Gearboxes for triple rotation for shank tools with shank diameter D and with gear postions #N		For holding and rotating sleeves D<=40 mm - N=6 D<=25 mm - N=8 D<=20 mm - N=12 D<=14 mm - N=18 The tools are rotating contiunously around the own axes. It allows very homogeneus coating around the tools. Gearboxes makes loading of batches significantly easier. You do not need the sensitive setting of the kickers.
Sleeves		For standard shank tools. Diameters: [mm] 6, 8, 10, 12, 14, 16, 18, 20 22, 25, 32 and 1/8", 3/16", 1/4", 3/8", 1/2",4/7", 5/8", 3/4", 7/8", 1" Special diameters on request
Revolvers for shank tools with shank diameter D and with postions #N		D=2.2 mm - N=12 D=1/8" (3.4mm) - N= 9 D=4.1 mm - N= 6 D=5 mm - N= 6 D=6 mm - N= 4 The tools are not rotating around the own axes.
Sphere revolvers		For holding big quantities of shank tools Drills: d=3 - 18 mm Taps: M3 - M16 End mills: d=8 - 20 mm The whole batch should contain the same tools. The tools are rotating around their own axes, moved stepwise by inside kickers. Sphere holders are products of 4pvd, Aachen, Germany

Holders		Application
Insert holders with satellites and rods		Satellites for inserts with diameter / edge length [mm] d / □ : 8.5, 12, 14, 19, 20, 27, 29.5, 42 Satellites positions: 6, 9, 15, 18 Support ring for rods of small inserts. Rods according to the hole diameters of the inserts: d > 2.4, 3.7, 4.2, 5.2, 6.2 mm TongS keep the inserts without holes, spindled on special rods. TongS are products of 4pvd, Aachen, Germany.
Hob holders for shank hobs and bore hobs		The parts of the hob satellite are set together according to the sizes and dimensions of the different hobs, they are coated together.
Parking station Loading base		Helping fixtures for loading and parking the satellites outside of the carussels.
Cage for double rotation Dummy cage		Cages for simple flat shapes, which can be laid down, like certain molds, dies, and inserts. Dummy cage has to fill empty satellites places in carussels.

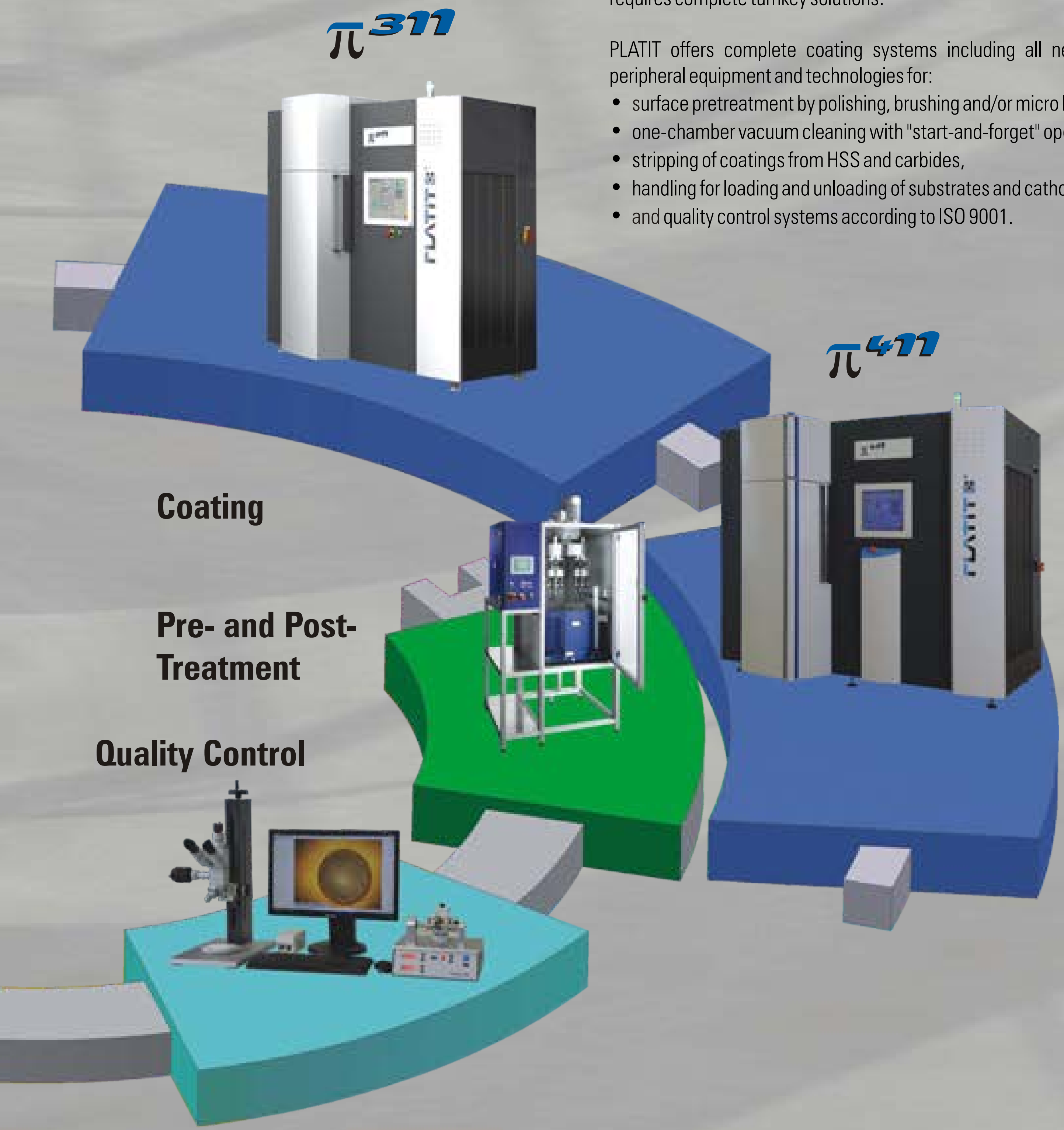
Turnkey Solutions



The integration of flexible coating into the manufacturing production requires complete turnkey solutions.

PLATIT offers complete coating systems including all necessary peripheral equipment and technologies for:

- surface pretreatment by polishing, brushing and/or micro blasting,
- one-chamber vacuum cleaning with "start-and-forget" operation,
- stripping of coatings from HSS and carbides,
- handling for loading and unloading of substrates and cathodes,
- and quality control systems according to ISO 9001.



Stripping of PLATIT Coatings

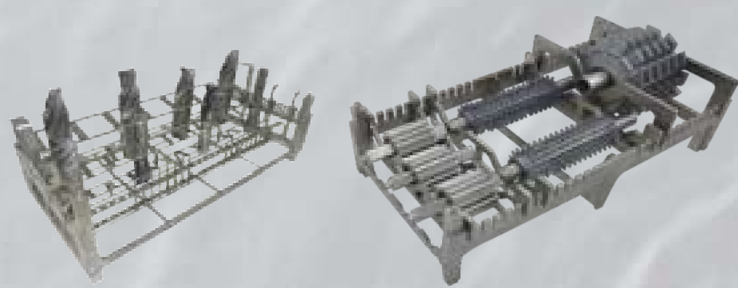
ST-40 Decoating System

Changeable decoating modules:

1. ST-40 HM: Decoating Ti, Al based coatings from carbide
2. ST-40 Cr: Decoating Cr based coatings from carbide and HSS
3. ST-40 HSS: Decoating Ti, Al, Cr based coatings from HSS
4. ST-170 Cr: Decoating Cr based coatings from carbide and HSS (module for 7 hobs ø80x180mm)
5. ST-170 HSS: Decoating Ti, Al based coatings from HSS (module for 7 hobs ø80x180 mm)
6. ST-40 R: Rinsing module
7. ST-40 P: Corrosion protection module

CleX®: Baskets and Carriers

Modular holder system for stripping.
See pages 40 and 41.



Available Stripping Processes

Stripping Ti, Al based coatings from HM

Water based environmentally friendly process.
Decoating of tungsten carbide K grades.
Suitable for these PLATIT coatings:

- TiN, TiCN, TiAlN, AlTiN, nACo®
- Mono- and Multilayer coatings

Stripping time: 1 – 24 h
Necesary modules: 1+6+7
Attention: Cobalt-leaching might occur

Stripping Ti, Al based coatings from HSS

Stripping Ti, Al based coatings from HSS
Water based environmentally friendly process.
Suitable for PLATIT coatings:

- TiN, TiCN, TiAlN, AlTiN, nACo®
- Mono- and Multilayer coatings

Stripping time: 1 – 2 h
Necesary modules: 3+6+7

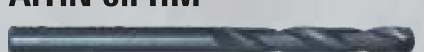
Stripping Cr based coatings from HM and HSS

Electrochemical process based on water. Decoating of tungsten carbide K grades and HSS.
Suitable for PLATIT coatings: CrN, nACRo®
Stripping time: < 1h
Necesary modules: 2+6+7 or 4+5+6
Attention: Used solution contains Cr^{6+}

Stripping CrTi based coatings from HSS

Electrochemical process based on water:
Suitable for PLATIT coatings: CrTiN, AlTiCrN, nATCRo®
Stripping time: 1 – 4 hours
Necesary modules: 3+6+7
Attention: Used solution contains Cr^{6+}

AlTiN on HM



Stripped AlTiN from HM

The listed data are valid for stripping of single coatings with thickness of $\sim 2\,\mu$m.

Stripping and its Ways

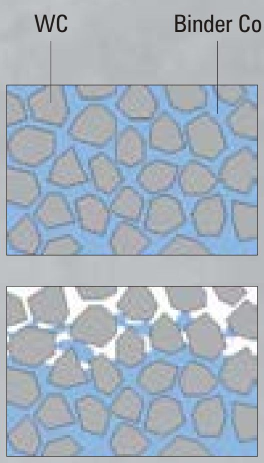
Under optimum conditions the electro-chemical stripping can be carried out without damaging the substrates. However, normally it damages the substrates, especially carbides with cobalt leaching.

What is Cobalt-Leaching?

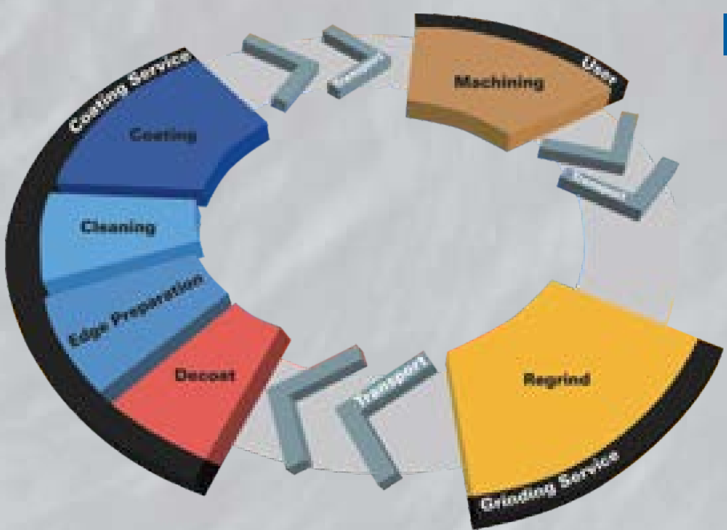
Removal of some cobalt from the top surface of the composite material tungsten carbide consisting of WC (grains) and cobalt (matrix).
Reason: Removal of cobalt by oxidation, mainly at contact with water:

- Water cooled grinding
- Too fast grinding with blunt grinding wheel (even when cooling with oil)
- Water based stripping

Coating of cobalt-leached carbide is useless. The coating has in fact a good adhesion to the top WC layer, but both peel off together at the first cut because the binding cobalt is missing.

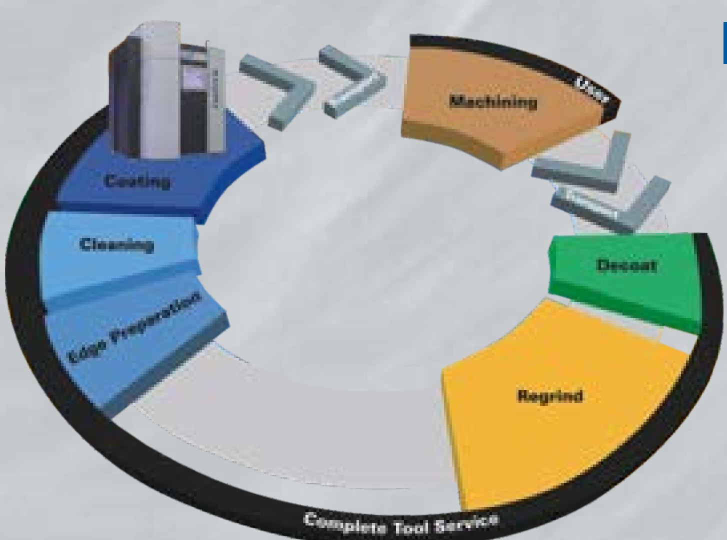


Stripping at conventional and integrated coating service



The conventional way

The risk of bad adhesion is very high. The stripping takes place after regrinding and damages the final geometry of the tool. The edge preparation after stripping can reduce the damage only. Additionally, packing, transport, and repackaging increase the risk of tool damaging enormously.



The integrated way

The stripping can be done prior to the regrinding. This creates a lot of advantages for your production:

- Less transport and packaging, less damages by handling
- No chemical destruction after regrinding, the edge preparation does its full effect (regularly)
- Optimum adhesion
- The performance is close to a new tool.

Cleaning Units

V80+, V311, V1011

Industrial single chamber cleaning units for fully automatic cleaning and vacuum drying of:

- Cutting tools, molds and dies, machine components
- Also for difficult to clean parts with cavities
- Developed in coorperation with Eurocold, Italy

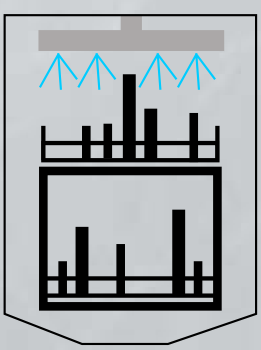
These products include:

- Single chamber cleaning unit with detergent (alkaline) tank, demineralized water tank, vacuum drying system
- Water preparation: water softener, reverse osmosis, demi water (external)
- Detergent, Salt
- Easy to understand touch screen for programming and handling as the π coating units
- CleX® modular holder system for carrying shank tools, inserts and hobs

Max. dimensions of substrates to be cleaned: WxDxH [mm]:		
V80+	**V311**	**V1011**
355 x 390 x 480	500 x 500 x 500	700 x 700 x 700

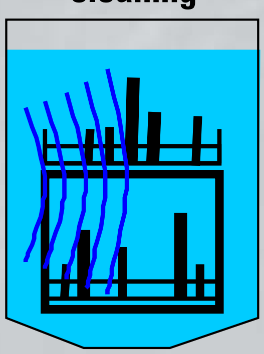
Washing Cycle (~45 min)

1. Pre-Cleaning



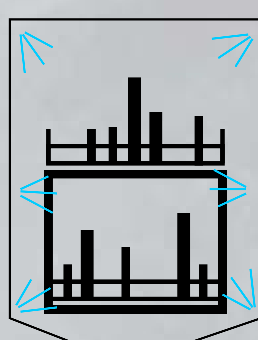
With flashing out of oil and rough dust, V*11 series only. Consider wastewater regulations of your country!

2. Ultrasonic cleaning

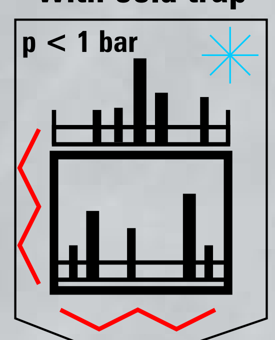


With oil skimming in V*11 series.

3. Rinsing



4. Vacuum drying with cold trap



Cleaning and its Control

Modular Manual Cleaning Unit

- CL - 40 EL: Module for electrolytical cleaning
- CL - 40 US: Module for ultrasonic treatment
- CL - 40 R: Module for rinsing
- CL - 40 D: Oven for drying

Cleaning unit for laboratories and institutes, which do not need automatic cleaning of higher substrate quantities.
The substrates are carried in special baskets by hand from module to module.

1. Rinsing away the raw dust using tap water
2. Precleaning the substrates using ultrasonic in demineralized water or in detergent
3. Rinsing using demineralized water
4. Fine cleaning using electrolytical treatment
5. Rinsing using demineralized water

See basket sizes on page 41.

Cleanness - Coatability Evaluation by Measuring Surface Tension

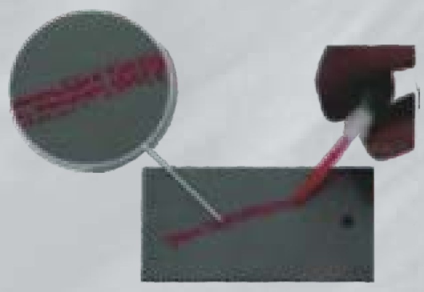
Only a metallic clean surface leads to good adhesion of the coating.
The surface tension (energy) on the substrate is one decisive criterion for the adhesion of coatings.
The higher the surface tension of the substrate the better is the adhesion of the coating.
Contaminations like grease, oil, finger prints or dust decrease the surface energy.

The minimum surface energy should be 42 mN/m on the cleaned substrates before coating.

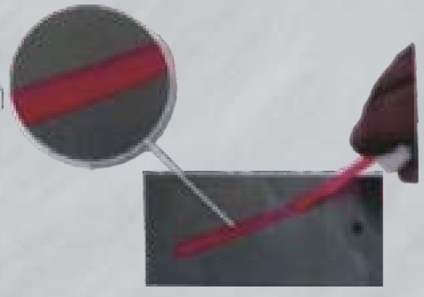
Bad wettability on oily part because of the low surface energy

Good wettability without oil because of high surface energy

The drop method can characterize the surface energy of the substrate on an easy way:
The measuring set contains a series of pens or inks. The testing fluid will be anted up from the pens or from inks to the surface of the substrate.
Every pens or inks is marked to recognize a surface energy value;
32, 34, 36, 40, 42, 44 mN/m



The ink generates droplets because its surface tension is higher than the surface tension of the substrate
Bad wettability - plate is not clean enough and needs more cleaning



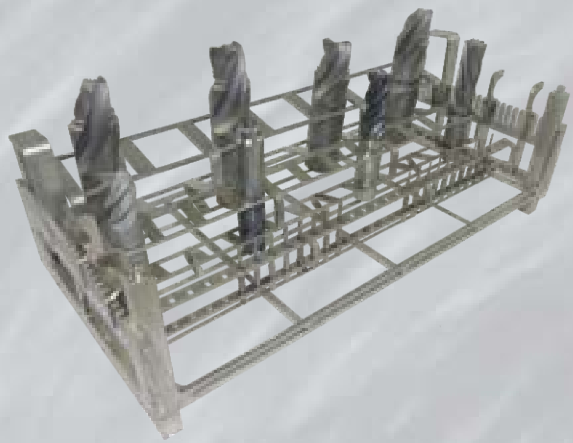
The ink does not generate droplets because its surface tension of the substrate is higher than this of the ink.
Good wettability - plate is clean for coating

CleX®: Clean Flexible

Modular Holder System for Cleaning and Stripping

CleX® for Shank Tools

Flexible holder system for cleaning and stripping of shank tools.



Advantages:

- Different tool-diameters can be held together
- Up to 150% more tools per foot print in comparison to conventional systems
- CleX® carriers can be handled even with tools loaded
- CleX® baskets are stackable
- Smart light design → Low shadowing
- Minor contact surfaces → Hardly cleaning spots
- Inclined surfaces → Good water draining
- Stainless steel construction → High temperature resistance → High durability

CleX® for Inserts

Flexible insert-holder for minimal handling at pre-, post-treatment and coating.

Advantages:

- Different insert-types can be held together
- For inserts with holes
- **Without reloading**, up to 500 inserts can sequentially run through **all** these processes:
  - Cleaning
  - Edge structuring by wet- / dry-microblasting
  - Coating
  - Polishing by wet- / dry-microblasting

At wet- / dry-microblasting, all sides of the inserts are treated.

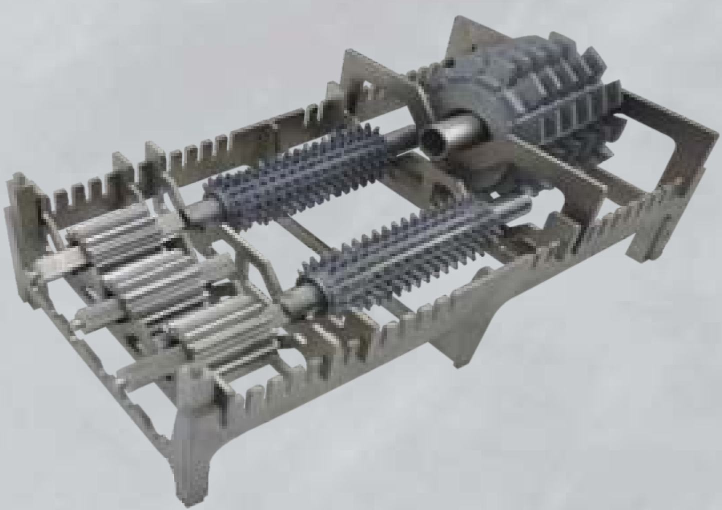
For inserts without holes the system can be used with the TongS system (see page 31) for coating only.

CleX® for Hobs

Flexible holder for cleaning and stripping of hobs.

Advantages:

- Hobs of different diameters and lengths can be held
- CleX® baskets are stackable



CleX®: Clean Flexible

CleX® for Shank Tools

CleX® Basket 330x160 mm	V80+ 2 pcs/level	V311 4 pcs/level	V1011 8 pcs/level

CleX® Carrier	Ø-Shank mm	Tools/CleX® Carrier	Tools/CleX® Basket
CleX®-S-3	Ø3	30	270
CleX®-S-5	Ø5	26	234
CleX®-S-6	Ø6	24	168
CleX®-S-8	Ø8	20	140
CleX®-S-10	Ø10	18	126
CleX®-S-12	Ø12	16	112
CleX®-S-14	Ø14	15	75
CleX®-S-16	Ø16	13	52
CleX®-S-18	Ø18	12	48
CleX®-S-20	Ø20	11	44
CleX®-S-25	Ø25	9	36
CleX®-S-32	Ø32	7	28

Inch sizes are available on request

CleX basket

CleX®-S-3 carrier for Ø3 mm

CleX®-S-18 carrier for Ø18 mm

CleX® for Inserts

For satellites Ø143x380mm	Positions	Optimized for Edge Length □ mm	for min. Insert-Hole Ø mm
CleX®-I-15R	15 with support ring	14	2.4
CleX®-I-15	15	14	3.7 4.2 5.2 6.2
CleX®-I-18	18	18 x 8.5 9 x 19.0 6 x 29.5	3.7 4.2 5.2 6.2

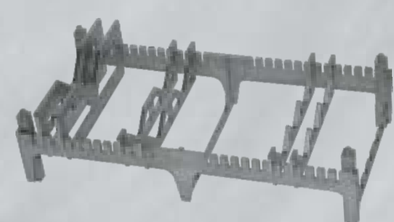
CleX®-I-15R

CleX®-I-15

CleX®-I-18

CleX® for Hobs

CleX holders	Optimized for
CleX-H: 330x160 mm	1 x Ø130 2 x Ø 70 3 x Ø 35
CleX-H-XL: 330x240 mm	1 x Ø170 2 x Ø 90 3 x Ø 60



CleX®-H hob basket

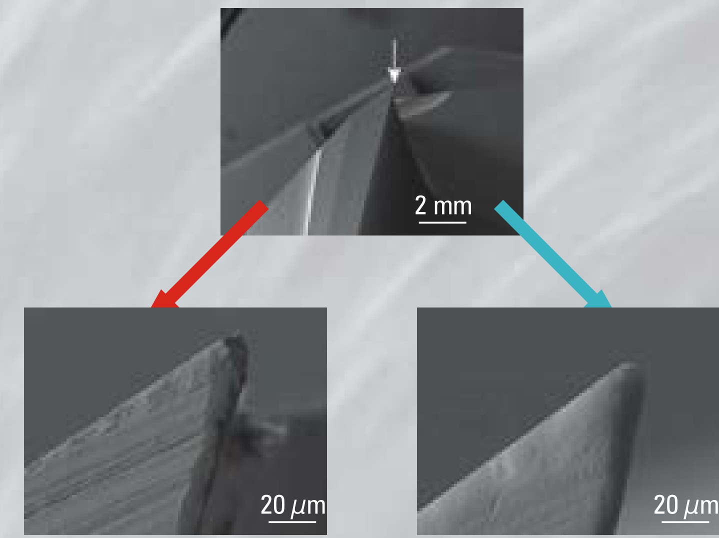
CleX®-H-XL hob basket

Micro Structuring of Cutting Edges

Why Edge Preparation?

1. Main goal: Increasing the edge stability
   a. Stable edge form:
      to avoid the edge's chipping
   b. Stable, low edge surface roughness:
      to decrease friction between tool and workpiece
   c. Stable material:
      e.g. to avoid cobalt leaching
2. Without edge preparation:
   - low performance
3. Different work piece materials need:
   - different edge preparation
4. Over the optimum edge preparation:
   - performance drops down abruptly
5. Optimum edge preparation can:
   - increase performance enormously

Typical Edge Images from High End Tool Manufacturers

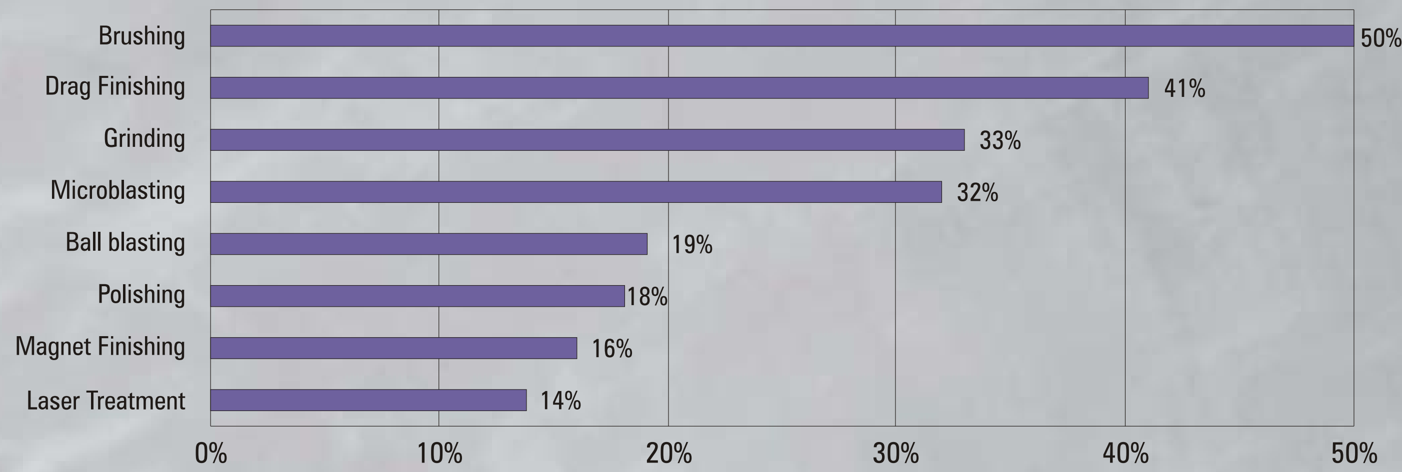


Edge Treatment Methods

Criteria / Features	**Honing by Hand** with diamond file	**Brushing**	**Drag Grinding (Polishing)**	**Micro Blasting Dry**	**Micro Blasting Wet**	**Water Beam**	**Magnet Finishing**
Quality	best	good	good	medium	good	good	good
Constancy	depending on person	good	good	medium	good	good	good
Flexibility	very high	high	medium	high	good	medium	good
Productivity	low	medium	medium	medium	high	very high	good
Price	salary only	high	medium	low	medium	very high	high
Standard machines available		yes	yes	yes	yes		yes
Flute polishing possible		limited in depth	yes	yes	yes		limited in depth
Droplet removal possible		yes	yes	yes	yes		yes
Special features	typical for small regrinders	commonly used for end mills, difficult for taps	droplet removal difficult for small diameters	residual materials on the surface	no residual mat. after blasting high air consumption	only for large scale production, corrosion protection needed	especially for micro tools demagnetizing necessary

Microstructuring: Why and How?

Which Methods are Used and how Often?



Source: IWF, Berlin, Germany

Comparison of Different Micro Structuring Methods

Tool	Drag Finish		Dry Blasting	Wet Blasting	Brushing	Magnet Finish
	Double	Triple Rotation				
Drill						
Tip only	C	C	C	C	A1	A1
Flank only	C	C	C	C	B1	A1
Tip and Flank	A1	A1	A3	A2	B1	A1
Step	A1	A1	A3	A2	C	C
Endmill						
Tip and Flank	B1	A1	A3	A2	B1	A1
Tip Different from Flank	C	C	C	C	B1	A1
Ball nose	A1	A1	A3	A2	C	C
Insert						
With Bore	B1	B1	A3	A2	A1	C
Without Bore	C	C	A3	B2	A1	C
Hob						
With Bore	B1	B1	A3	A2	C	C
Without Bore	C	C	A3	B2	C	C
Biggest Advantage	Price	Smooth Surface	Easy loading	Easy loading	Easy loading	Full automatic for small series
Biggest Limitation	Manual clamping	Manual clamping	Rough surface	Maintenance	Limited tool variety	Price

Possible:

A	yes
B	with difficulty
C	no

Surface:

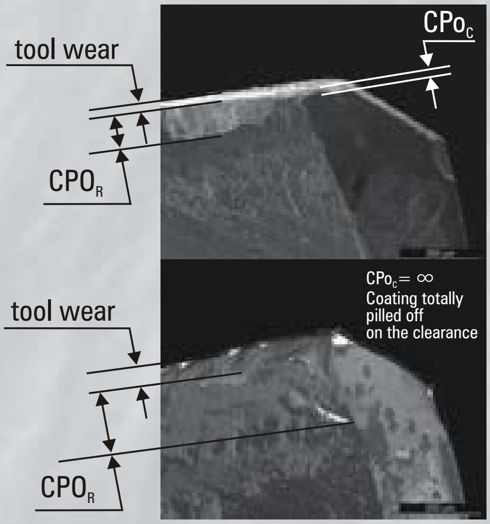
1	smooth
2	rough
3	very tough

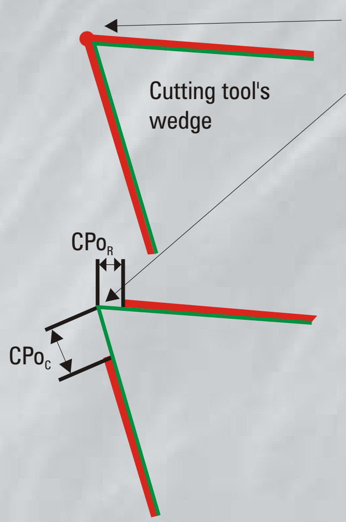
Recommendation:

(green)	best
(yellow)	alternative
(red)	not recommended

Applications

The Aim of Edge Preparation



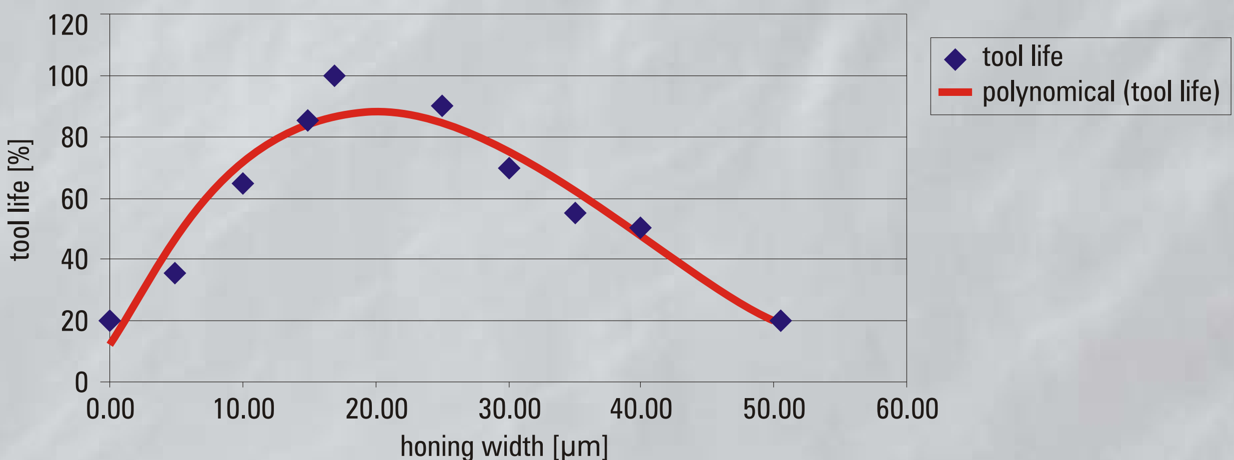


1. Sharp edge: High internal stress of the PVD coating
2. Shortly after starting cutting, the coating breaks away

   CPo$_R$: Coating's Peel off on the tool's rake surface
   CPo$_C$: Coating's Peel off on the tool's clearance surface

3. Good coating -> CPo$_r$ and CPo$_c$ grow slowly
4. **The aims of the edge preperation:**
   - **Ensharping the cutting edges**
   - **Smooth transition between rake and clearance**
   - **Reducing internal stress, but**
   - **without making the edge blunt**

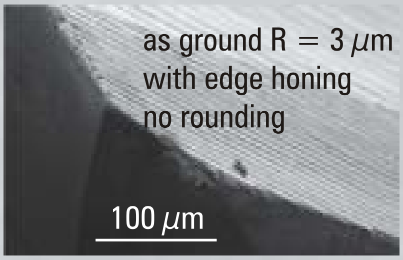
Influence of Edge Preparation at Milling in High Alloyed Steel

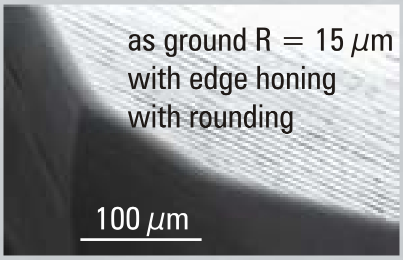


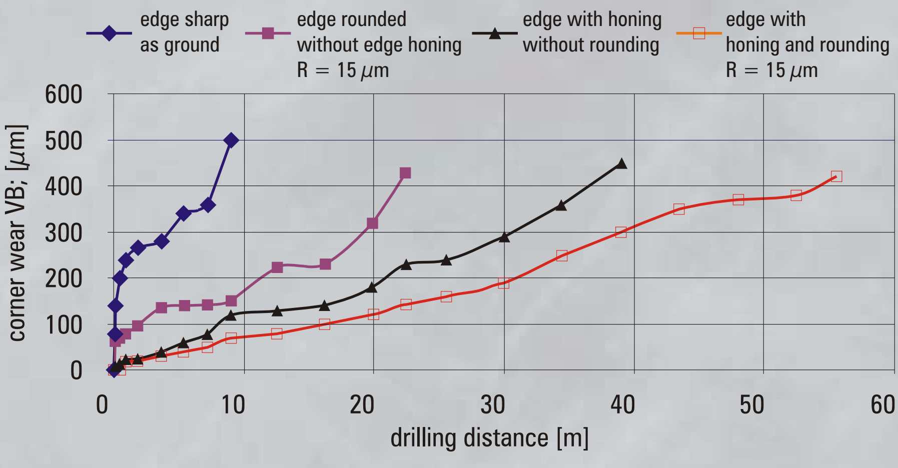
Material: 1.2379 - X155CrVMo12-1 - End mill: nACRo coated - d=10mm, z=4, ae=0.25 x d – ap=1.5 x d – vc=150 m/min – fz=0.05 mm/z – Measured: GFE, Schmalkalden, Germany

Drilling

Influence of Corner Edge Preparation on the Performance of Drills



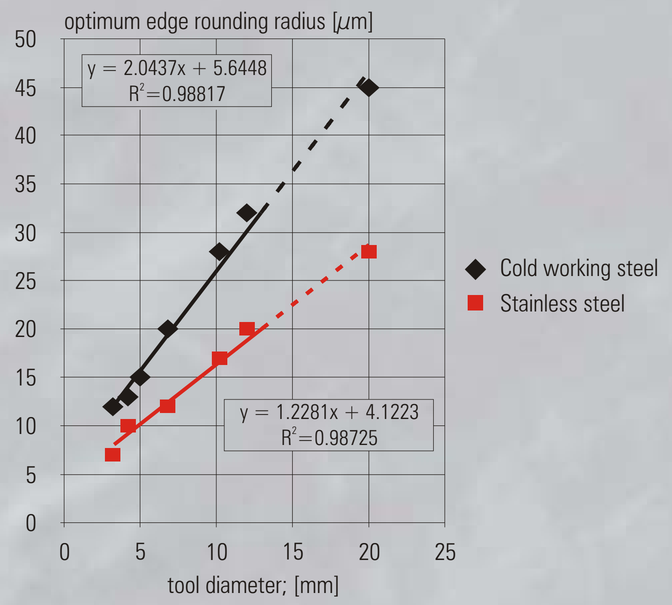




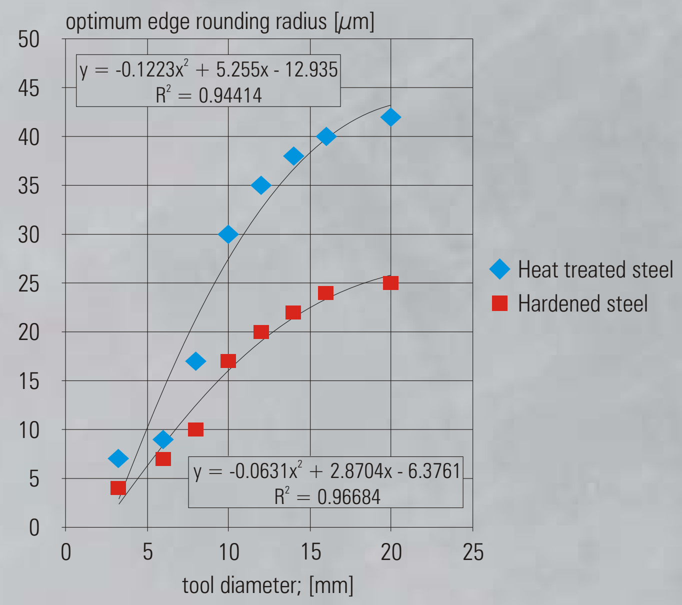
Work piece material: cold working steel - 1.2379 - X155CrVMo12-1 - HRC22 - blind holes
Solid carbide drills with nACo coating: d=5 mm - vc=75 m/min - fz=0.15 mm/z - ap=15mm - dry air coolant

Optimum Edge Rounding

Edge Preparation for Drills



Edge Preparation for End Mills



The optimum edge rounding values were elaborated in cooperation with GFE, Schmalkalden, Germany

Edge Preparation after Coating

- The edges are rounded after coating
- The coating is removed around the edge
- The edge is "set free"

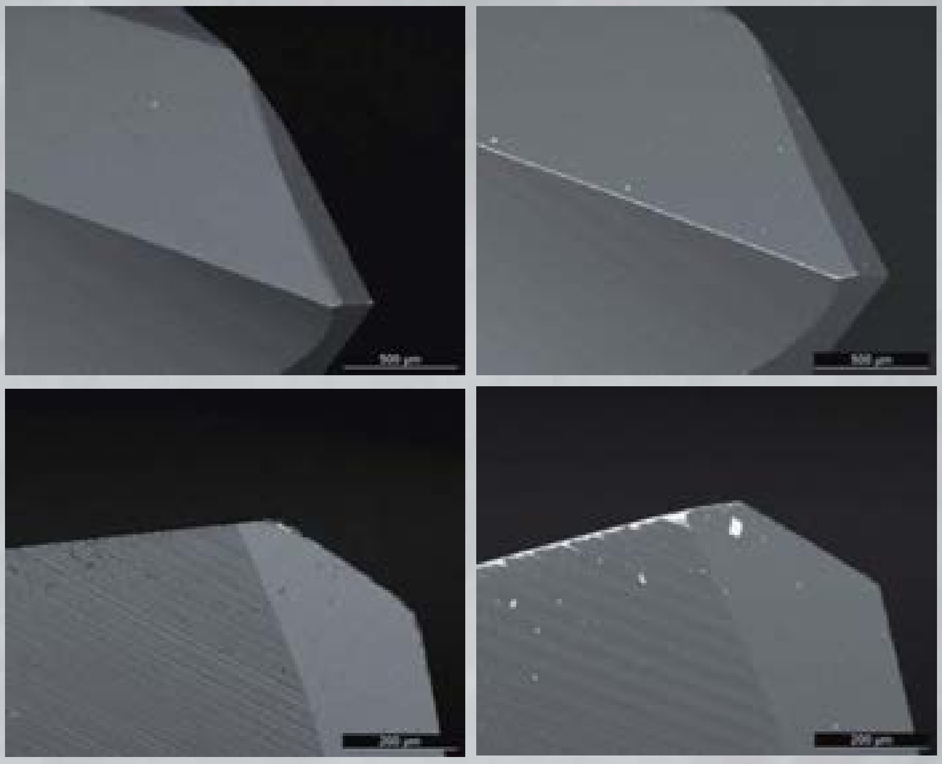
Advantages of edge preparation after coating:

- Edge rounding and
- Droplets removing in one step
- Combined break outs of coating+carbide can be avoided
- Elimination of antenna effect

Disadvantages of edge preparation after coating:

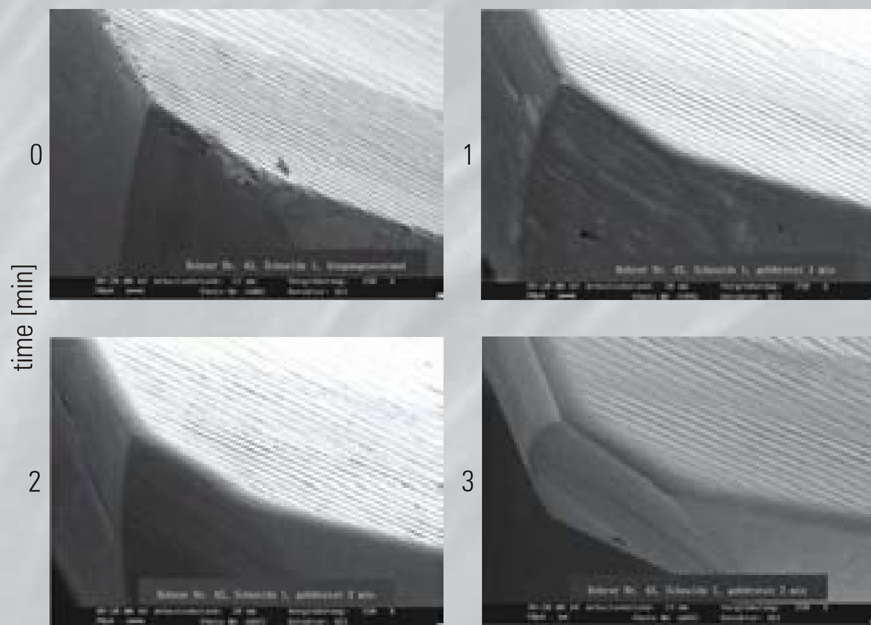
- Interruption of coating structure on long surface line
- Immediately full and direct contact of cutting and work piece material
- Lower heat and chemical insulation
- Low coating thickness near to the edge
- Full coating structure begins far from cutting edge
- Bigger edge radius (e.g. for roughing) results in larger surfaces without coating
- Gives the impression of bad coating

as coated | Edges are "set free" treated after coating



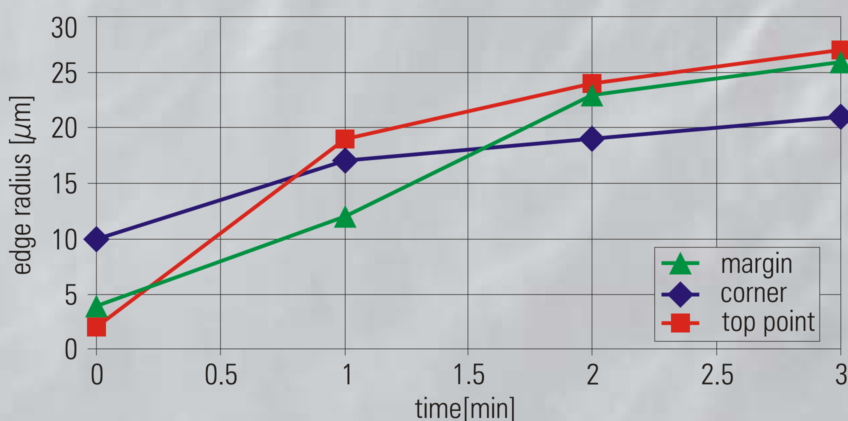
Brushing

Working Principle and Results



Brushes are filled with different additional pastes (e.g. diamond suspense) periodically
Brush materials: e.g.

- Horse hair
- Rice root
- Nylon with silicon carbide (to brush without paste)



Advantages

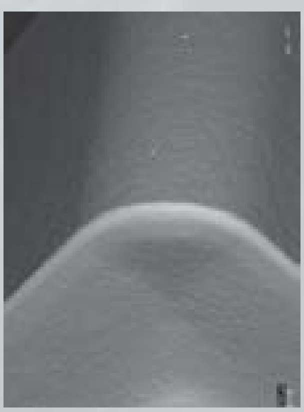
- Easy process and high reproducibility
- Surface polishing with extra step possible
- Different geometries treatable

Limitations

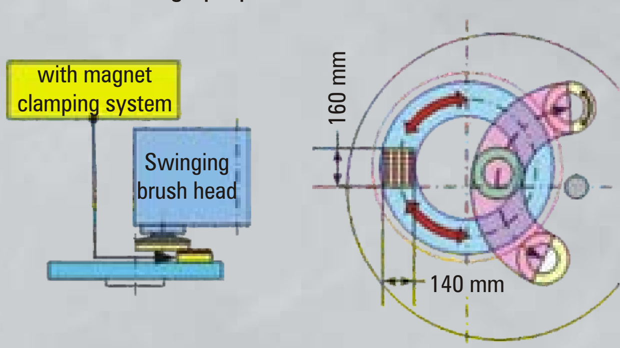
- Exact positioning of brush is necessary

Swinging Brushing (Flakkoting) with Double Movement

- Both brush and work piece are moving
- Special brushes with impregnated diamond grain
- Acoustic positioning system for exact brush positioning
- Very low roughness achievable



Edge preparation of inserts

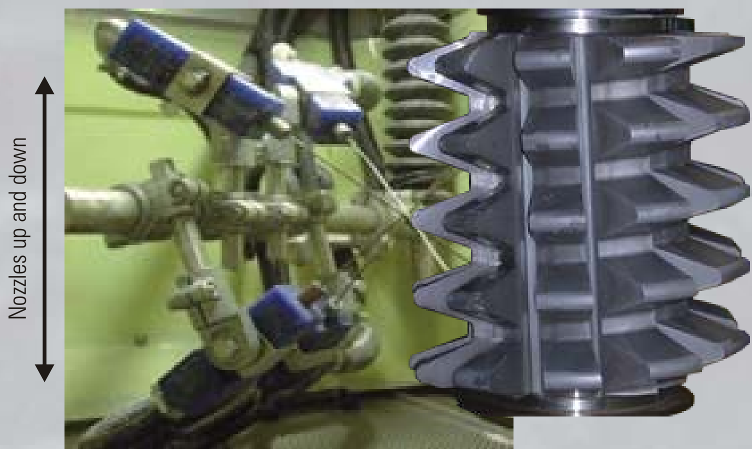


Edge preparation of a saw band

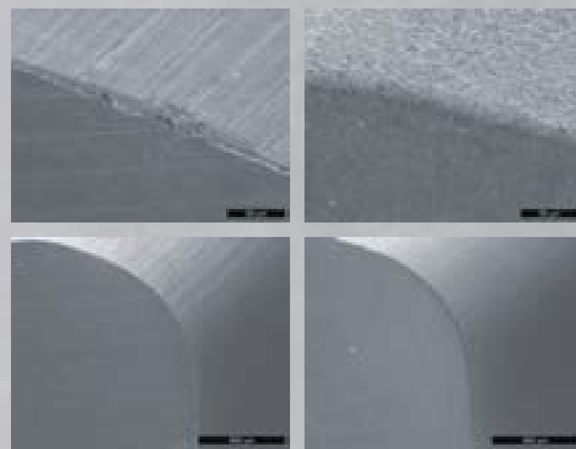
Source: Profin, Luzern-Littau, Switzerland

Microblasting

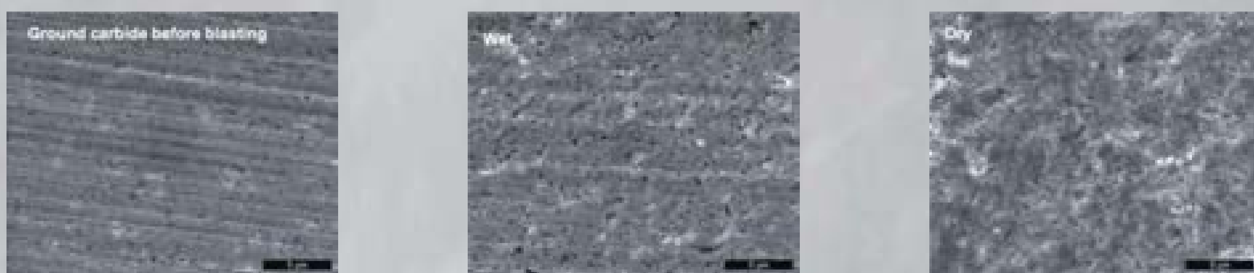
Working Principle and Results

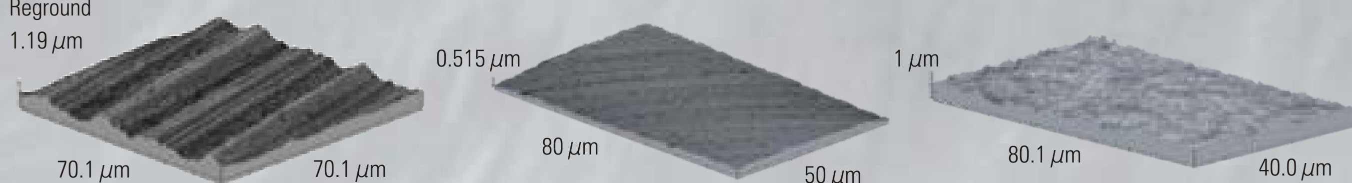


After grinding | After microblasting



Comparison of Wet and Dry Microblasting



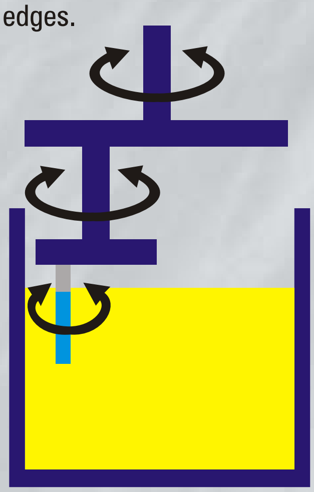


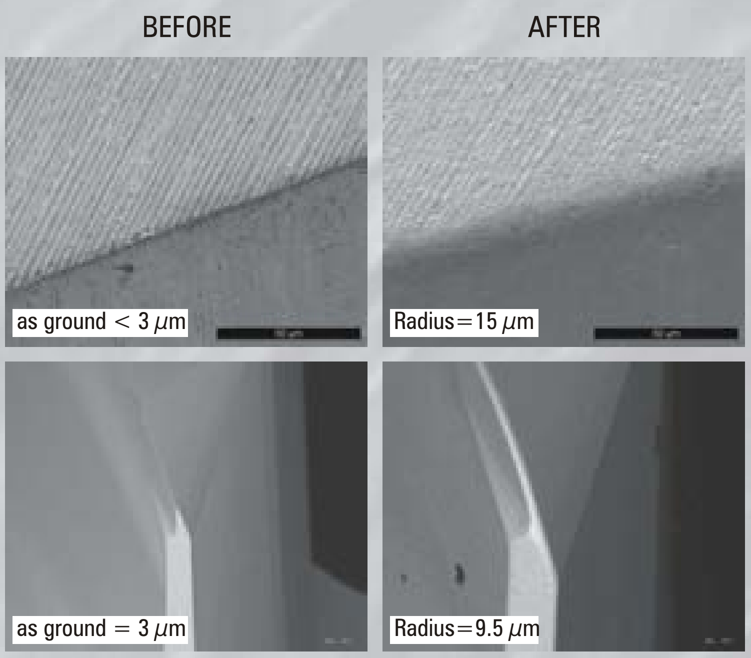
Comparison	WET	DRY
Surface roughness	Sa=0.05 μm - Sz=0.32 μm slightly shiny surface	Sa=0.11 μm - Sz=1.14 μm
Rest material after blasting	Danger of cobalt leaching because of water	Smearing of residual material
Coating adhesion	HF1	HF1
Edge rounding	Better to control	Difficult to control
Grain size	Mesh 320 (50 μm) course, for edge rounding Mesh 400 (37 μm) middle, for surface activation Mesh 500 (30 μm) fine, for polishing	
Typical micro blasting time [min] for hob ø80 mm - R=10 μm	3	6
Main features	• Pre cleaning not needed • Drying after blasting needed • Difficult cleaning at interrupted work • Higher price – huge air consumption	• Pre cleaning needed • No drying needed after blasting • Easy handling at interrupted work • Lower price – high air consumption

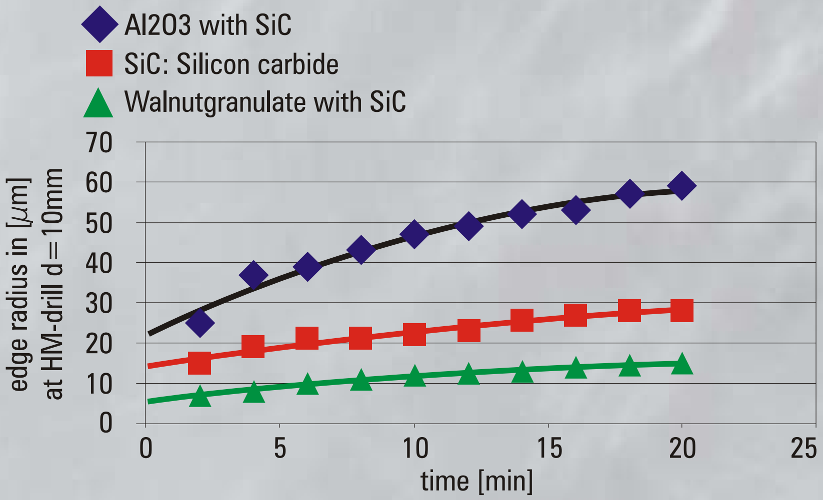
Drag Finishing

Working Principle and Results

The tools are clamped in a planetary drive. The tools are dragged in the process media. The auto rotation of the tools guarantees a homogenous edge rounding of all cutting edges.







Advantages

- Reliable process
- High reproducibility
- Flute polishing

Limitations

- Inflexible clamping system
- Clamping head must be full for homogeneous treatment
- Relatively long process time

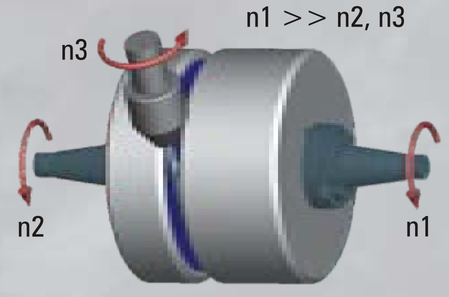
Process Media

Composition	Edge rounding	Polishing
Walnut + SiC	Carbide (+HSS)	Standard coatings
Ceramic 1 + SiC	Carbide (+HSS)	Super hard coatings

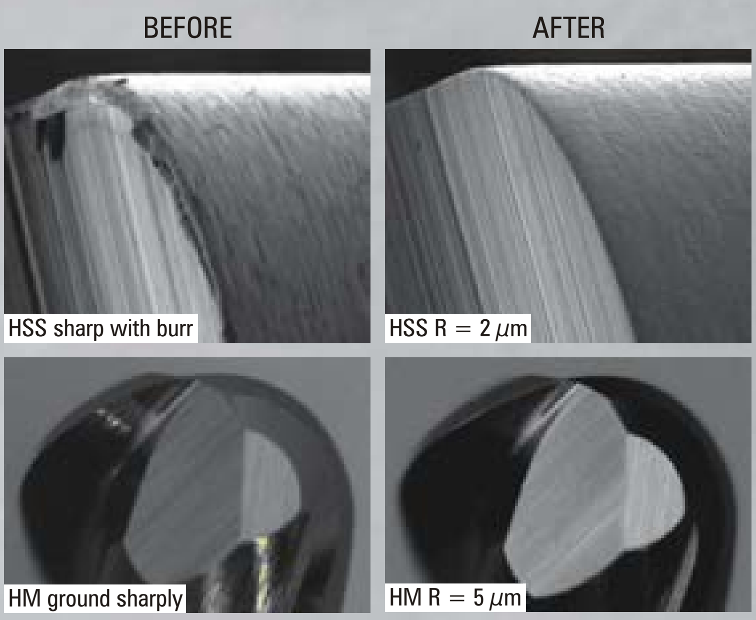
Source: OTEC, Straubenhardt, Germany

Magnet Finish

Working Principle and Results



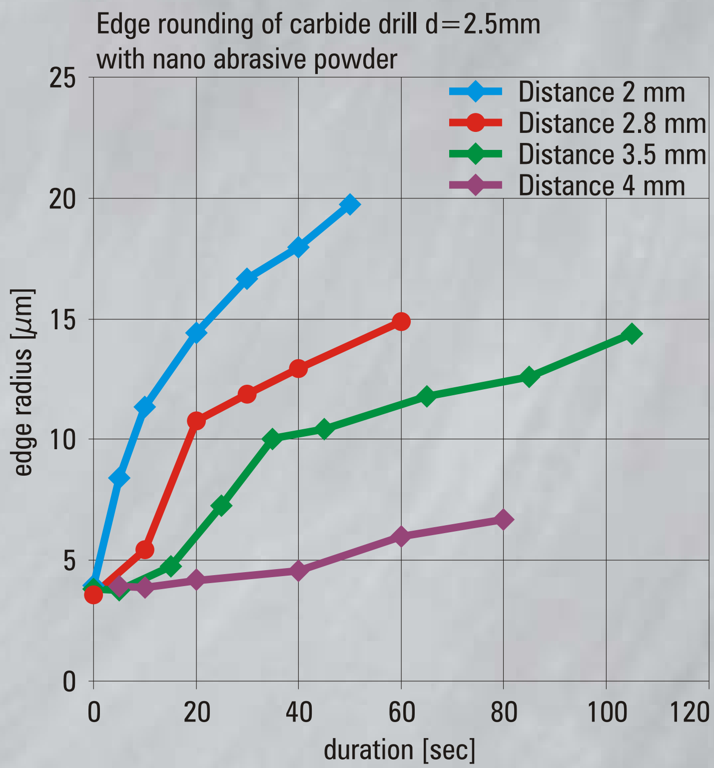
The magnetfinish process bases on two rotating disks with an adhered magnetic abrasive. This abrasive sticks on the flat side of the magnetic disks and operates as a thick elastic mass adopting to the shape of the tool. Rotation results in a movement of the abrasive mass against the tool surface. Due to the high velocity of this movement the surface treatment is very intense.



Source: Magnetfinish GmbH, Switzerland

Process Media

Name	Edge rounding	Polishing
Middle Grain Abrasive	HSS	Standard Coatings
Big Grain Abrasive	Carbide	
Nano Abrasive	Carbide, PCD, CBN	Superhard and DLC coatings



Advantages

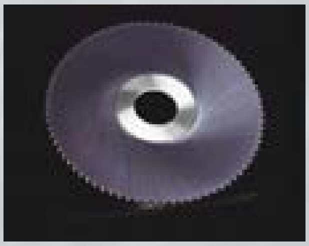
- Easy automatic processing
- Good for small quantities, no dummies needed
- Short process time
- Cooling channels on drills stay clean
- Deburring possible without edge rounding
- Consistent quality over tool length
- High repeatability due to constant abrasivity

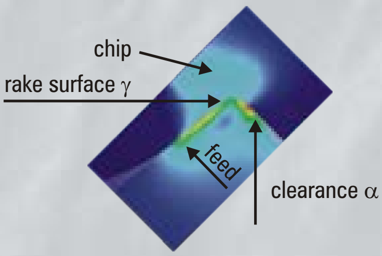
Limitations

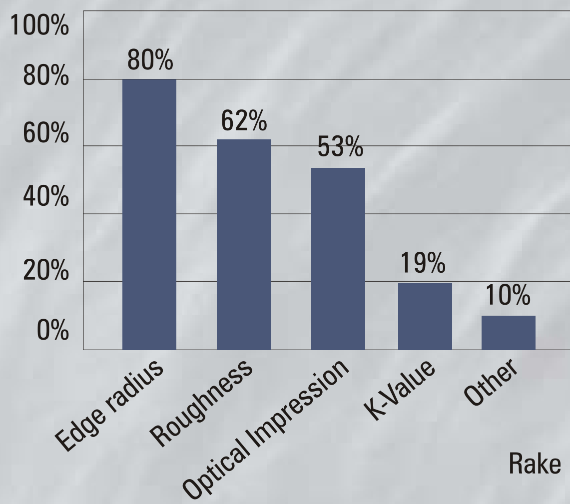
- Tool range: 0.1 – 25 mm
- Flute on drill polishing up the Ø 12 mm
- After magnet finishing, demagnetization of the tools is necessary

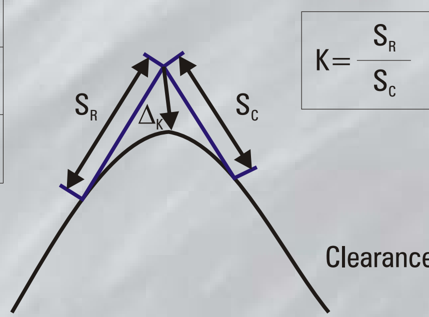
Microstructuring
Influence of the Edge Shape

Importance of the Geometric Edge Parameters



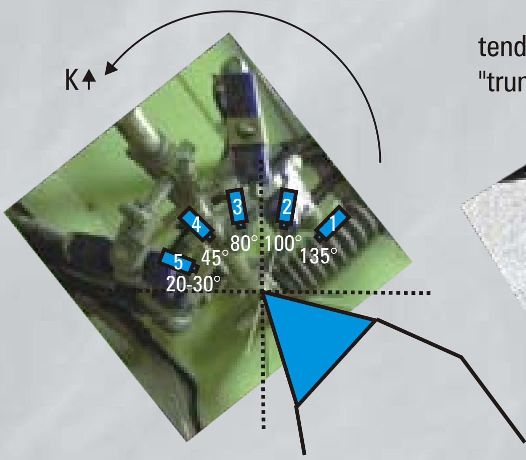






Source: IWF, Berlin, Germany

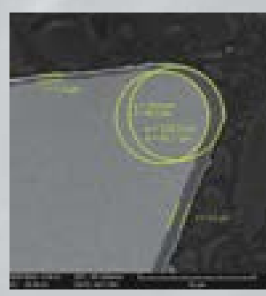
K-Factor and its Influence on the Application



tends to rake K > 1
"trumpet"

for high depth of cuts, for roughing

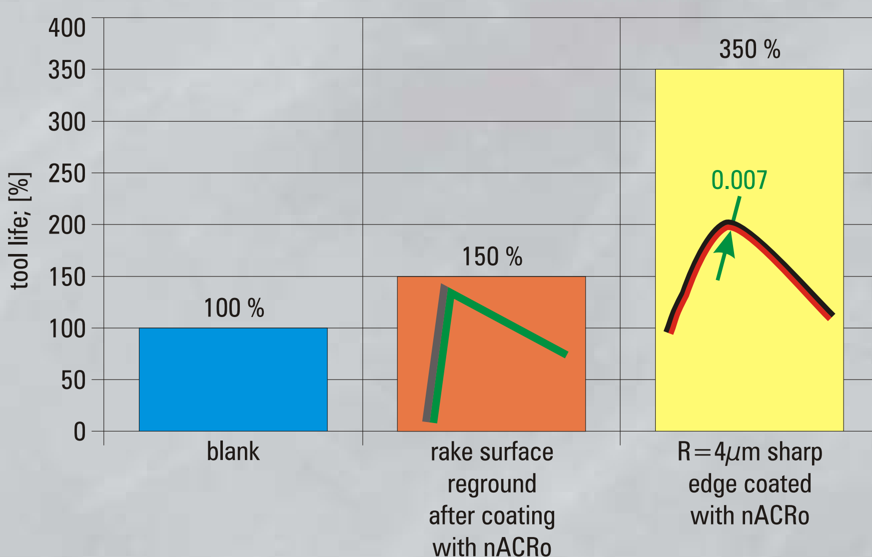
Symmetrical K=1



tends to clearance K < 1
"waterfall"

for low depth of cuts, for finishing

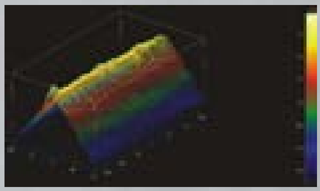
Edge Preparation Increases Tool Performance even for WOOD CUTTERS



Cutting Edge Measurement

3D Inspection of Cutting Edges

Sharp edge after grinding



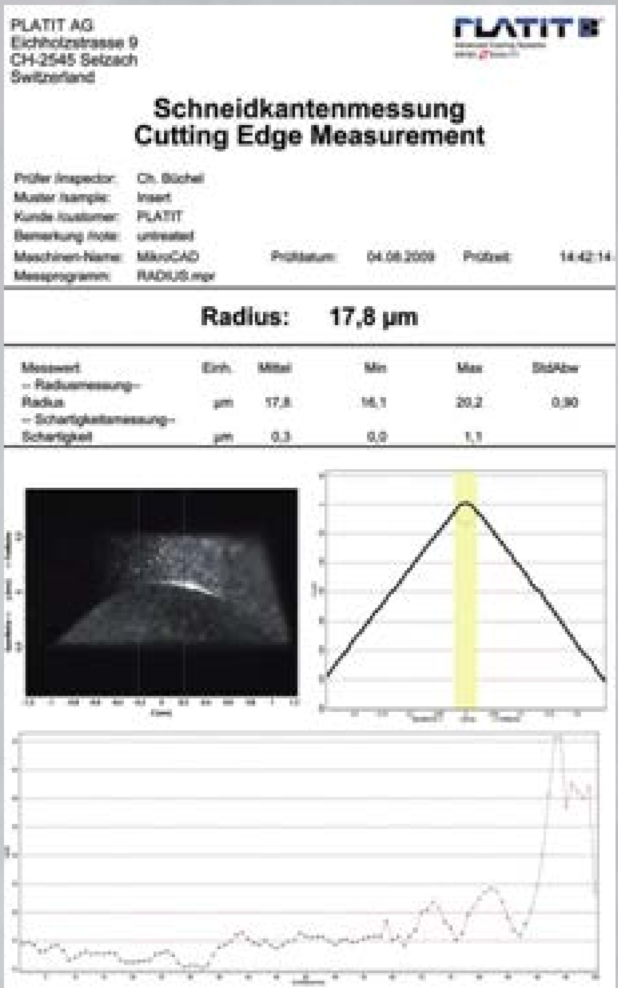
Rounded edge after drag finishing

	MikroCAD Premium	MicroCAD LITE
Measuring volume	2.4 x 1.8 x 1 mm^3	1.8 x 1.2 x 1 mm^3
Min. edge radius	2 μm	10 μm
Features	Radius, Chipping Optional: K-factor, chamfer angle, form error	Radius + Chipping

Measuring Method

- Aligned, sectional planes of light are projected on the cutting edge. These are captured by a CCD camera and compared with the emitted light to calculate the edge radii.
- The working distance is 30 mm

3D view of cutting edge of insert



PLATIT AG
Eichholzstrasse 9
CH-2545 Selzach
Switzerland

Schneidkantenmessung
Cutting Edge Measurement

Prüfer /inspector: Ch. Büchel
Muster /sample: Insert
Kunde /customer: PLATIT
Bemerkung /note: untreated
Maschinen-Name: MikroCAD Prüfdatum: 04.08.2009 Prüfzeit: 14:42:14
Messprogramm: RADIUS.mpr

Radius: 17,8 µm

Messwert	Einh.	Mittel	Min	Max	StdAbw
-- Radiusmessung--					
Radius	µm	17,8	16,1	20,2	0,90
-- Schartigkeitsmessung--					
Schartigkeit	µm	0,3	0,0	1,1	

Advantages

- contact-free, non-destructive edge
- radius and chipping measurement
- high reproducibility
- many measuring points

Limitations

- limited depth resolution for surface structure measurement

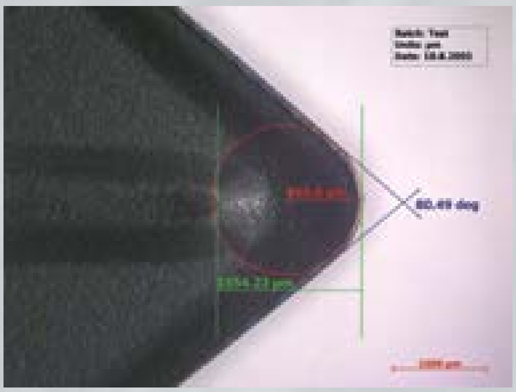
Quality Control
PQCS 2012

Image Processing System

- Microscopical analysis of test plates and coated tools
- Thickness measurement by Calotest on test place and real tools
- Adhesion evaluation using Rockwell test

Measurement

Calo, measured on tool



PLATIT Quality Control System 2012

- Easy user interface
- Step by step "Coating Report" generation
- Automatic database entries after "Coating Report" generation and links to:
  - Batch photo
  - Calo image
  - Rockwell image
  - Coating Report

Batch photo

Database Entries

- Report no. (with link to report)
- Tester
- Date
- Coating unit
- Batch no. (with link to batch photo)
- Measured substrate
- Substrate material
- Coating
- Hardness before coating [HRC]
- Hardness after coating [HRC]
- Thickness [μm] (with link to Calo image)
- Adhesion class [HF] (with link to Rockwell image)
- Customer
- Contact

- 5 user defined text fields e.g.
  - pretreatment
  - posttreatment
  - used holders
- 5 user defined number fields e.g.
  - positions of special substrates on carousel
  - ...

PQCS-Report

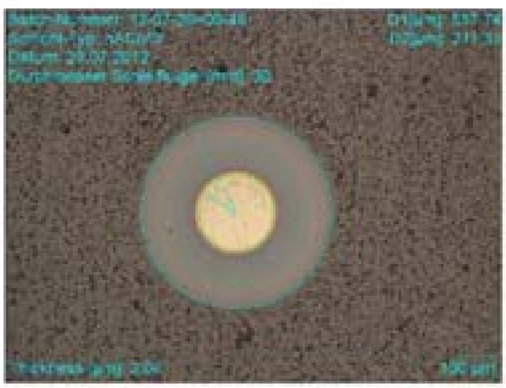
Coating Report

Power Tools

Tester:	Didier Cuche	Report no.:	25
Date of measurement:	7/23/12		
Coating unit:	Pi111-006		
Batch no.:	12-07-20=09-45		
Measured substrate:	Testpiece	Customer:	PowerTools
Substrate material:	HSS	Contact:	Jack Taylor
Coating:	nACo³	Order confirmation number:	AF002345

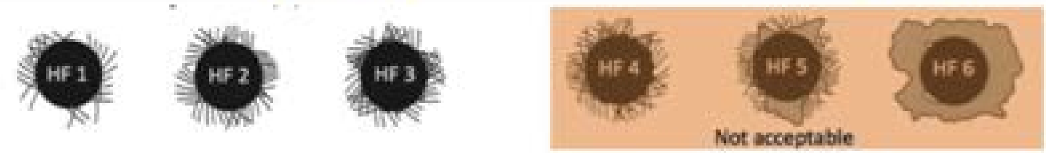
Calo parameters:	KaloMAX	**Hardness:**	Rockwell C
Grinding time:	25 s	before coating	65.4 HRC
Grinding speed:	400 min-1	after coating	65.2 HRC
Grindball diameter:	30 mm		
Diamond suspension quality:	0.50 µm		

Grinding image



Rockwell indentation

Thickness total:	**2.04 µm**	**Adhesion class:**	**HF1**



Comments:

Sign: ____________________

Quality Control System Description

Measurement system with metallurgical microscope and measurement software module. Thickness control test according to "ENV 1071 Part 2".
Rockwell indenter according to standard DIN EN ISO 6508 (Rockwell). Adhesion control test in accordance to VDI-RL 3198, paragraph 5.4 (Substrate hardness > 54 HRC, Coating thickness < 5µm).

Page 1 of 1

Scratch Tester

Method

- Linear scratching of an indenter with an applied load to characterize the coating adhesion
- The diamond of the scratch test is the same as the diamond of a Rockwell indenter
- The scratch tester allows three ways to apply the load:

Source: CSM Instruments, Peseux, Switzerland

Limitations

- Analysis of the scratch on an external microscope
- Flat surface required
- Length of scratch: 0 – 30 mm
- Load range: 0 – 200 N (for hard coatings)

X-Ray Spectrometer

Method

- X-rays excite the substrate to emit X-ray fluorescence
- The analysis is focused on a small spot of 0.3 μm
- The penetration depth is about 40 - 50 μm (for HSS)

Source: Fischer, Sindelfingen, Germany

Advantages

- Non-destructive coating thickness measurement
- Non-destructive composition measurement
- Non-destructive cobalt leaching measurement

Limitations

- Al (element 13) and Si (element 14) detectable
- Measuring chamber size (L x W x H): 360 x 380 x 240 mm

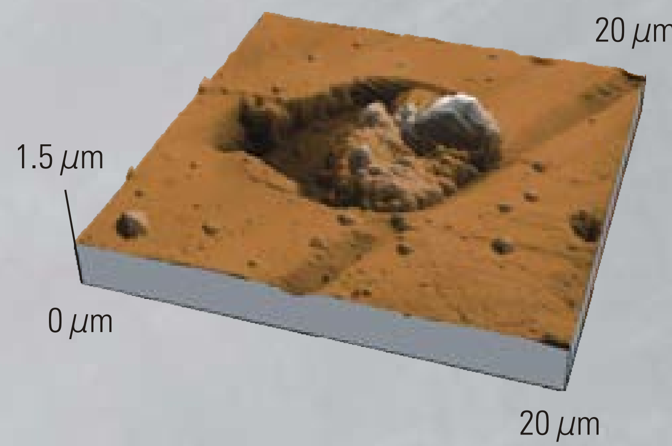
Surface Analysis by AFM

Method

- Atomic Force Microscopy (AFM)
- Static and dynamic measuring modes
- Attached to optical microscope (e.g. to the PLATIT Quality Control System PQCS) or as a standalone equipment

Manufacturer: Nanosurf AG, Liestal, Switzerland

Defect Analysis on Hard Coated Surface by AFM



Adavantages

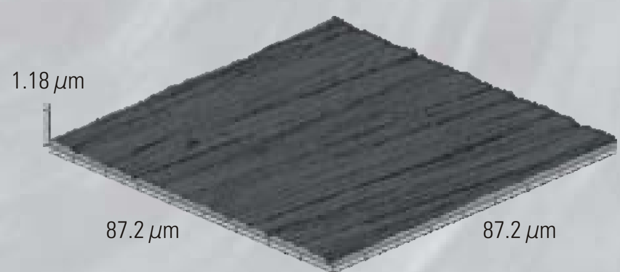
- High-resolution 3D data of the coated surface
- Integrates seamlessly with your optical analysis
- Easy to use and robust scanner
- Automated reports and sample acceptance/rejection rules

Limitations

- Max. scan range (XY): 70 / 110 µm
- Max. height range (Z): 22 µm
- Resolution (XY / Z): 1.7 nm / 0.34 nm
- Typical noise levels: 0.4 nm (0.55 nm max.)

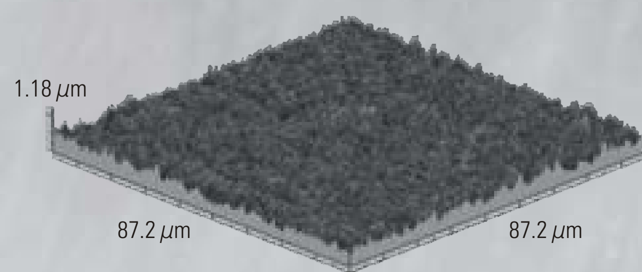
Typical Surface Structures and Roughnesses Measured by AFM

After grinding



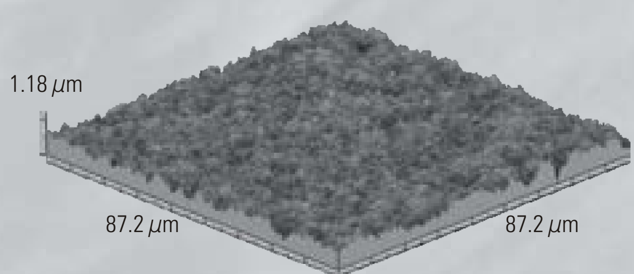
Sa = 0.019 µm - Sz = 0.28 µm

After EDM



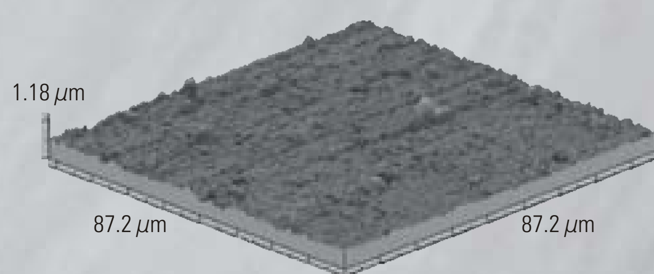
Sa = 0.073 µm - Sz = 0.86 µm

After (grinding + wetblasting)



Sa = 0.076 µm - Sz = 0.76 µm

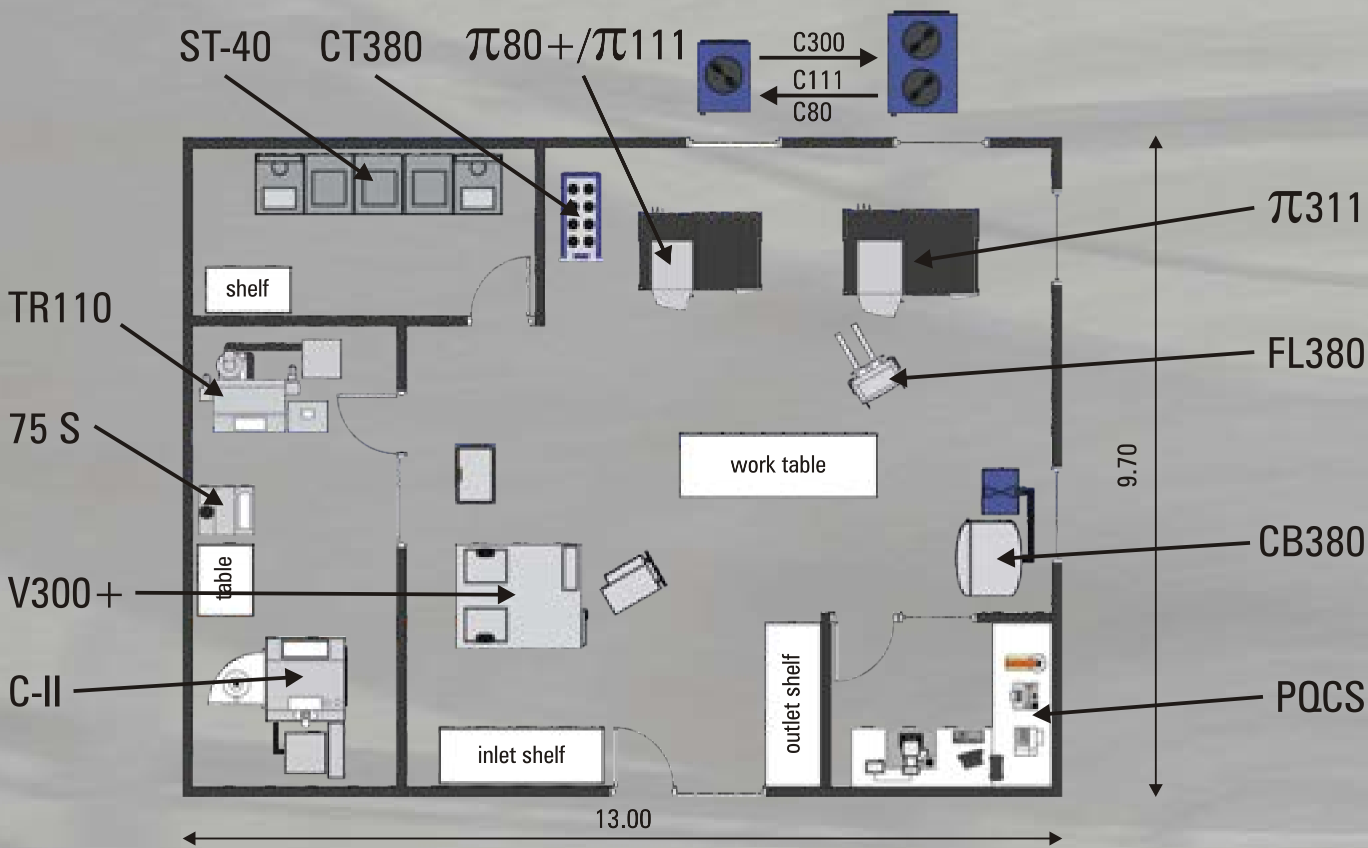
After (AlCrN coating + wetblasting)

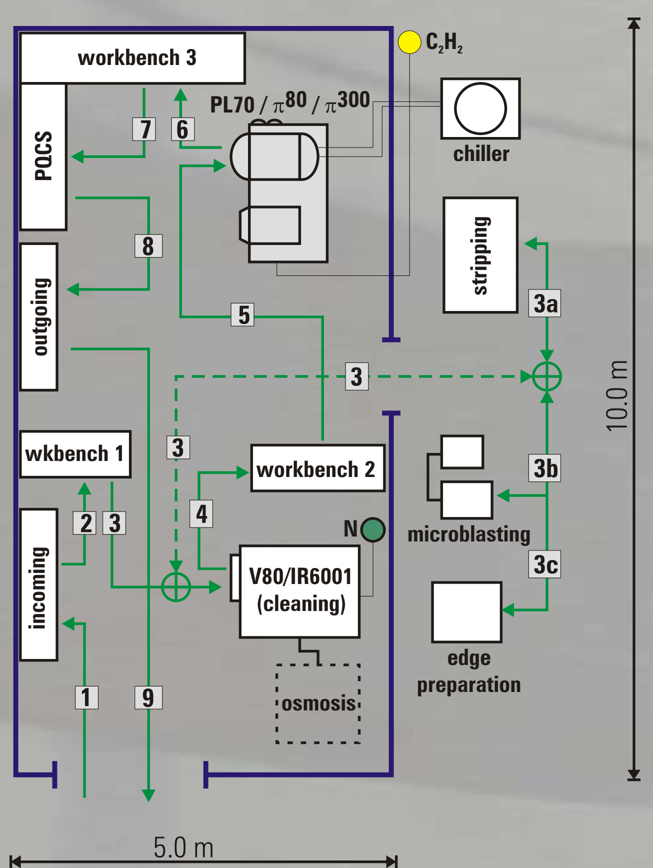


Sa = 0.039 µm - Sz = 0.10 µm

Equipment Layout

In-House Coating Center





Work Flow in Minimal Coating Center

1. Incoming goods
2. Preparations for cleaning (e.g. microblasting)
3. Cleaning
3a. Optionally: stripping
3b. Optionally: microblasting
3c. Optionally: edge preparation
4. Preparations for coating (e.g. loading carousels)
5. Coating
6. Unload charge
   Optionally post surface treatment
7. Check quality with PQCS
8. Packing for shipping
9. Outgoing goods / shipping

Some equipment (chiller, stripping, microblasting, edge preparation) should be set up in a different room, apart from the coating area. The chiller can be placed outside.

Connection Data

Name	Description	Dimension WxDxH [mm]	Weight [kg]	Power supply [V / Hz]	Consumption [kW]	Fuse [A]	Water [bar]	Air [bar]	Gas
PL1001	Coating unit	3880 x 1950 x 2220 x 4200	4400	400 / 50 - 60	90	200	3 - 4.5	-	N_2, Ar, C_2H_2, He
C1001	Chiller for PL1001	1000 x 1000 x 2055	400	400 / 50 - 60	14.2	35	3 - 5	-	-
π411	Coating unit	2720 x 1721 x 2149 x 3200	2300	400 / 50 - 60	76	160	3 - 4.5	-	N_2, Ar, C_2H_2, He
C411	Chiller for π411	1000 x 1000 x 2055	400	400 / 50 - 60	18.5	35	3 - 5	-	-
π311	Coating unit	2350 x 1660 x 2300 x 3200	2100	400 / 50 - 60	45	100	3 - 4.5	-	N_2, Ar, C_2H_2, He
C311	Chiller for π311	1000 x 1000 x 2055	400	400 / 50 - 60	14.2	35	1 - 6	-	-
π111	Coating unit	1890 x 1500 x 2120 x 3100	1400	400 / 50 - 60	30	100	3 - 4.5	-	N_2, Ar, C_2H_2, He
C111	Chiller for π111	1000 x 1000 x 1680	350	400 / 50 - 60	10.2	25	1 - 6	-	-
π80+	Coating unit	1870 x 1320 x 2155 x 3000	1200	400 / 50 - 60	20	100	3 - 4.5	-	N_2, Ar, C_2H_2, He
C80/C70	Chiller for π80/PL70	715 x 715 x 1375	200	400 / 50 - 60	6.1	16	1 - 6	-	-
PL70	Coating unit	1870 x 1320 x 2155 x 2400	1250	400 / 50 - 60	15	100	3 - 4.5	-	N_2, Ar, C_2H_2, He
DF4	Drag finish unit	1105 x 970 x 1990	370	400 / 50 - 60	2	16	-	-	-
75S	Dry sand blasting unit	760 x 870 x 1400	133	230 / 50 - 60	0.25	10	-	3 - 6	-
TR110	Dry micro blast unit	2100 x 1450 x 2430	480	400 / 50 - 60	2	16	-	4 - 6	-
C-II	Wet micro blast unit	2100 x 2050 x 3000	1200	400 / 50 - 60	7	32	3 - 6	4 - 5	-
ST-40	Stripping unit	2540 x 850 x 1180	380	230 / 50 - 60	1.1, 2.5	13	1 - 6	-	-
V80+	Cleaning unit	1325 x 1020 x 2010	1800	400 / 50 - 60	9.5	32	3 - 6	3 - 6	N_2
RO80	Reverse osmosis	910 x 610 x 1800	300	230 / 50 - 60	2.5	16	3 - 6	-	-
V311	Cleaning unit	1500 x 1200 x 2100	2500	400 / 50 - 60	15	80	3 - 6	3 - 6	N_2
RO300	Reverse osmosis	910 x 610 x 1800	300	230 / 50 - 60	2.5	16	3 - 6	-	-
PQCS	Microscope + PC	440 x 610 x 685	30	230 / 50 - 60	-	10	-	-	-
CT50	Calotester	300 x 300 x 250	5	230 / 50 - 60	-	10	-	-	-
RT-N3A	Rockwell tester	120 x 430 x 810	40	-	-	-	-	-	-
CB380	Cooling box	1140 x 960 x 1450	150	400 / 50 - 60	0.75	10	-	-	-
FL380	Fork lift	840 x 1300 x 1940	220	230 / 50 - 60	0.75	10	-	-	-
CT380	Cathode holder table	1300 x 700 x 1250	40	-	-	-	-	-	-

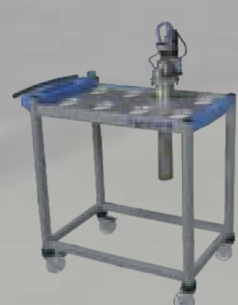
Handling Devices

FL380 Fork Lift

Fork lift for easy transportation of loaded carousels and cathodes to and from the coating unit. Compatible with PL70, π^{80}, π^{111}, and π^{300}.

CT380 Cathode Table

For correct vertical holding and stocking of LARC and CERC cathodes.



CB380 Cooling Box

Special box to allow quick cooling of work pieces in carousel through pressurized air.

See loading wagon for π411 on page 25

Loading Capacities

PL70 / π80 / π111

PL70 / π80

	Tool Diameter	Tool Length	Satellites	Discs / Satellite	Holders / Disc	Tools / Holder	Tools / Disc	Tools / Batch
End mills	6 mm	50 mm	1	4	44	1	44	176
	6 mm	50 mm	3	4	18	1	18	216
	6 mm	50 mm	1	4	22	4	88	352
	6 mm	50 mm	3	4	12	4	48	576
	6 mm	50 mm	3	9	22	1	22	594
	8 mm	60 mm	3	4	18	1	18	216
	10 mm	70 mm	3	3	18	1	18	162
	16 mm	75 mm	3	3	12	1	12	108
	20 mm	100 mm	3	3	8	1	8	72
	32 mm	133 mm	3	2	6	1	6	36
Drills	3 mm	46 mm	3	4	12	12	144	1728
	4.2 mm	55 mm	3	4	12	6	72	864
	6.8 mm	74 mm	3	3	12	4	48	432
	8.5 mm	79 mm	3	3	18	1	18	162
	10.2 mm	102 mm	3	3	18	1	18	162
	16 mm	115 mm	3	2	12	1	12	72
	20 mm	131 mm	3	2	12	1	12	72
	25 mm	170 mm	3	2	8	1	8	48
Inserts	20 mm	6 mm	3	1	15	28	420	1260
Hobs	60 mm	80 mm	3	4	1	1	1	12
	80 mm	180 mm	3	2	1	1	1	6
							Average number of tools / batch	348.9

π111

	Tool Diameter	Tool Length	Satellites	Discs / Satellite	Holders / Disc	Tools / Holder	Tools / Disc	Tools / Batch
End mills	6 mm	50 mm	1	5	52	1	52	260
	6 mm	50 mm	4	5	18	1	18	360
	6 mm	50 mm	1	5	26	4	104	520
	6 mm	50 mm	4	5	12	4	48	960
	6 mm	50 mm	4	11	22	1	22	968
	8 mm	60 mm	4	4	18	1	18	288
	10 mm	70 mm	4	4	18	1	18	288
	16 mm	75 mm	4	4	12	1	12	192
	20 mm	100 mm	4	3	8	1	8	96
	32 mm	133 mm	4	2	6	1	6	48
Drills	3 mm	46 mm	4	5	12	12	144	2880
	4.2 mm	55 mm	4	4	12	6	72	1152
	6.8 mm	74 mm	4	4	12	4	48	768
	8.5 mm	79 mm	4	4	18	1	18	288
	10.2 mm	102 mm	4	3	18	1	18	216
	16 mm	115 mm	4	3	12	1	12	144
	20 mm	131 mm	4	2	12	1	12	96
	25 mm	170 mm	4	2	8	1	8	64
Inserts	20 mm	6 mm	4	1	15	28	420	1680
Hobs	60 mm	80 mm	10	4	1	1	1	40
	80 mm	180 mm	4	2	1	1	1	8
							Average number of tools / batch	538.9

- tools in single holders driven by kickers
- tools in single holders driven by gearboxes
- tools in revolvers driven by kickers
- tools in revolvers driven by gearboxes
- tools in sphere holders
- inserts with holes fixed on rods
- hobs on satellites

Only standard holders were used for capacity calculations.
Capacity can be increased with dedicated holders.

π311 / π411 / PL1001

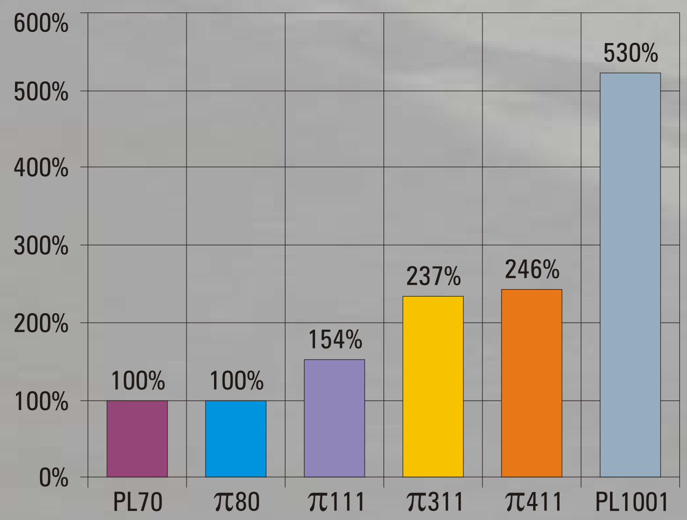
Machine	Tool type	Tool Diameter	Tool Length	Satellites	Discs / Satellite	Holders / Disc	Tools / Holder	Tools / Disc	Tools / Batch
π311 / π411	End mills	6 mm	50 mm	7	5	18	1	18	630
		6 mm	50 mm	7	5	9	4	36	1260
		6 mm	50 mm	7	10	22	1	22	1540
		8 mm	60 mm	7	4	18	1	18	504
		10 mm	70 mm	7	4	18	1	18	504
		16 mm	75 mm	7	3	12	1	12	252
		20 mm	100 mm	7	3	8	1	8	168
		32 mm	133 mm	7	2	6	1	6	84
	Drills	3 mm	46 mm	7	5	9	12	108	3780
		4.2 mm	55 mm	7	5	9	6	54	1890
		6.8 mm	74 mm	7	3	9	4	36	756
		8.5 mm	79 mm	7	3	18	1	18	378
		10.2 mm	102 mm	7	3	18	1	18	378
		16 mm	115 mm	7	3	12	1	12	252
		20 mm	131 mm	7	2	12	1	12	168
		25 mm	170 mm	7	2	8	1	8	112
	Inserts	20 mm	6 mm	7	1	15	28	420	2940
	Hobs	60 mm	80 mm	14	4	1	1	1	56
		80 mm	180 mm	14	2	1	1	1	28
								Average number of tools / batch	825.3
PL1001	End mills	6 mm	50 mm	4	7	23	4	92	2576
		6 mm	50 mm	4	7	36	1	36	1008
		6 mm	50 mm	8	17	22	1	22	2992
		8 mm	60 mm	4	7	36	1	36	1008
		10 mm	70 mm	4	6	36	1	36	864
		16 mm	75 mm	4	6	30	1	30	720
		20 mm	100 mm	4	4	23	1	23	368
		32 mm	133 mm	4	3	15	1	15	180
	Drills	3 mm	46 mm	4	9	23	12	276	9936
		4.2 mm	55 mm	4	7	23	6	138	3864
		6.8 mm	74 mm	4	6	23	4	92	2208
		8.5 mm	79 mm	4	5	36	1	36	720
		10.2 mm	102 mm	4	4	36	1	36	576
		16 mm	115 mm	4	4	36	1	36	576
		20 mm	131 mm	4	4	23	1	23	368
		25 mm	170 mm	4	3	23	1	23	276
	Inserts	20 mm	6 mm	8	2	15	28	420	6720
	Hobs	60 mm	80 mm	4	7	4	1	4	112
		80 mm	180 mm	4	3	3	1	3	36
								Average number of tools / batch	1847.8

Only standard holders were used for capacity calculations.
Capacity can be increased with dedicated holders.

- tools in single holders driven by kickers
- tools in single holders driven by gearboxes
- tools in revolvers driven by kickers
- tools in revolvers driven by gearboxes
- tools in sphere holders
- inserts with holes fixed on rods
- hobs on satellites

Cost Comparison for PLATIT's Standard Coating Units

Comparison of the Loading Capacity of PLATIT's Standard Units



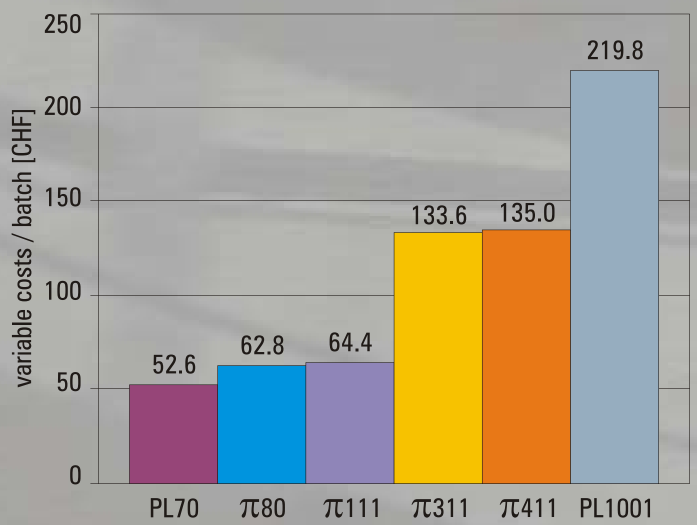
Considered costs:

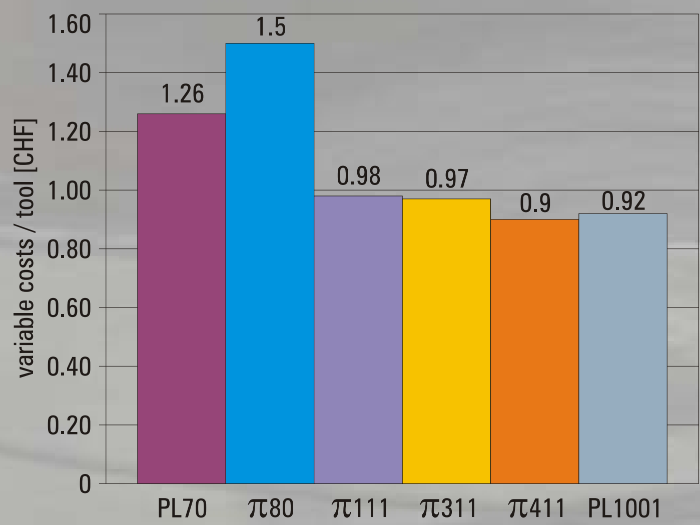
Fix costs:
- loan (credit) costs,
- labour costs,
- social costs
- room rental costs,
- depreciation

Variable costs:
- energy costs,
- target costs,
- gas costs,
- cleaning costs,
- stripping costs

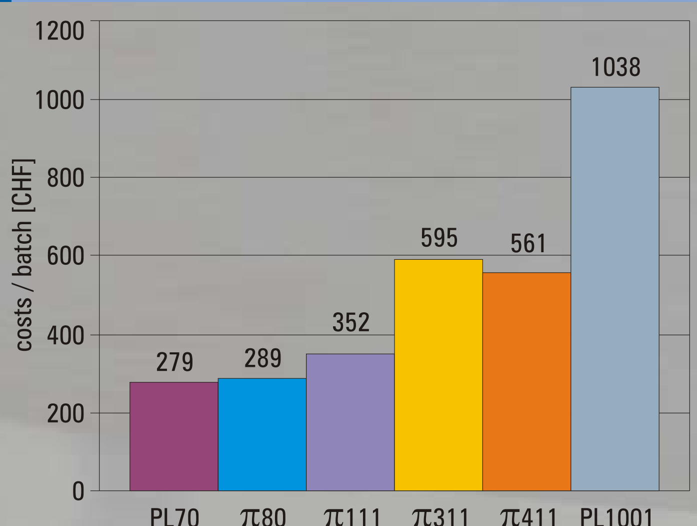
The costs are calculated for typical mixed tools, like drills, end mills, inserts and hobs with the sizes Ø3-80mm – L46-180mm (see pages 58-59)

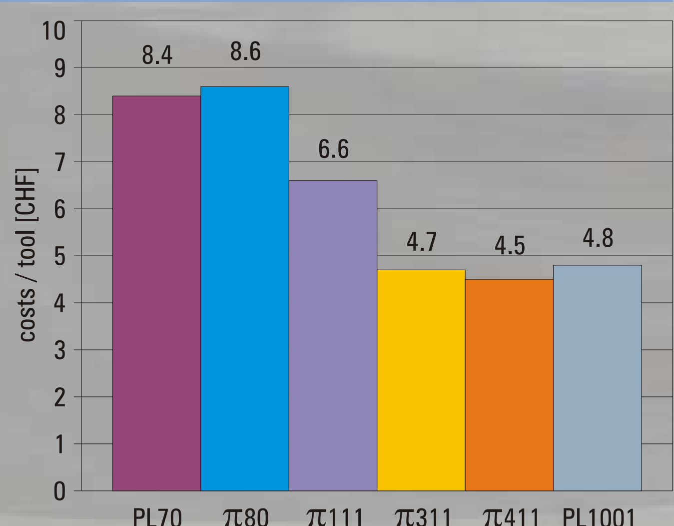
Variable Costs





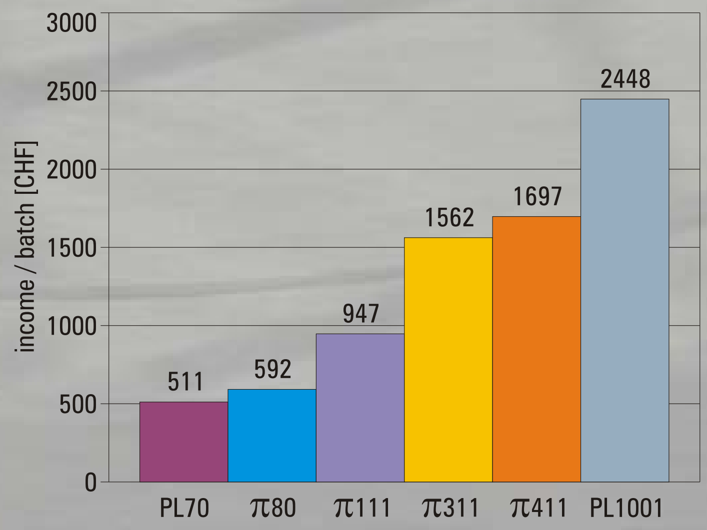
Total Costs

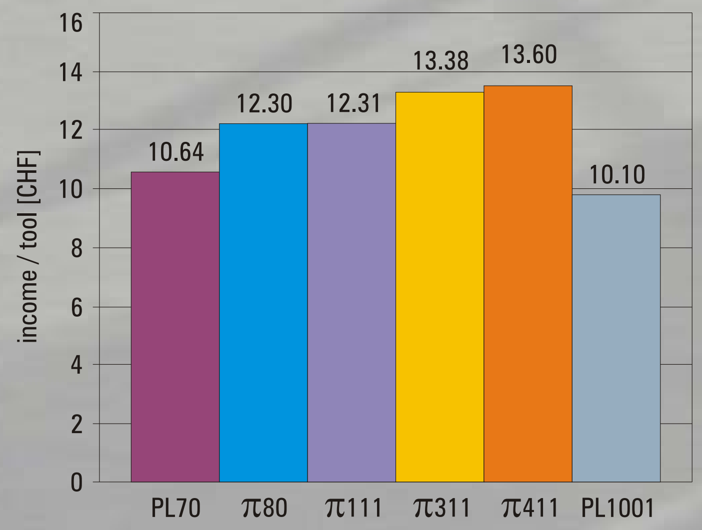




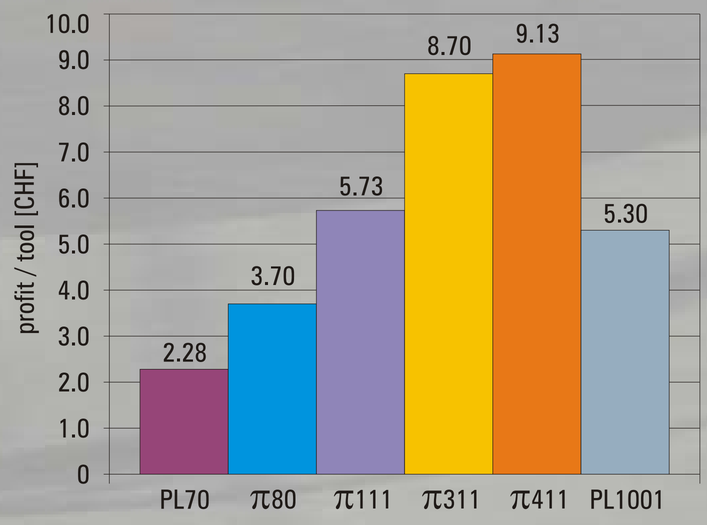
Payback

Income





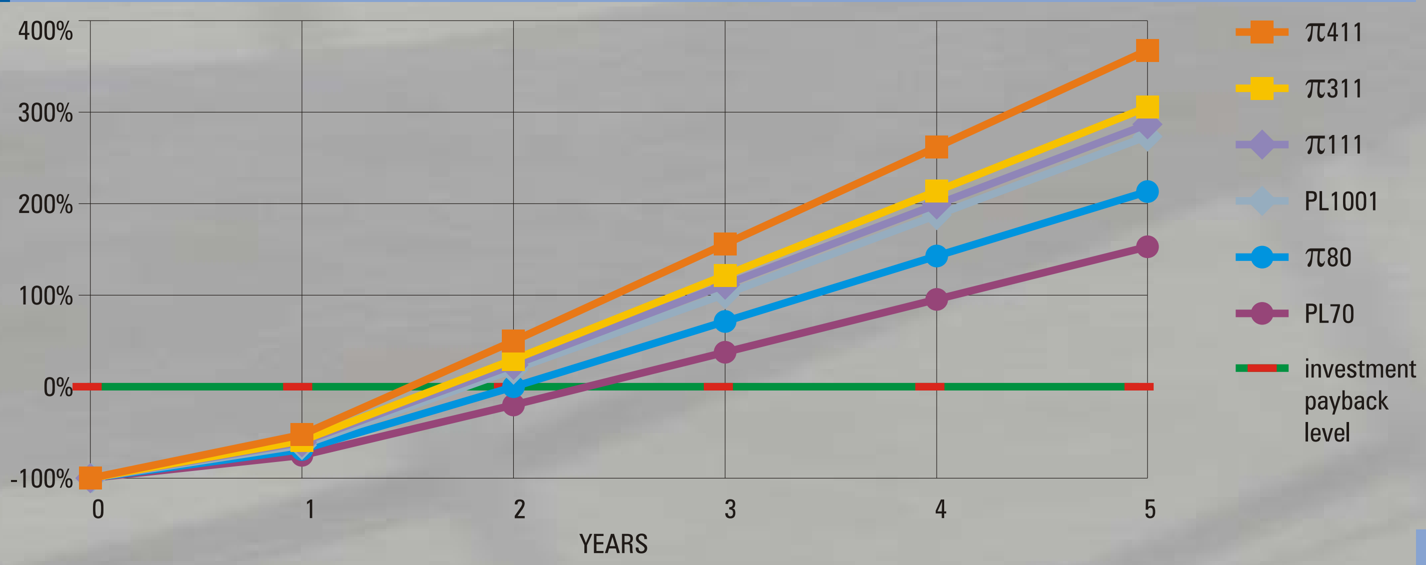
Profit / Tool



The following factors are considered for the calculation of incomes and profit:

- Costs (see page 60)
- 2 shifts (2 x 8 hours) production time / day
- Filling rate / batch ; 80%
- Possible coatings for the different units
- Typical coating discounts depending on the units and on possible coatings
- For the first year a by 50% reduced utilization assumed

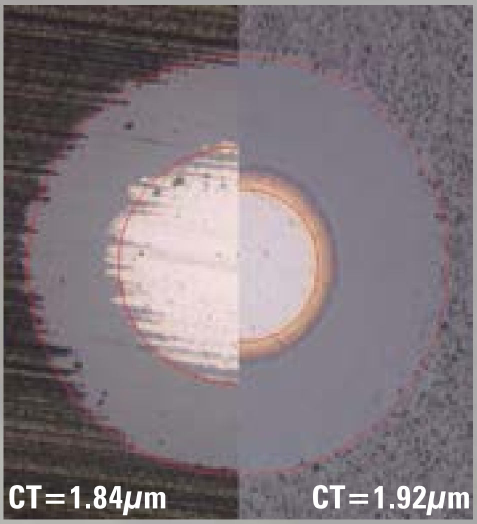
Profit / Investment



Coating Structures

Microstructures

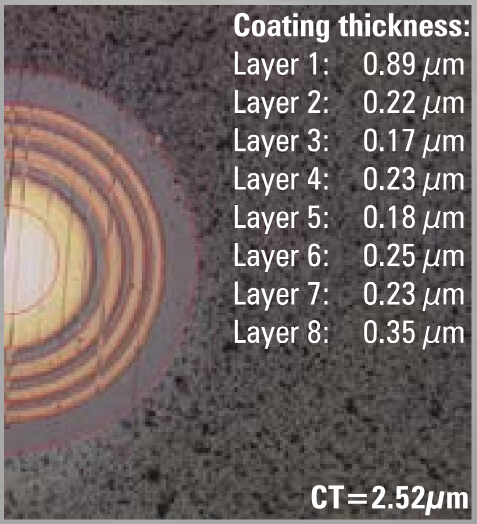
Monoblock (MB)



The **monoblock structure without adhesion layer** can be produced by the fastest, most economical process. All targets are the same and run during the whole deposition process.

Especially at high aluminum content the **monoblock coating** should be started **with adhesion layer** (e.g. TiN or CrN).

Multilayer (ML)

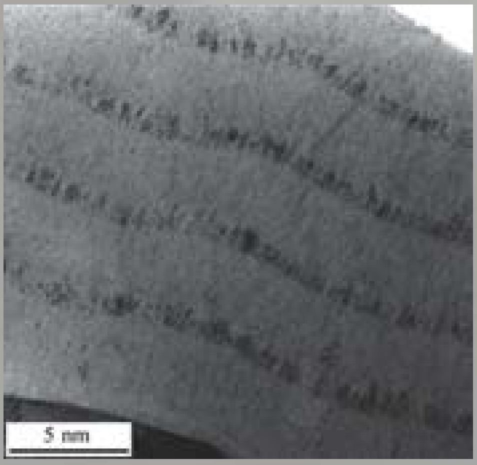


The **multilayer structure** has higher toughness at lower hardness than a comparable monoblock coating. The "sandwich" structure absorbs the cracks by the sublayers. Therefore the multilayer is usually preferred for high dynamical load, e.g. for roughing.

Gradient (G)

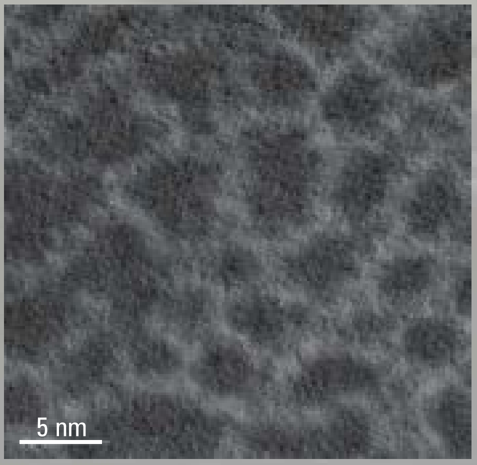
The **gradient structure** also starts with **adhesion layer**, with components like TiN and CrN, generating a tough core for the coating. The ratio of hard components (e.g. cubic AlN) will be continuously increased obtaining the highest hardness on the top of the coating.

Nanolayer (NL)



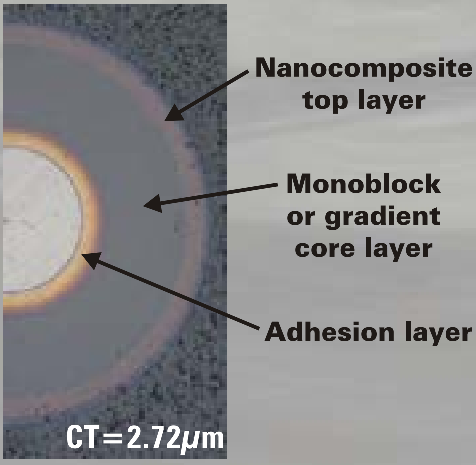
Nanolayer is the conventional structure for the so called Nanocoatings. It is a finer version of multilayers with a period of < 20 nm. Its hardness depends on the period. The period depends on the rotation speed of the substrates. Therefore the coating hardness can be different on substrates with different sizes deposited in a mixed batch.

Nanocomposite (NC)



By depositing different kinds of materials, the components (like Ti, Cr, Al, and Si) are not mixed, and 2 phases are created. The nanocrystalline TiAlN- or AlCrN-grains become embedded in an amorphous Si_3N_4-Matrix. This nanocomposite structure significantly improves physical characteristics, they are not depending on the batch load.

TripleCoating³®



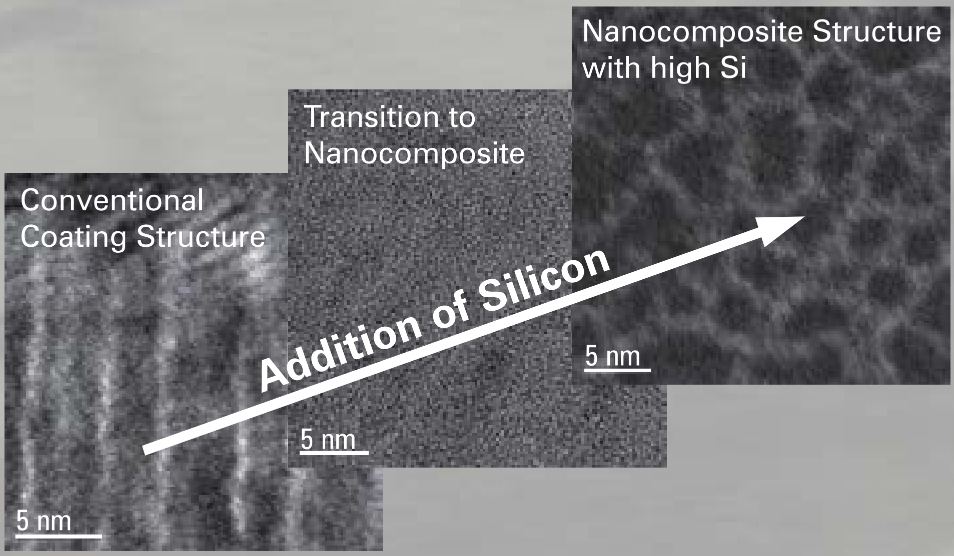
TripleCoatings are deposited with 3 sections freely programmed in one batch:

- The adhesion layer is generated with TiN or CrN.
- The core is deposited with the nowadays most used AlTiN.
- The nanocomposite (e.g. AlTiN/SiN) generates the wear resistant skin with extrem high warm hardness.

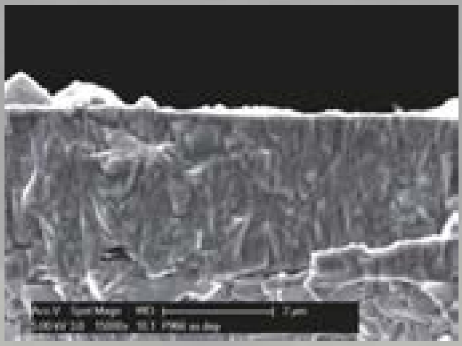
Comparison of Coating Structures

By deposition of very different kinds of materials, the components (like Ti, Cr, Al in the first group, and Si in the other) are not mixed completely, and 2 phases are created. The nanocrystalline TiAlN- or AlCrN-grains become embedded in the amorphous Si_3N_4-matrix and the nano-composite structure develops.

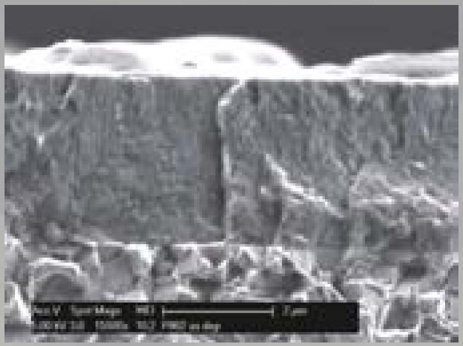
Silicon increases the toughness and decreases the internal residual stress of the coating. The increasing of the hardness is generated by the structure only, the SiN matrix enwraps the hard grains and avoids growing of their size.



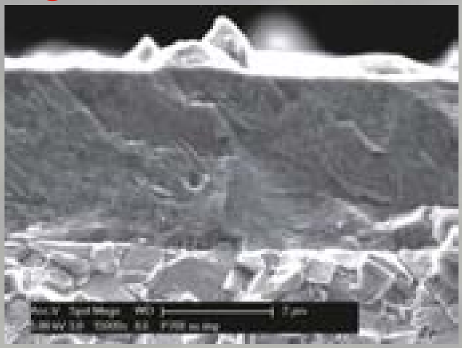
No Silicon: AlCrN



Low Silicon: AlCrN/SiN



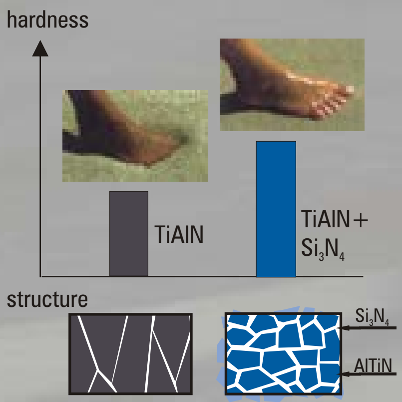
High Silicon: AlCrN/SiN

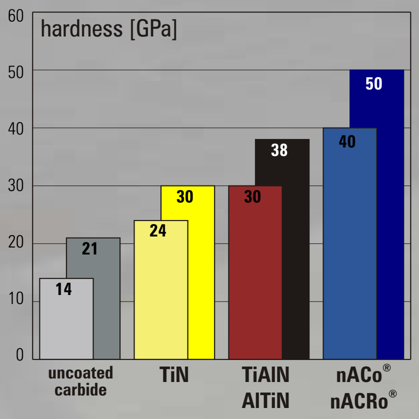


- Si addition changes microstructure from columnar to isotropic
- Effect analogous to the Ti-based system
- In TiAlN/SiN less Si is needed to reach glassy structure

High Silicon: AlTiN/SiN: nACo®

Hardness Increase through Nanocomposites





The beach comparison illustrates the hardness increase made possible by using a nano-composite structure. Usually, the foot sinks into dry sand. In wet sand, the foot does not sink in or not as far, because the space between sand-corns is filled with water. The surface has a higher resistance, so it is harder.

Coating Types

Conventional Coatings

The machine symbols show which machine the coating can be deposited by.
The coatable stoichiometries can be different depending on the machine used.

TiN

The **general-purpose coating** for:
- cutting
- forming
- injection molding
- tribological applications (for machine components)
- available process with 1, 2 or 4 cathodes

TiCN-MP

PLATIT MultiPurpose gradient coating for:
- interrupted cutting
- milling and tapping
- forming, stamping and punching
- higher edge stability than at TiCN-grey

TiCN-grey

Conventional carbonitride coating (grey):
- for milling and tapping
- for stamping, punching and forming

Ti_2N

Titanium-rich PLATIT coating for:
- medical tools and implants

SuperTiN S

Special multilayer TiN-coating with carbon to increase performance:
- at sawing
- at tapping
- at hobbing
- injection molding

CBC + DLC^2

Hard lubricant

cVIc® | $cVIc^2$®

PLATIT double coating with nanogradient structure:
- for cutting sticky materials to avoid built up edges
- for forming application with optimum release
- for tapping

PLATIT®

X-VIc®: a:C:H:Me; metal doped Carbon Based Diamond Like Coating (CBC)
X-VIc^{2}®: a:C:H:Si metal free silicon doped Carbon Based Diamond Like Coating (DLC^{2})

The CBC and DLC^{2} coatings can be deposited as top layers only.

CrN

The standard coating for non-cutting applications:
- for molds and dies
- for machine parts
- for optimal release of molds and dies
- low deposition temperature possible (above 220 °C)

CrTiN

PLATIT multilayer coating for universal use:
- improved economy by using Ti
- outstanding chemical resistance and toughness due to fine multilayer structure
- for molds, dies and machine parts
- for HSS cutting tools in high alloyed materials
- lower deposition temperature possible

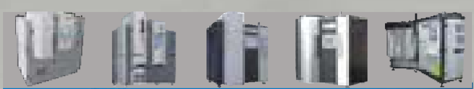
ZrN

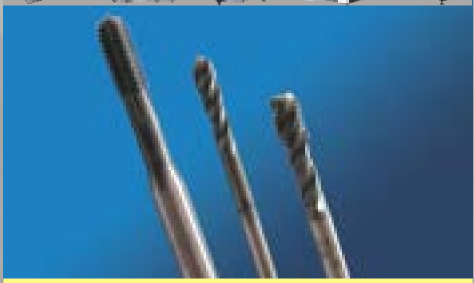
Ti- and Cr-free monolayer coating
- Effectively reduces the built up edges when machining aluminum and titanium alloys.
- High heat resistance
- Fancy color

CBC + DLC^{2}

Hard lubricant

CROMVIc® | CROMVIc^{2}®



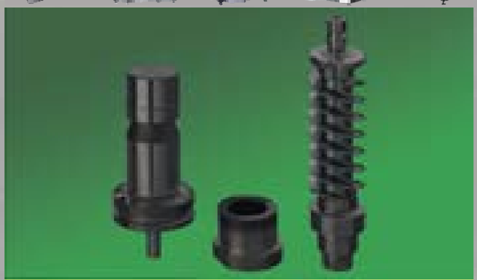


PLATIT double coating with nanogradient structure:
- to avoid built up edges
- for machining aluminium and titanium alloys
- for forming application with optimum release

CBC + DLC^{2}

Hard lubricant

CROMTIVIc® | CROMTIVIc^{2}®



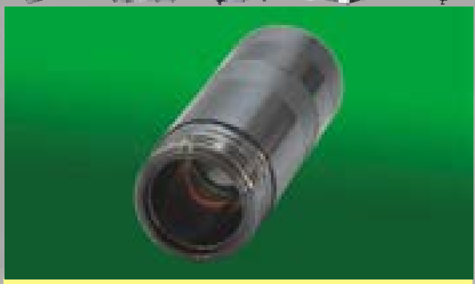
PLATIT multilayer coating for universal use:
- Same usage as CrTiN

plus
- prevents built-up edges
- easy release of forming tools
- wear and corrosion protection on machine parts and components

CBC + DLC^{2}

Hard lubricant

ZIRVIc® | ZIRVIc^{2}®



PLATIT double coating with nanogradient structure:
- for machine parts used at higher temperature with low friction
- to avoid built up edges
- for machining aluminum and titanium alloys
- for forming application with optimum release

Coating Types

Conventional Coatings

The machine symbols show which machine the coating can be deposited by.
The coatable stoichiometries can be different depending on the machine used.

TiAlN (UniversAl®)

Universal high-performance coating for cutting (drilling, milling, reaming, turning).

Monolayer (MB): for stable finishing and roughing
Multilayer (ML): for interrupted cuts

TiAlN-F (ML); Ti/Al ~50/50%
TiAlN-G (G: gradient); Ti/Al > 50/50%
TiAlN-MB; Ti/Al ~50/50%

AlTiN

High-performance coating:
- high heat resistance
- for dry, high speed machining
- hard machining

AlTiN-G (gradient); Ti/Al ≥ 40/60%
AlTiN-ML; Ti/Al ≥ 40/60%
AlTiN-T (MB); Ti/Al ≥ 40/60%
AlTiN-C (MB); Ti/Al ≥ 33/67%

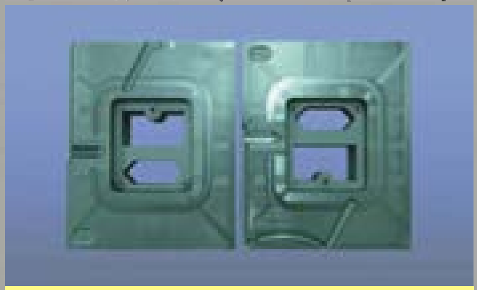
TiAlCN

PLATIT *gradient* coating for universal use:
- with high toughness and hardness
- at very low friction coefficient
- for milling and tapping
- for stamping and punching

CBC + DLC²

Hard lubricant

ALLViC® | ALLViC²®



Universal PLATIT Double coating:
Very low friction coefficient for:
- minimal lubrication
- dry processing

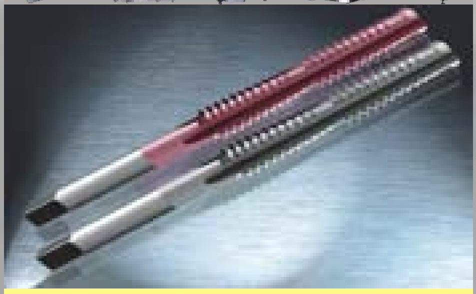
µAlTiN®

Special high-performance PLATIT coating:
Like the AlTiN coatings,
but with polished surfaces for extremly good chip evacuation.

CBC + DLC²

Hard lubricant

GRADVIc® | GRADVIc²®



PLATIT double coating with nanogradient structure:
- for milling, tapping, punching and stamping
- to avoid built up edges
- for machining high alloyed materials as nickel alloys, Inconel, superalloys etc.
- for forming application for optimum release

PLATIT®

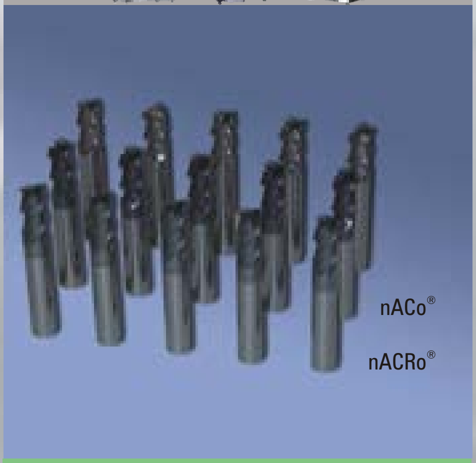
Coating Types

Nanocomposite Coatings

nACo®

Nanocomposite PLATIT coating
nACo® = (nc-AlTiN)/(a-Si_3N_4):
- extremely high nanohardness
- extremely high heat- and oxidation-resistance
- for hard machining
- for high performance and also for normal machining conditions
- also available with decorative blue top layer

nACRo®



Nanocomposite PLATIT coating
nACRo® = (nc-AlCrN/a-Si_3N_4)
- extremely high scratch resistance
- extremely high heat resistance
- high coating thickness possible
- eliminates important disadvantages of AlCrN coatings
- for "tough" diffcult to cut materials

nATCRo®

Nanocomposite PLATIT coating
nATCRo® = (nc-AlTiCrN/a-Si_3N_4)
- All-in-One - coating for universal use
- the successor of AlCrN-based coatings
- higher hardness
- high abrasive wear resistance

CBC + **DLC²**

Hard lubricant

Fi-VIc® | Fi-VIc²®

Double Nanocomposite PLATIT coating:
- high hardness, heat and scratch resistance
- high toughness
- extremely low friction coefficient
- dedicated coating for machine parts, especially in racing engines

CBC + **DLC²**

Hard lubricant

nACVIc® | nACVIc²®

Double Nanocomposite PLATIT coating with nanogradient structure:
- high hardness, heat and scratch resistance
- high coating thickness possible
- outstanding for HSS cutting in high alloyed materials and in titanium
- for machine parts of high strength materials

CBC + **DLC²**

Hard lubricant

nATVIc® | nATVIc²®

Double Nanocomposite PLATIT coating with nanogradient structure:
- high hardness, heat and scratch resistance
- for forming of highly hard materials, even in the most difficult conditions; e.g. no or few lubrication

Al-Cr Based Coatings

Conventional Coatings

TripleCoatings3®

AlCrN

(EMO 2003)

Classic coating with monoblock structure for universal use
- high wear resistance against abrasive load
- with aluminum, therefore good heat resistance
- good oxidation resistance for dry machining
- excellent adhesion layer deposited with non alloyed Cr target

+ CBC DLC²

Hard lubricant

AlCRINVIc® | AlCRINVIc²®

Double PLATIT coating with nanogradient structure:
- high hardness, heat and scratch resistance
- for forming of highly hard materials
- for machine components with highly abrasive load

AlTiCrN

PLATIT All-in-One coating for universal use, mainly for wet cutting

Deposition also possible with conventional planar technology.

In comparison to classic AlCrN:
- higher hardness
- more economical production

AlCrN3®

Stoichiometry:
CrN - Al/CrN Multi/Nanolayer - AlCrN

Application field:
- universal use
- hobbing, especially micro hobbing
- dry milling

User3®

Stoichiometry:
Cr(Ti)N - AlTiCrN - AlCrN

Application field:
- fine punching
- forming
- hobbing

AlTiCrN3®

Stoichiometry:
CrN Al/CrN Multi/Nanolayer - AlTiCrN

Application field:
- wet and dry cutting
- cutting with minimal lubrication

PLATIT®

TripleCoatings3®

TripleCoatings3®

nACo3®

Stoichiometry:
nACo3® = TiN + AlTiN + TiAlN/SiN

- tough core with high wear and heat resistance
- top layer with extremely high nanohardness
- for production with low deviation
- high performance at wider applicability
- preferably for drilling and punching

nACRo3®

Stoichiometry:
nACRo3® = CrN + AlTiCrN + AlCrN/SiN

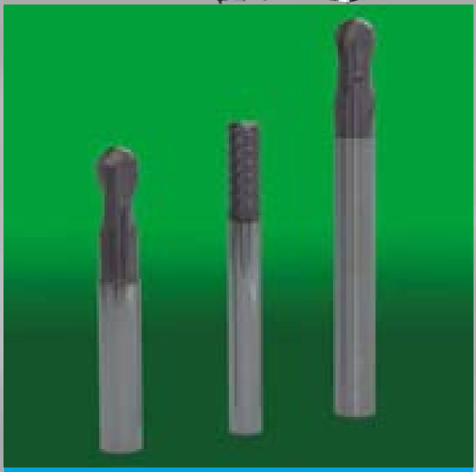
- high abrasive wear and heat resistance
- top layer with high hardness and toughness
- high performance at wider applicability
- preferably for very tough operations; e.g. friction welding, die casting

nATCRo3®

Stoichiometry:
nATCRo3® = CrTiN + AlTiN + AlTiCrN/SiN

- for all cutting and forming tools
- tough core
- higher hardness
- high abrasive wear resistance
- preferably for drilling using HSS tools

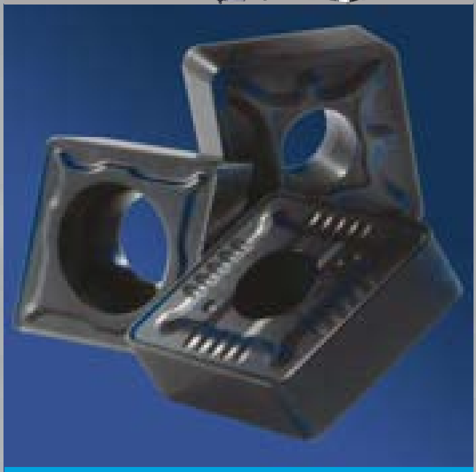
TiXCo3®



Stoichiometry:
TiN + nACo + TiXN/SiN
Possibilities for the component X:
X : Boron, X: Chromium, X: confidential

Dedicated application field:
Cutting of very hard materials (> 60HRC)

nACoX3®



Stoichiometry:
TiN + nACo + AlCrN + AlCrON + X
Possibilities for the component X:
X : TiN, X: CrTiN, X: AlTiN, X: confidential

Dedicated application field:
Dry turning and milling using indexable inserts

User3®

Stoichiometry:
User A's-Triple: CrN - AlCrN-Multilayer/SiN - AlCrN/SiN

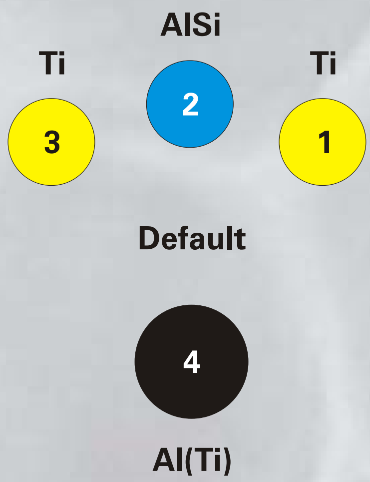
User B's-Triple: TiN - AlTiN - AlTiYN/SiN

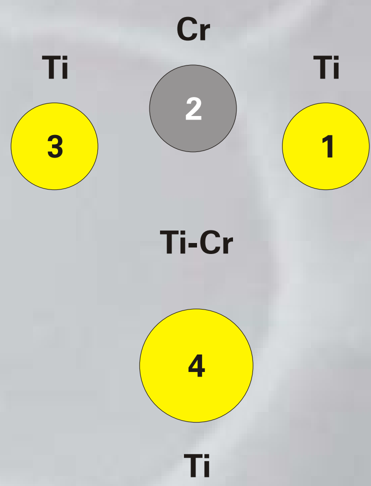
User C's-Triple: TiN - AlTiN - CrSiN

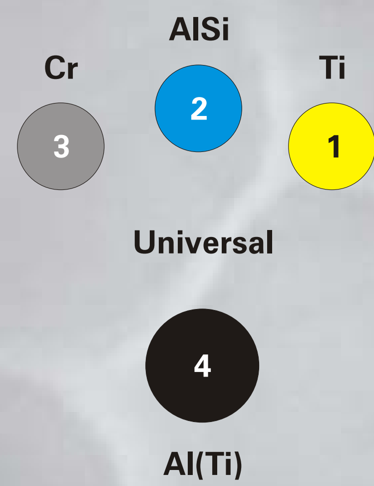
User D's-Triple: ...

TripleCoatings3®
Deposited by the π311 and π411

Typical Cathode Configurations





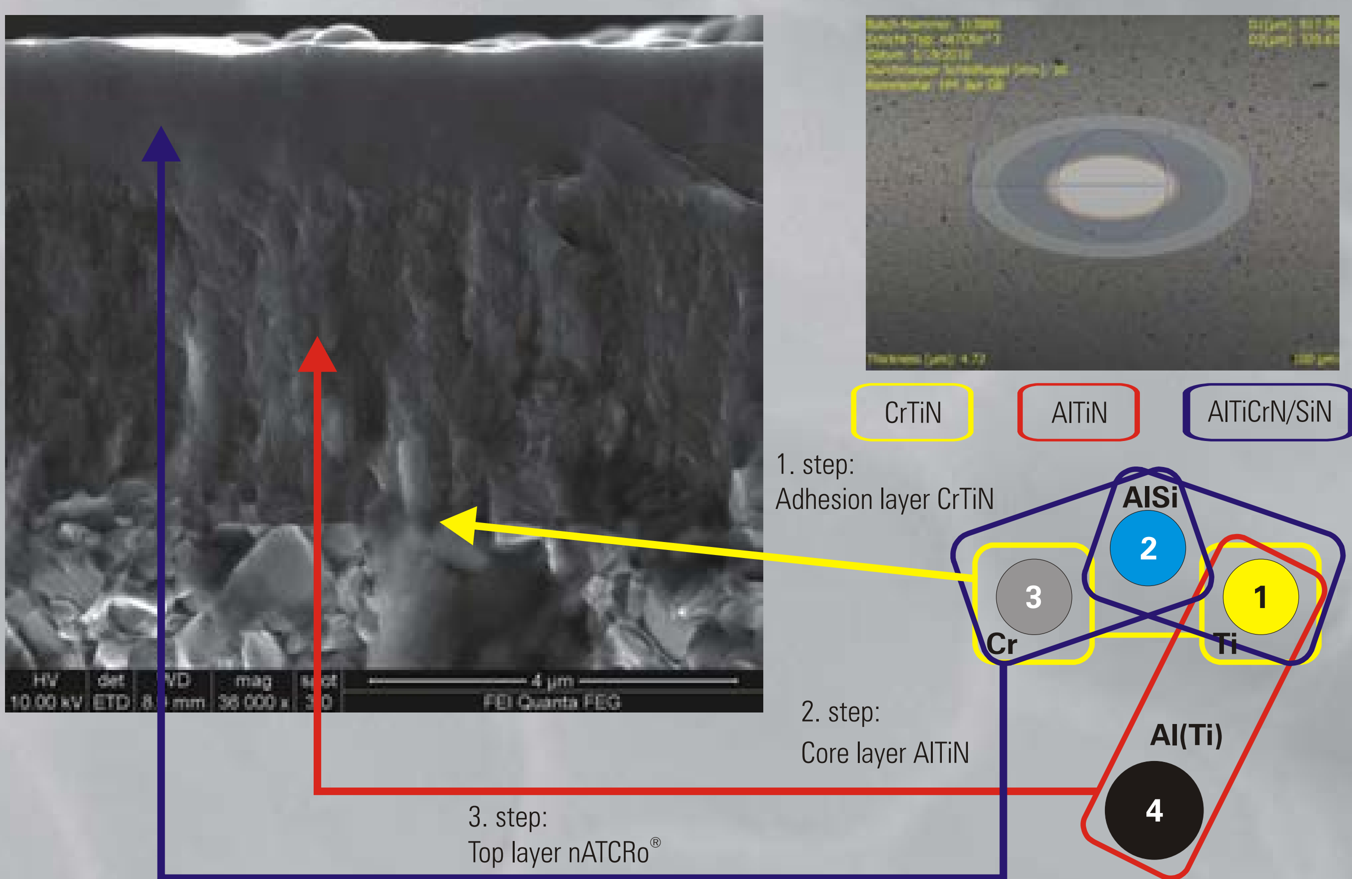


Used for most effective and flexible deposition of Ti-Al based coatings as TiN, TiCN, TiAlCN, TiAlN, AlTiN, nACo®;

Primarily used for coatings
- for molds and dies,
- for oxidization protection
- for cutting aluminum alloys with TiN, TiCN, CrN, and CrTiN;

The "universal" configuration offers the highest flexibility.
More than **30 different coatings** can be deposited **without cathode exchange**. These are practically all PVD coating compositions used in industry nowadays.

nATCRo3®

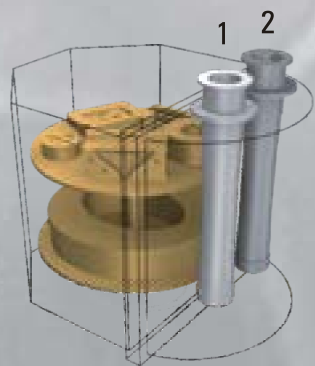


TripleCoatings3® made in π111 and PL1001

Deposition of Triple Structures in π111

TiXCo3®
Cathodes: 1: AlTi - 2: TiSi
Triple Structure:
TiSiN - nACo - TiSiN

AlCrN3®
Cathodes: 1: Cr - 2: Al
Triple Structure:
CrN -
Al/CrN Multi/Nanolayer -
AlCrN

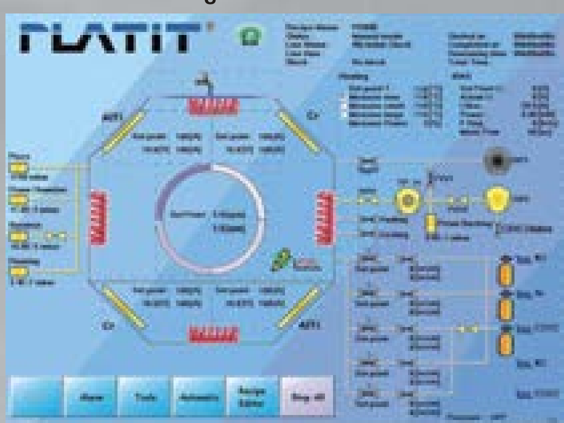


nACoX3®
Cathodes: 1: AlCr-OXI - 2: TiSi
Triple Structure:
TiSiN - nACRo - TiSiN - AlCrON

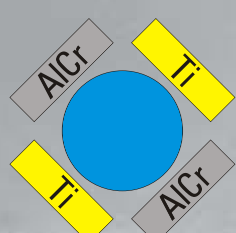
AlTiCrN3®
Cathodes: 1: AlCr - 2: Ti
Triple Structure:
TiN - AlTiCrN - AlCrN

Deposition of Triple Structures in PL1001

Cathode configuration: Cr - AlTi - Cr - AlTi

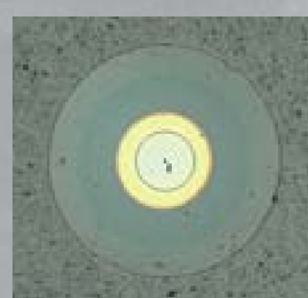


AlTiCrN3® (Cr-Based)
Cathodes: 1: Cr - 2: AlTi
3: Cr - 4: AlTi
Triple Structure:
CrN - AlTiN - AlTiCrN



Cathode configuration: Ti - AlCr - Ti - AlCr

AlTiCrN3® (Ti-Based)
Cathodes: 1: Ti - 2: AlCr
3: Ti - 4: AlCr
Triple Structure:
Ti - AlCrN - AlTiCrN

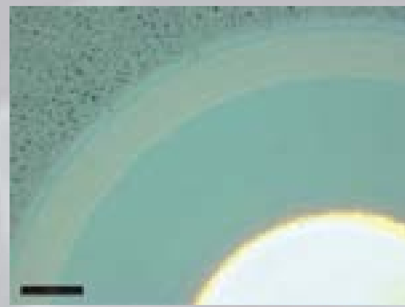


TripleCoatings^{3}® *and* QUADCoatings^{4}®

Nanocomposites with Silicon

nACo^{3}®: For Universal Use

TiN - AlTiN - nACo
Cathodes: 1: Ti - 2: AlSi - 3: no - 4: AlTi



nACRo^{3}®: For Superalloys

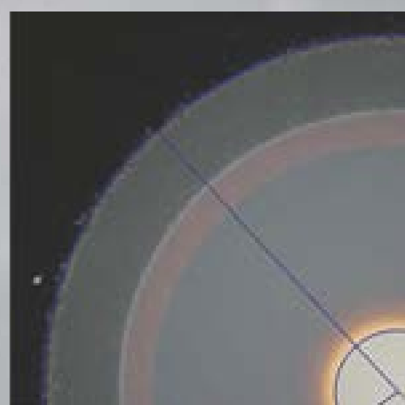
CrN - AlTiCrN - nACRo
Cathodes: 1: no - 2: AlSi+ - 3: Cr - 4: AlTi

TiXCo^{3}®: For Superhard Machining

TiN - nACo – TiSiN
Cathodes: 1: Ti - 2: Al - 3: TiSi - 4: no

nACoX^{4}®: For HSC Dry Turning and Milling

TiN – AlCrN – nACo – AlCrO(N)
Cathodes: 1: Ti - 2: AlSi+ - 3: AlCr-OXI - 4: AlCr



Dedicated for User's Application

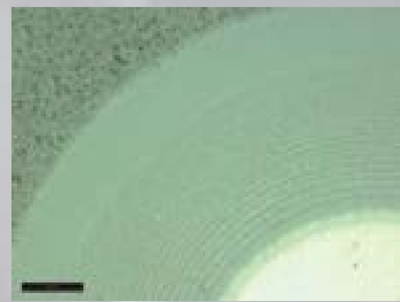
A: Cathodes: 1: Al - 2: AlSi+ - 3: Cr - 4: no
User A's-Quad: CrN - AlCrN - AlCrN-ML/SiN - AlCrN/SiN
for hobbing

B: Cathodes: 1: Ti - 2: Al - 3: CrSi - 4: AlTi C: D: E: F:...
User B's-Triple: TiN - AlTiN - CrSiN
for milling soft steels

without Silicon

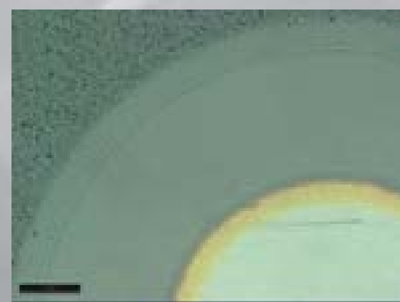
AlCrN$^{3®}$: For Dry Cutting Abrasive Materials

CrN - Al/CrN Multi/Nanolayer - AlCrN
Cathodes: 1: Ti - 2: Al - 3: Cr - 4: no



AlTiCrN$^{3®}$: For Dry and Wet Cutting

Cr(Ti)N - Al/CrN Multi/Nanolayer - AlTiCrN
Cathodes: 1: Ti - 2: Al - 3: Cr - 4: no



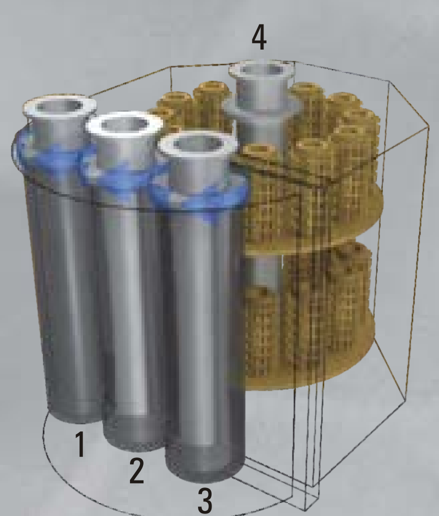
AlCrTiN$^{4®}$: Dedicated for User's Application

For thread forming and cutting
CrN - Al/Ti/CrN Multi/Nanolayer - AlCrN (CrCN optional as Tribo)
Cathodes: 1: Ti - 2: Al - 3: Cr - 4: AlCr

Dedicated for User's Application for Punches

CrN - AlTiCrN - AlCrN - CrCN
Cathodes: 1: Ti - 2: Al - 3: Cr - 4: no

Numbering for Cathodes' Positions in π311 and π411



TripleCoatings$^{3®}$ aim at combining these 3 features:

- optimal adhesion layer (e.g. TiN, CrN)
- tough core layer (e.g. multi- or nanolayer coatings)
- hard wear resistant toplayer (e.g. Nanocomposites)

Aim of QuadCoatings$^{4®}$:

- Integration of an additional 4. feature (e.g. extreme heat isolation with AlON, lubrication with CrCN)

Oxide and Oxynitride Coatings

Goal of the Oxide and Oxynitride Coatings

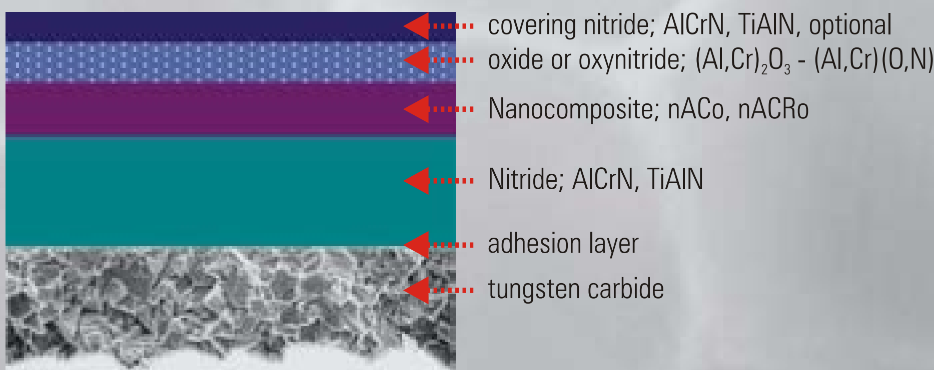
Separator to decrease chemical affinity between tool and workpiece in dry cutting processes at high temperature

Wear protection
- against adhesive wear
- against abrasive wear
- stable against further oxidation, avoiding oxygen diffusion
- chemical and thermal insulation

Decreasing friction
- At temperatures over 1000°C
- Reducing build-up edges and
- Reducing material interdiffusion in the tribological contact zone
- chemical indifference

Layer-architecture
- "Sandwich" like at CVD
- Metal nitride basis necessary, to avoid cracks and plastic deformation

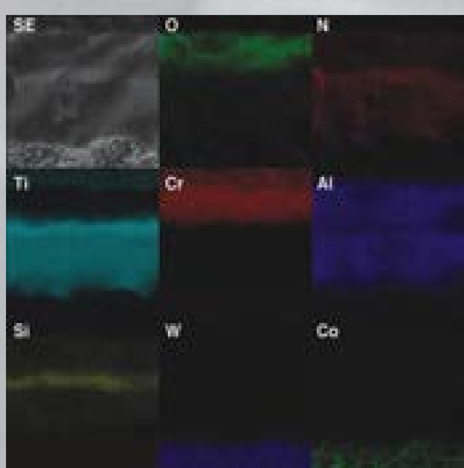
Layer Architecture



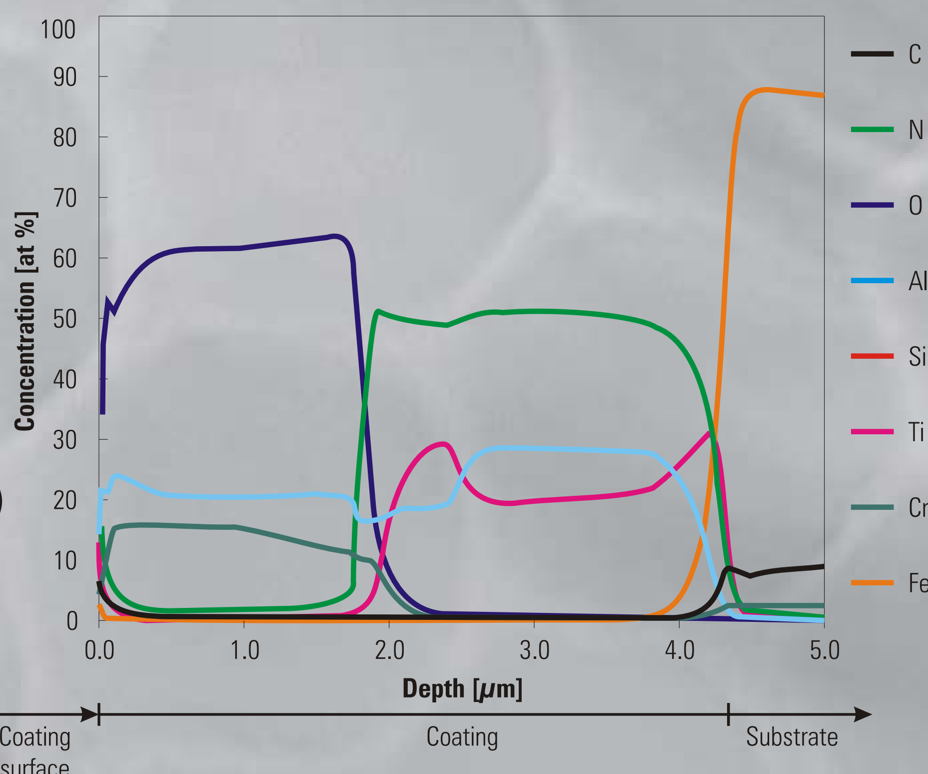
Features of nACoX[3®]

- Ratio nitrogen to oxygen: N/O: 50/50% – 80/20%
- Typical coating thickness on turning inserts: 4 - 18 μm
- Typical total hardness: 30 GPa
- Typical Young's modulus: ~400 GPa

Depth Profiles of nACoX[3®]



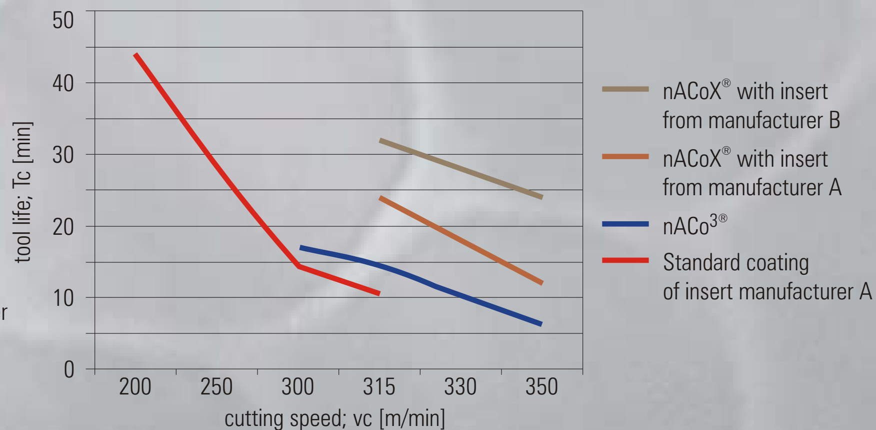
EDX (Energy-dispersive X-Ray spectroscopy) Coating Map shows the distribution of the elements in the depth of the coating



Measured by Fraunhofer Institute, Braunschweig. Germany

Applications

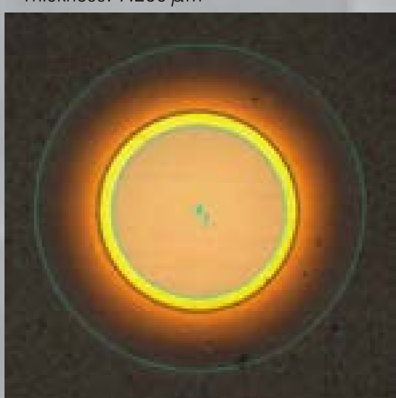
TripleCoatings³® and Oxynitride-Coatings at Dry Turning with High Cutting Speeds

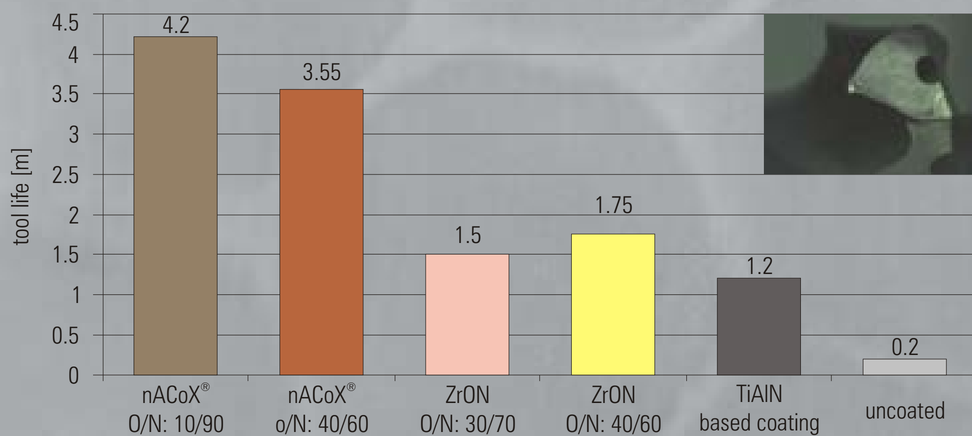


vc=200 - 350 m/min, f=0.25mm/rev, a=1.5 mm
Material: C60 (1.1221), HB225 tool life end criterium: VBmax≤200 µm -
Measured at TH Budapest

Drilling in Difficult to Cut Austempered Ductile Cast Iron with Oxynitride Coatings

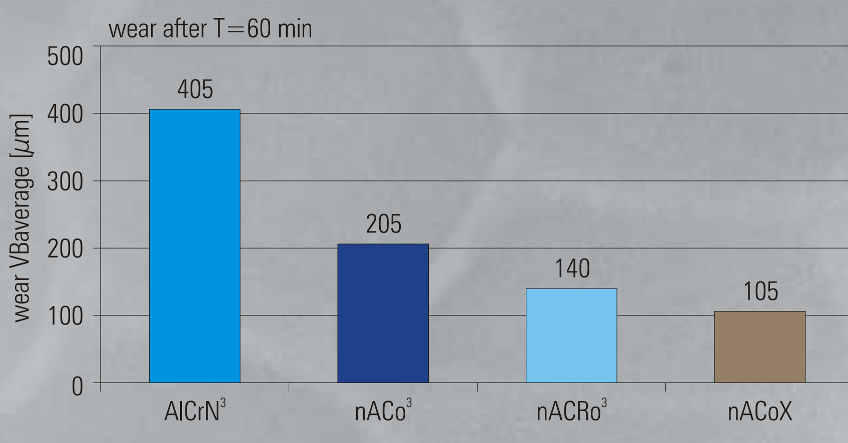
Zr-O-N with Gradient Triple-Structure
Grindball Diameter [mm]: 30
300 U/min 120s
Thickness: 7.260 µm





Mat.: ADI 900 – Tool: Solid carbide drill d=6.8mm
vc=120 m/min – f=0.3 mm/rev – ap=15mm - Internal MQL
Source: GFE, Schmalkalden, Germany

Profile Milling with Inserts - Roughing

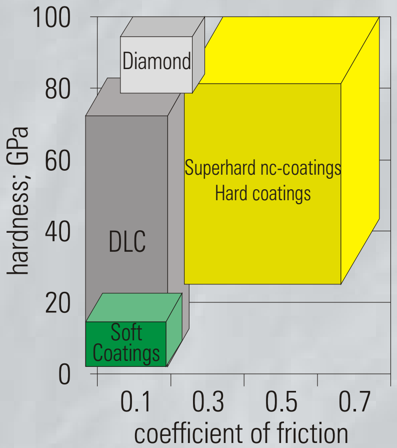


Material 1.2379 – Rm =1000 N/mm2
vc=240 m/min – fz=0.4mm ap=1.5 mm - ae=1 mm
Coolant: internal air

PLATIT 's DLC-Coatings

Diamond-Like Carbon (DLC) is a metastable form of amorphous carbon containing a significant fraction of sp^3 bonds. It can have high mechanical hardness, chemical inertness, optical transparency, smooth surface and low friction behavior.

Since their initial discovery in the early 1950s, DLC films have emerged as one of the most valuable engineering materials for various industrial applications, including microelectronics, optics, manufacturing, transportation, and biomedical fields. In fact, during the last two decades or so, DLC films have found uses in everyday devices ranging from razor blades to magnetic storage media.



Instead of using the term DLC, the term amorphous carbon is favoured, to avoid the mix-up with diamond coatings, which are by definition crystalline.
These amorphous carbon coatings are classified into seven categories:

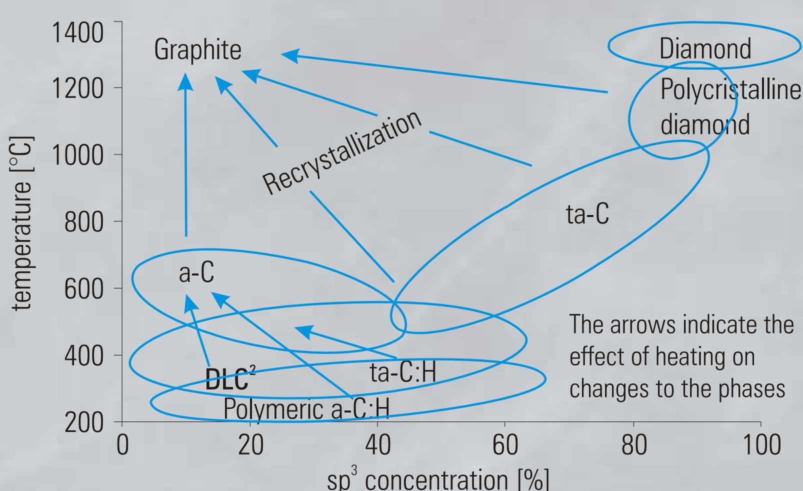
a-C	hydrogen-free amorphous carbon
ta-C	tetrahedral-bonded hydrogen-free amorphous carbon
a-C:Me	metal-doped hydrogen-free amorphous carbon (Me= W, Ti)
a-C:H	hydrogen-containing amorphous carbon
ta-C:H	tetrahedral-bonded hydrogen-containing amorphous carbon
a-C:H:Me	metal-doped hydrogen-containing amorphous carbon (Me=W, Ti)
a-C:H:X	modified hydrogen-containing amorphous carbon (X=Si,O,N,F,B)

						CBC = DLC^1	**DLC^2**
	a-C(:X)	**ta-C**	**a-C:Me**	**a-C:H (polymer)**	**ta-C:H**	**a-C:H:Me**	**a-C:H:X**
Process	PVD	PLD/ FCVA	PVD / MS	RS / PECVD	HPD- PECVD	PVD/PEPVD/CVD	PECVD
Interlayer	None or Ti	Ti / Cr	Ti / Cr	Si/Ti	-	Ti or Cr	Si
Doping	None or Ti, Al, Si	None	Si/Ti/Cr/W	None	-	Ti or Cr	Si
H content [%]	0	0	0	40-60	25-30	~15	~20
Thickness (μm)	0.2-1	1	3	1/2	/	~0.5	<5
Young's Modulus (GPa)	200	>500	350	110/260	300	200	250
Hardness (GPa)	8 to 28	>50	30	8/28	50	<20	<25

PLD: Pulsed Laser Deposition – FCVA: Filtered Cathodic Vacuum Arc – MS: Magnetron Sputtering – RS: Reactive Sputtering – PECVD: Plasma Enhanced Chemical Vapor Deposition – HPD: High Plasma Density

Simplified Overview of Thermal Stability Limits of Different Categories of Hard Carbon Materials

Coating of punches with DLC^2 in the π111



Source: K. Holmberg, A. Matthews, Coatings Tribology, Elsevier, 2007

Applications with DLC-Coatings

Punches with nACVIc^{2}®

Fluteless thread former with CROMTIVIc^{2}®

Injection mold
coated with nACVIC®

Tool holder chuck
coated with nACVIc^{2}®

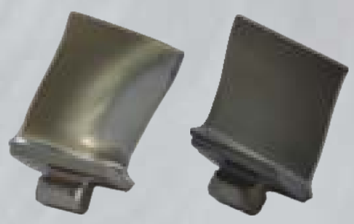
Camshaft with CROMVIc^{2}®

Control lever for cylinder head of
a racing car with Fǐ-VIc®

Thread former for TETRA packs,
made from copper, coated with cVIc^{2}®

Valve seat of a racing car
coated with Fi-VIc®

PET-Core with ALLVIc^{2}®



Uncoated and coated
turbine blisk with Fǐ-VIc^{2}®

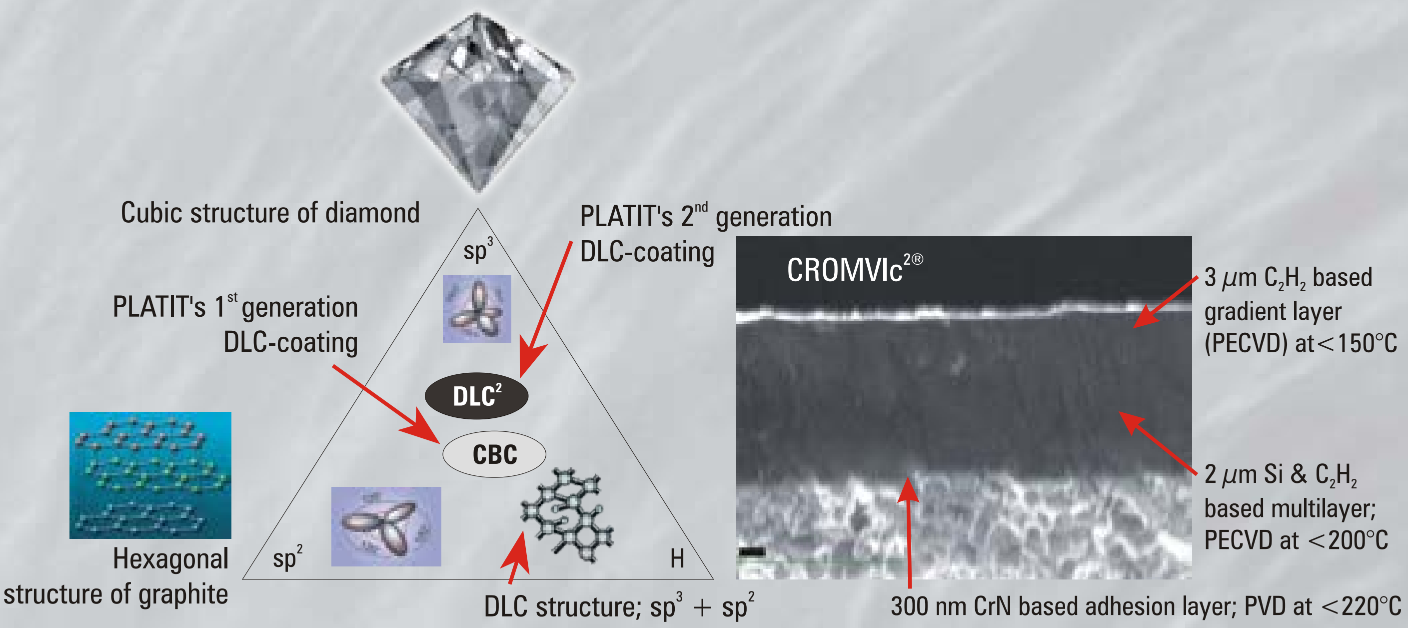
Medical Parts from titanium with cVIc®

Water pump shaft
coated with CROMVIc^{2}®

Machine parts
coated with CROMVIc^{2}®

Sewing machine part
coated with CROMTIVIc^{2}®

PLATIT 's DLC-Coatings



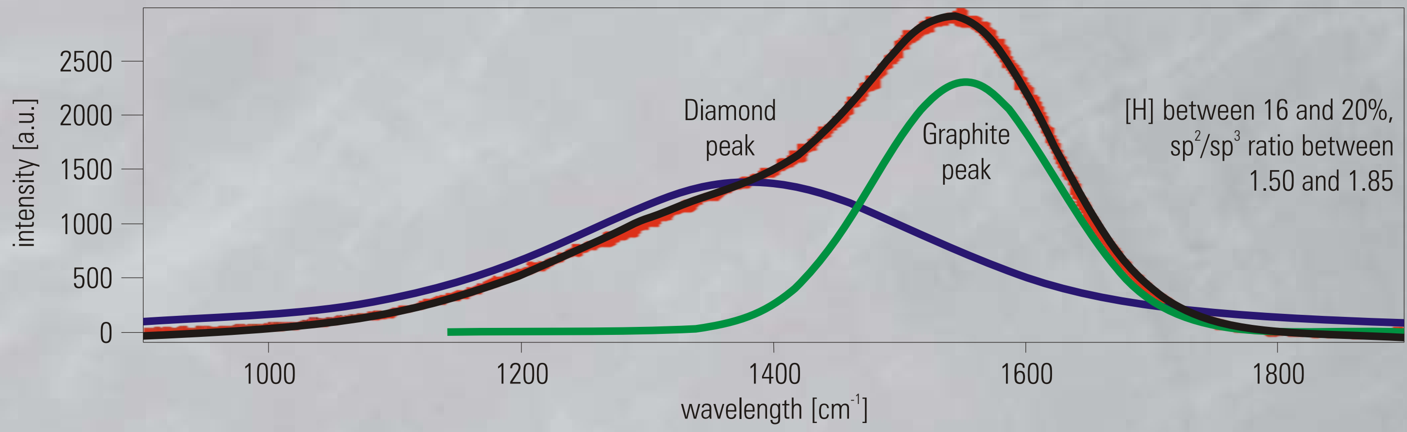
The goals of PLATIT's development of DLC-coatings

- The combination of the extremely good features of PLATIT's conventional and Nanocomposite coatings (especially of the outstanding adhesion) with the advantages of the DLC-coatings (like smoothest surface and low coefficient of friction).
- Deposition of double coatings, (PVD and DLC-coatings) in one chamber in one batch
- Profitable coating production with DLC even in small series, for:
  - high quality machine components - medical devices - aerospace components
  - cutting tools for composite materials with affinity for sticking - molds and dies and punches

Comparison of the most important features of PLATIT's DLC-coatings

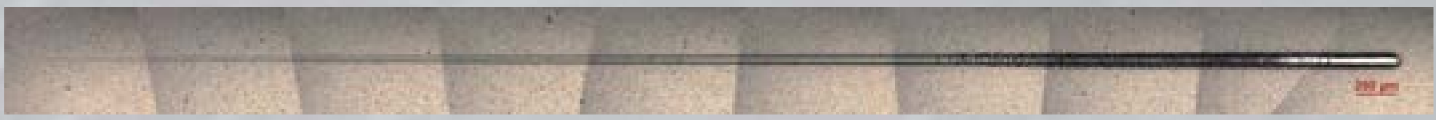
	1st generation	2nd generation
Name	**CBC - X-VIc®**	**DLC² - X-VIc²®**
Availability	as top coating only Basis coating + CBC	recommended as top coating Basis coating + CBC²
Most common coatings	CROMVIc®, CROMTIVIc®, cVic®, Fř-VIc®	CROMVIc²®, CROMTIVIc²®, cVIc²®, Fř-VIc²®
Coating process	PVD	PVD+PECVD
Composition	a-C:H:Me - Metal doped DLC	a-C:H:Si - Silicon doped metal free DLC
Heat resistance	< 400°C	higher due to Si
Internal stress	high	lower due to Si
Possible thickness	< 1 μm	up to 5 μm
Electrical conductivity	good	none
Hardness	20 GPa	25 GPa
Roughness	Ra~0.1μm - Rz~0.6 μm	Ra~0.03μm - Rz~0.2μm
Friction coefficient to steel	μ~0.15	μ~0.1
Wear resistance	Wear through after a short time	Wear through after a long time
Main application goal	Improvement of tool's run-in behavior	Reducing friction and wear for long run

Chemical Properties of DLC^2 of PLATIT



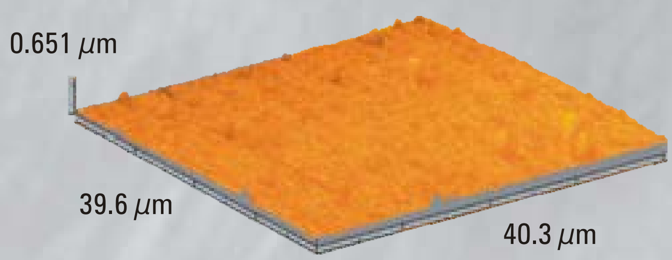
RAMAN Spectroscopy of CROMVIC2® with l=514.5 nm, Si calibrated, Labspec Software
G-band position: 1552.9 cm^{-1} - D-band position: 1382.8 cm^{-1} - Ratio IG/ID=0.85
Measured at Physics Department, Fribourg University, Switzerland

Adhesion measured by scratch-test: CROMVIc$^{2®}$ on carbide; L_{c2} = 74.3 N



Surface roughness measured by AFM: CROMVIc$^{2®}$ on carbide: S_a=0.0374 µm

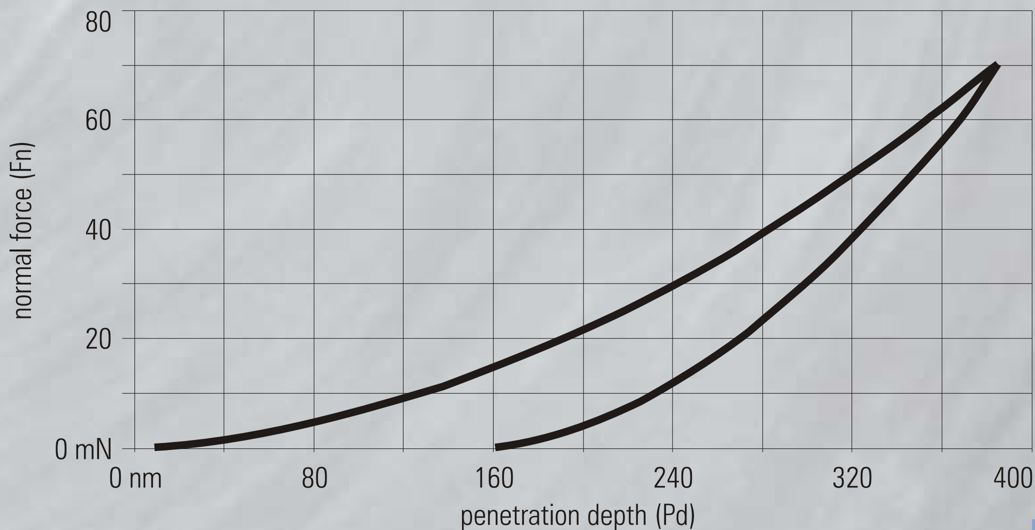
Sa	=	0.0374 µm
Sq	=	0.0501 µm
Sp	=	0.447 µm
Sv	=	0.136 µm
St	=	0.583 µm
Ssk	=	1
Sku	=	9.34
Sz	=	0.282 µm



Nanoindentation for Measuring Hardness of DLC^2 Coatings

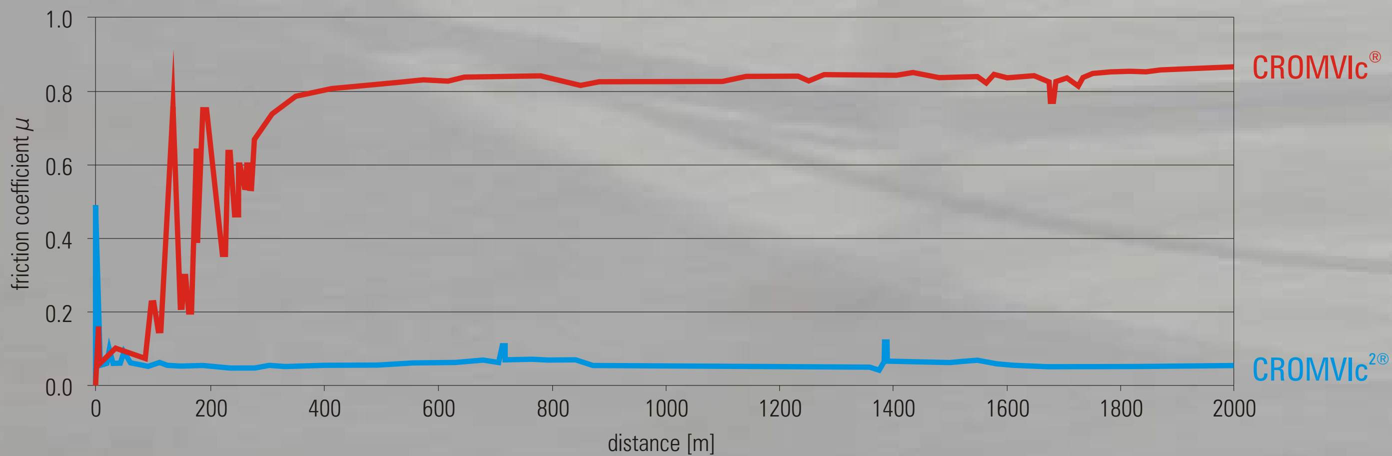
Berkovich Indenter
Method: Oliver & Pharr
Approach speed: 2000 nm/min
Acquisition rate: 10 Hz
Linear loading
Max. load: 70 mN
Loading rate: 70 mN/min

Main results:
HIT=25444 Mpa
EIT=331.99 Gpa
Hv=2356.4 Vickers



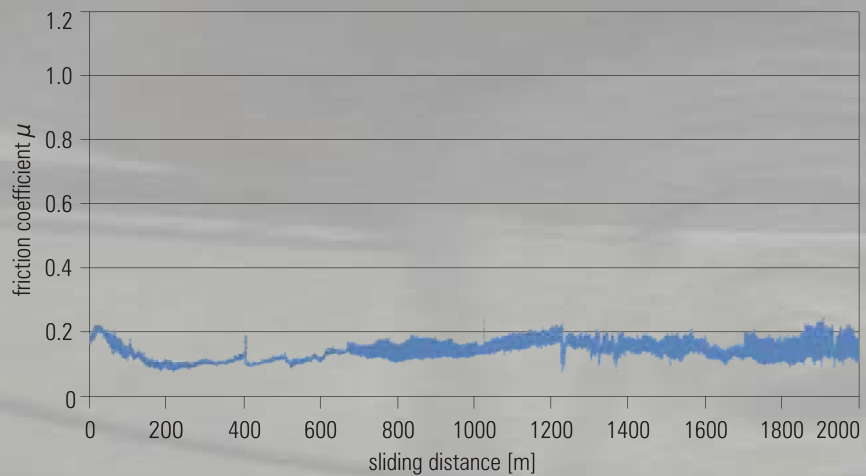
Friction Behaviour of DLC² Coatings

Measurement of the Coefficient of Friction by Pin on Disc Wear Test: CROMVIc²®; $\mu = 0.06 \pm 0.01$



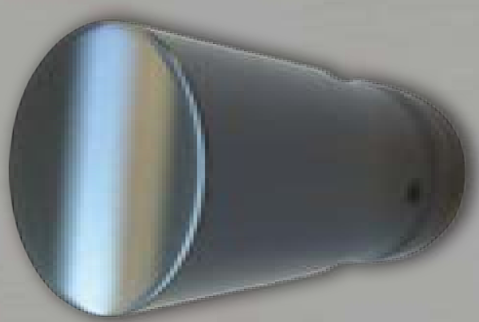
Test with Si_3N_4 ball: r=6 mm - Load=10.00 [N] - Lin. speed=20.00 [cm/s] - Acquisition rate : 2.0 [Hz] - T=25.00 [°C] - Rel. humidity=5.00 [%]

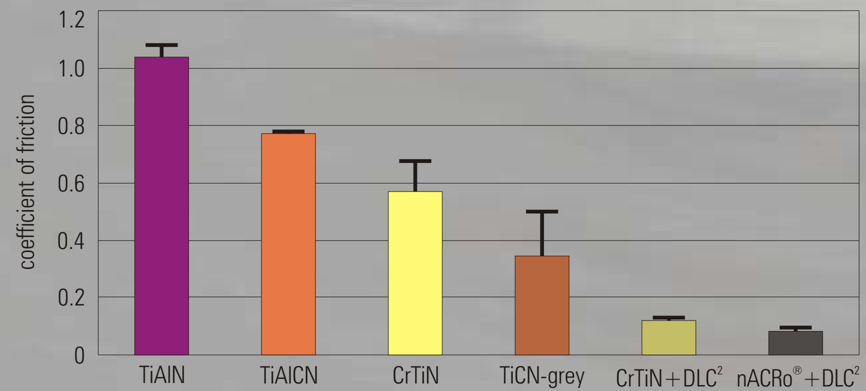
Measuring of the Coefficient of Friction at 400°C: nACVIc²® : $\mu = 0.12 \pm 0.02$



Pin on disc wear test with Ti pin grade 5 - r= 10.00 [mm] - Normal load : 2.00 [N] - Lin. Speed : 6.67 [cm/s] - Acquisition rate : 2.0 [Hz] - Rel. humidity: 0%

Coefficient of Friction Measurement by Pin-on-Disc Wear Test at 400°C





- (Ti, Al)-based layers are not suitable because of their high coefficient of friction
- Clear influence of the carbon gradient in the TiCN coating (high scatter)
- Excellent friction coefficients with DLC films and very low scatter
- Si-doped DLC survives more than 8-hour tests at 400°C !

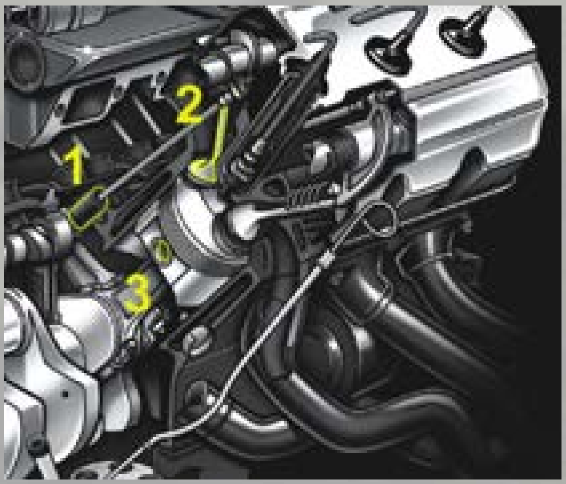
DLC² Coating in High Performance Racing Engines

Demanding Engine Applications for Racing Cars

1 → Mechanical lifter (M2 steel, 63-64 HRC)
Contact partner: tool steel camshaft with case hardened lobes
- No material transfer to the foot
- Low friction and high wear resistance

2 → Intake valve (Ti alloy)
Contact partner: AMCO45, Ni-Al Bronze alloy
- No material transfer to the seat
- Low friction on the stem

3 → Wrist pin (PM-HSS)
Contact partner: tool steel
- No material transfer
- Very low friction and low wear



V8 engine, up to 9'000 RPMs, 750 HP

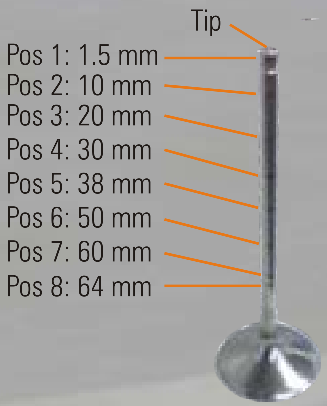
Coating Evaluation After Test Benches

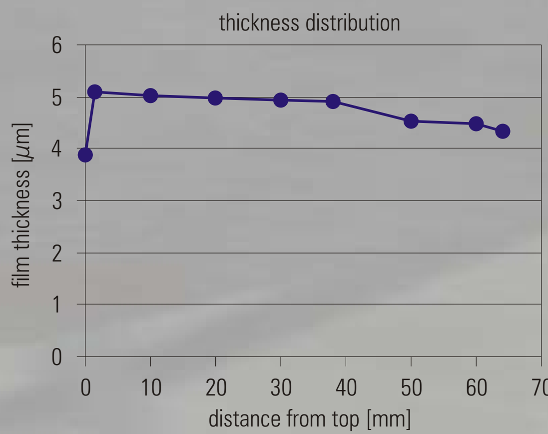
SEM micrograph of a lifter foot after a run with over 1000 miles

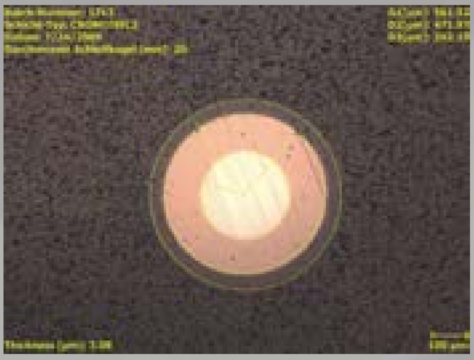
Result: Outstanding DLC coating for reliability and performance

DLC² Thickness Distribution on Valve Shanks for Racing Cars, Deposited in π80+DLC Unit

One of the most important applications is the DLC-coating of valves for the racing and normal road cars, trucks and bikes.





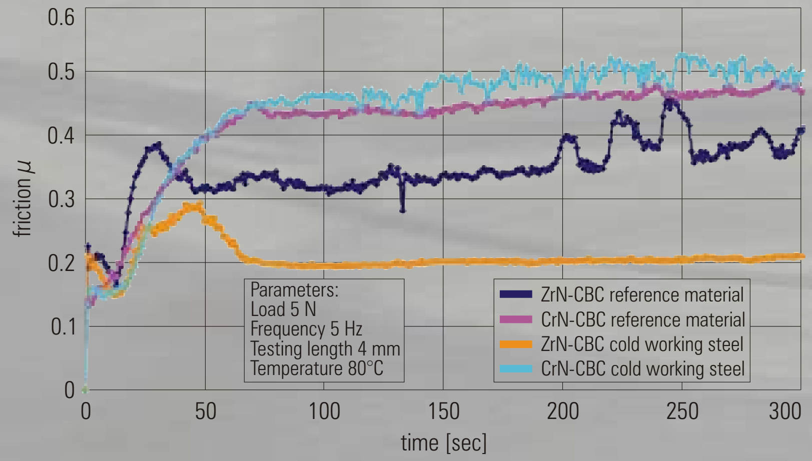


Using DLC Coatings in Small and Medium Size Industries

Lubricant-Free Operation at Injection Molding

Uncoated:
unstable process,
high wear, chatter marks

CrN+CBC:
Very low wear



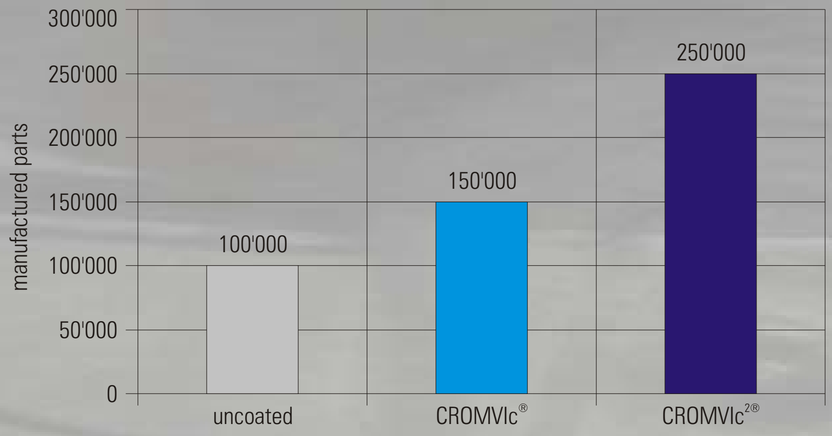
Result:
- CBC coating increases process stability enormously

Source: Haseltal Werkzeugbau
GFE Schmalkalden, Germany

Minimizing of Wear and Friction at Extrusion

Manufacturing of case-parts from aluminium through extrusion

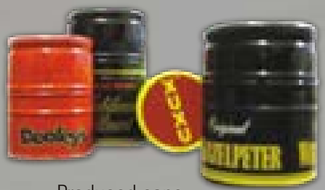
Coated tools for extrusion of aluminium-parts



Result:
- DLC containing Si show very good tool life behaviour

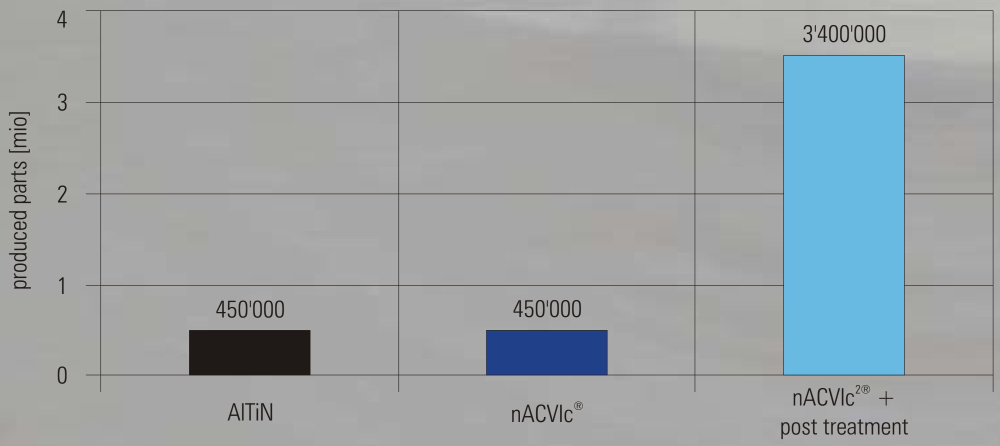
Source: Coexal Werkzeugbau, Gotha
GFE, Schmalkalden, Germany

Minimizing of Wear and Friction at Deep Drawing



Produced caps

Tool for deep drawing of aluminium parts

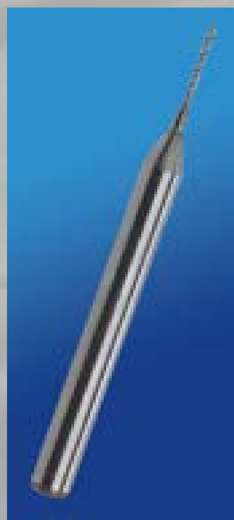


Result:
- Post-treatment absolutely necessary

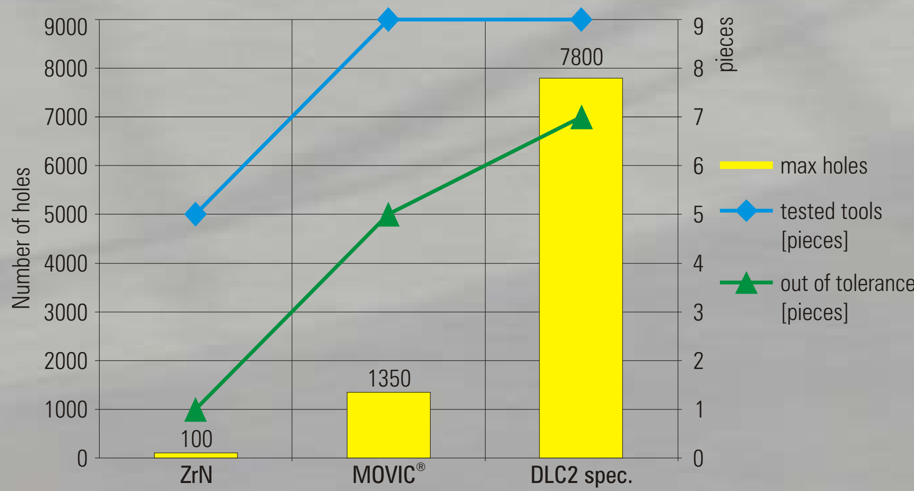
Source: Mala Verschlusssysteme, Schweina
GFE, Schmalkalden, Germany

Cutting Sticky Materials with DLC²

Micro Drilling in Titanium

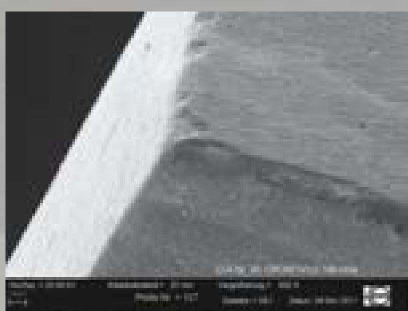


Tool Life Comparison

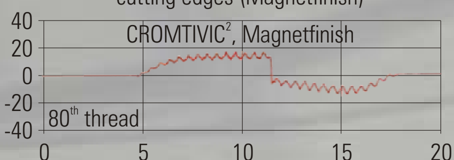


Source: Diamond SA, Losone, Switzerland

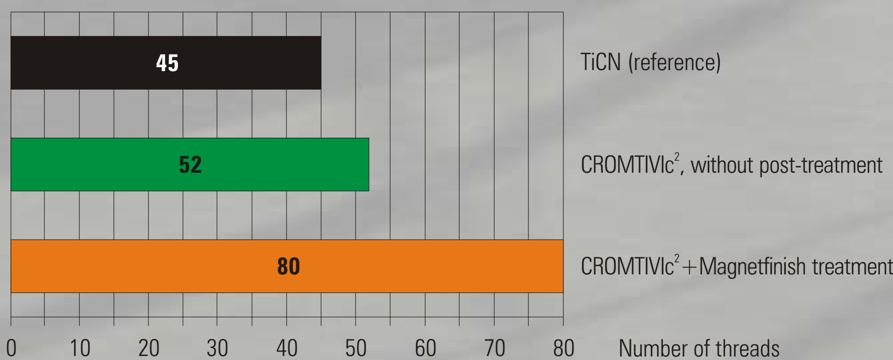
Tapping in Titanium



Polished, droplet-reduced surface with burr-free cutting edges (Magnetfinish)



Tool Life Comparison



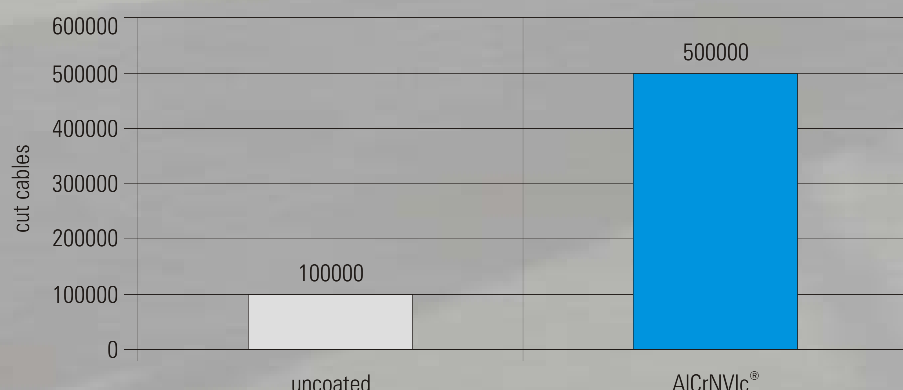
Material: TiAl6V4
Thread: M10 x 1.5
Thread-depth: 24 mm
v_c = 4 m/min

Source: IGF R&D project in cooperation with WZL RWTH Aachen, Germany

Quality Optimization at Cutting Cables

Wear on uncoated knife
after tool life L_m = 10'000

Wear on coated knife
after tool life 5 x L_m



Reduced servicing and maintenance costs > 10€ per tool

Source: Robert Bosch Fahrzeugelektrik, Eisenach GmbH

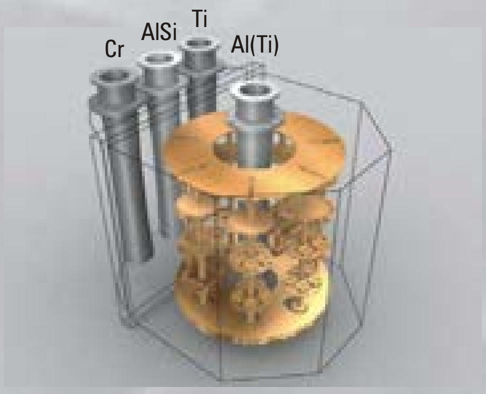
Coating Features

Influence of the Most Important Component Materials on Coating's Features

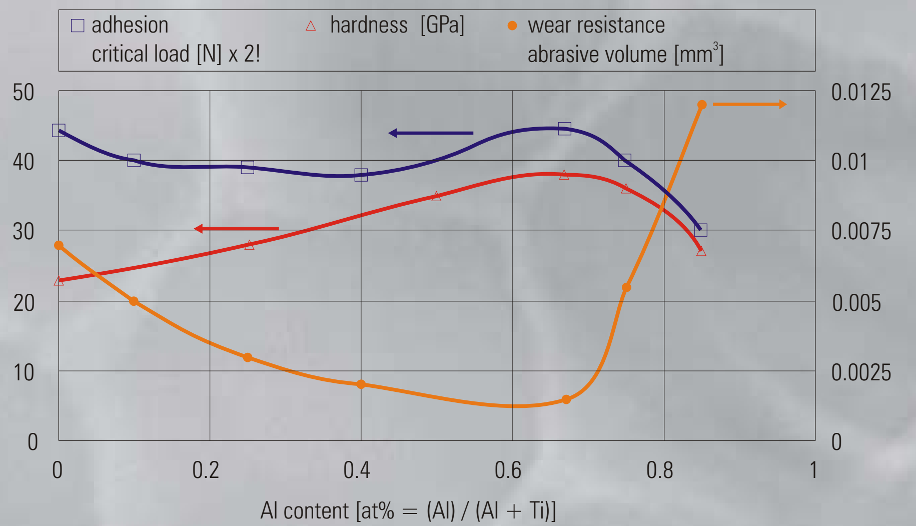
Coating	+ Component	Grain fineness	Decreasing Internal stress	Hardness	Wear resistance (abrasive)	Wear resistance (oxidation)	Hot hardness	Heat insulation	Max. usage temperature	Possibility of thickness increase	Decreasing friction	Possibility of Nanocomposite	Low target costs with alloyed targets	Low target costs with unalloyed targets LARC
Ti+N=TiN Basic coating	**+N**	0	-	+	+	+	0	0	0	-	0	no	0	0
TiCN	**+C**	0	--	++	++	-	-	--	-	--	++	no	0	0
typically **TiAlCN** with Al~20-25%	**+ Al**	(+)	+	-	-	+	+	+	+	+	-	no	--	0
typically **TiAlN**	**+Al** / (-C)	+	-	+ if Al<X% / - if Al>X%	+	+	+	++	+	-	-	no	-	+
typically **AlTiCrN**	**+Cr**	-	+	+	+	+	+	+	(+)	+	-	no	-	(-)
typically **AlCrN** Cr~30%	**+Cr** / (-Ti)	--	+	(+)	++	(+)	+	+	(+)	+	(-)	no	--	-
typically **TiAlN/SiN CrAlN/SiN, AlCrTiN/SiN**	**+Si**	++	(+)	++	+	++	++	++	++	0	0	yes	--	+

+ means mainly positive change in the user's point of view - means mainly negative change in user's point of view X is approximately around 65%

Influence of Al Content

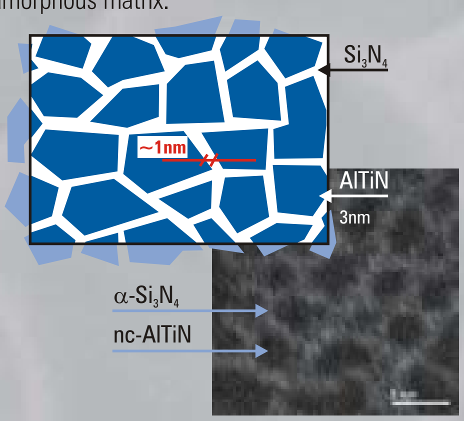


With the universal configuration of the π300 the composition and the stoichiometry of the coating can be defined by software, deposited from mainly unalloyed targets.

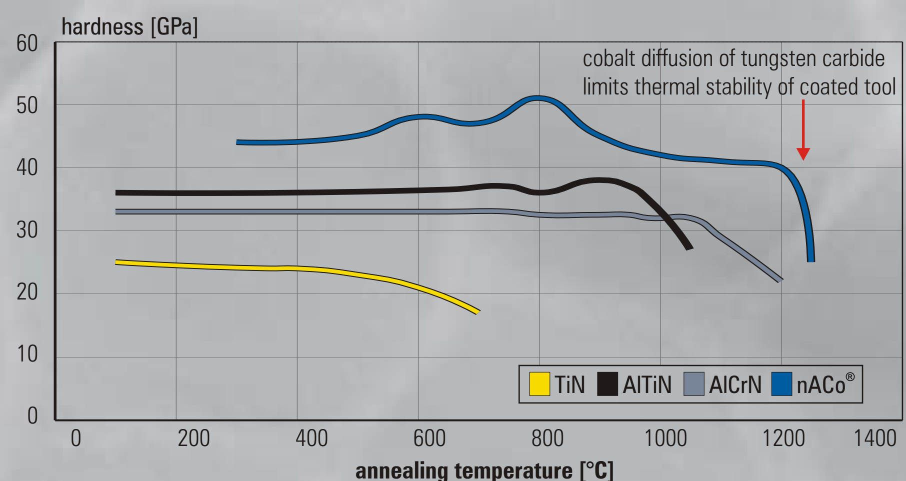


Nanocomposites

Composite of non-mixable components. Nanocrystalline grains are embedded into an amorphous matrix.



Heat Resistance Comparison

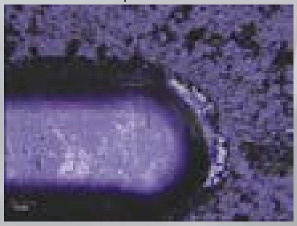


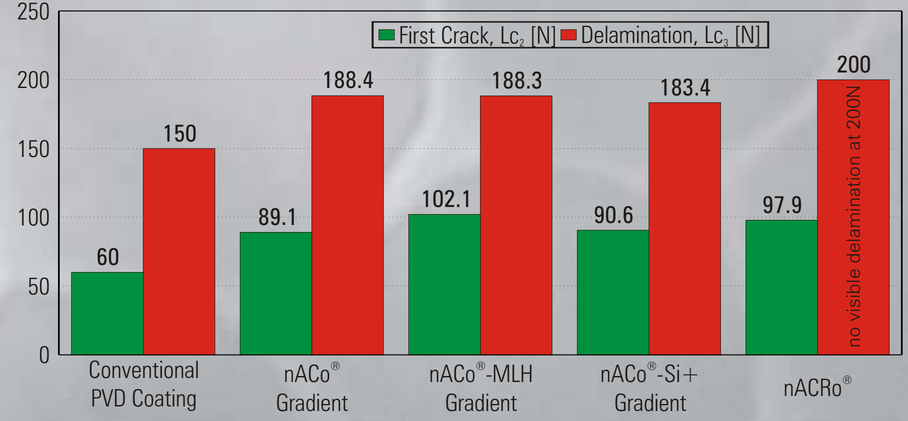
Adhesion

Critical Loads at Scratch Test

First crack

End of crack: partial delamination

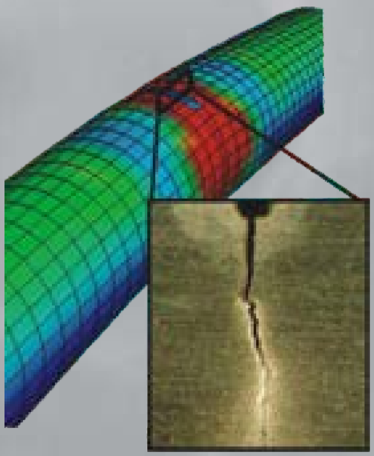




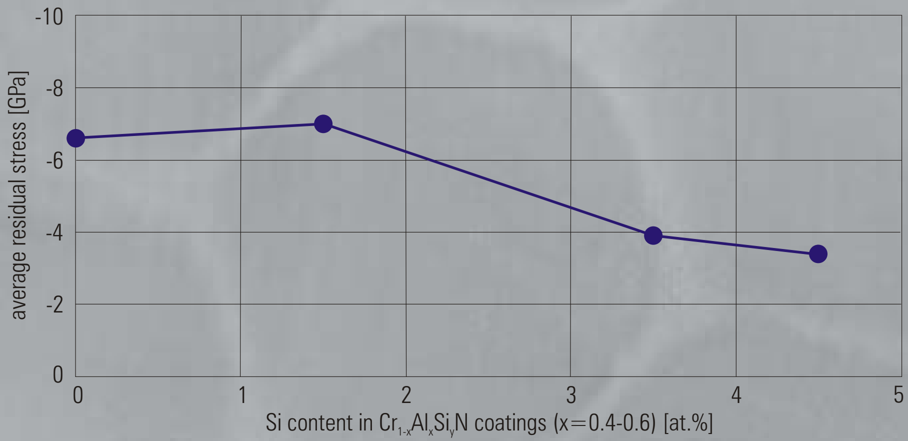
Average values from min. 10 measurements with deviation; <5%
Scratch length: 70 mm - scratch speed: 0.4 - 60 mm/min
Measured on tungsten carbide K40, by CSEM, Neuchâtel, Switzerland

Residual Stress

Si reduces residual stress



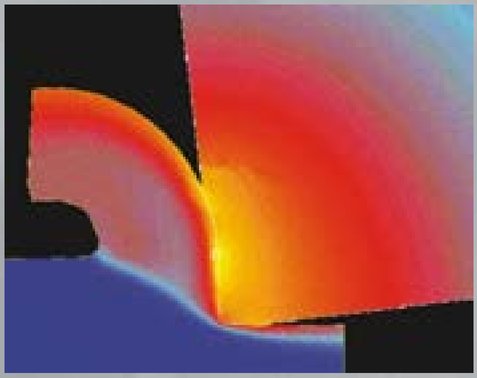
High residual stress means low thoughness and danger of cracking

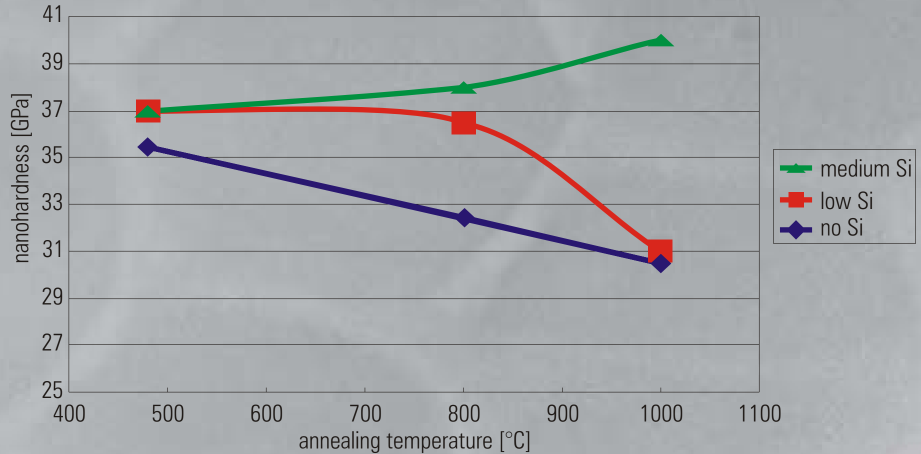


Si addition reduces the residual compressive stress to 50% compared to AlCrN
Average values of samples close to the hardness maximum
Measurement by XRD (sin2φ method); stress by strip bending is lower

Thermal Stability

Influence of the Silicon Content in AlCr-based Coatings



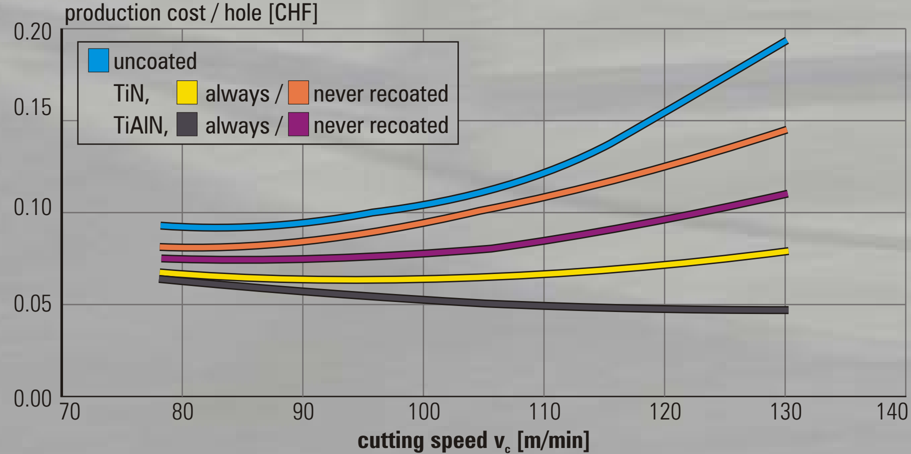


ACrlN without silicon loses up to 10 GPa after 1000°C annealing in forming gas (N2 / 8% H2)
Hardness increase ("age hardening") for optimum Si content samples for 2 hours

Conventional Coatings

Cost Advantage

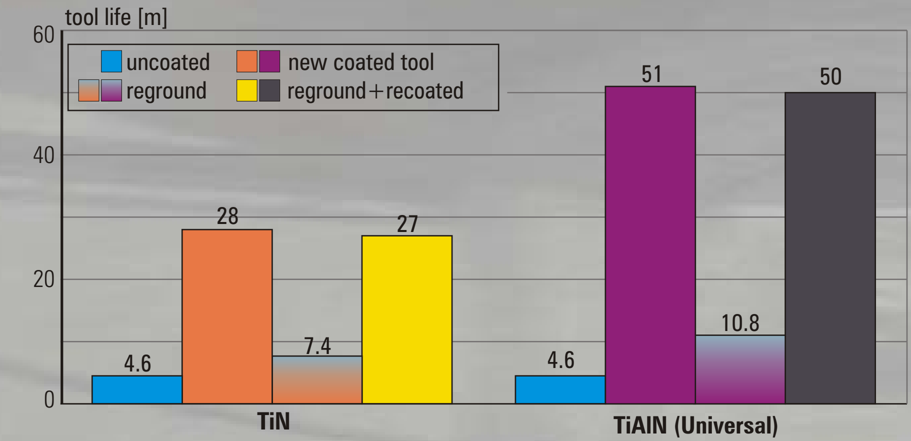
Production Costs with Solid Carbide Drills



Production costs = machine costs + work costs + tool costs
Tool changing costs are not considered, all tools reground 10x

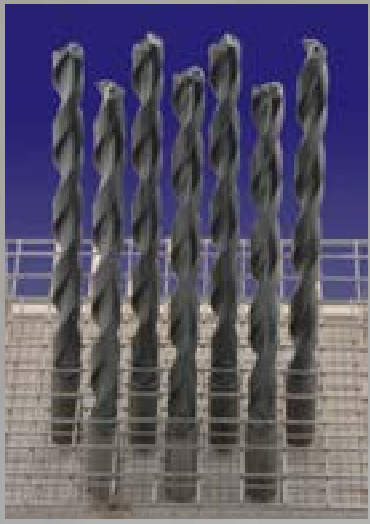
Solid Carbide Drills

Tool Life Comparison

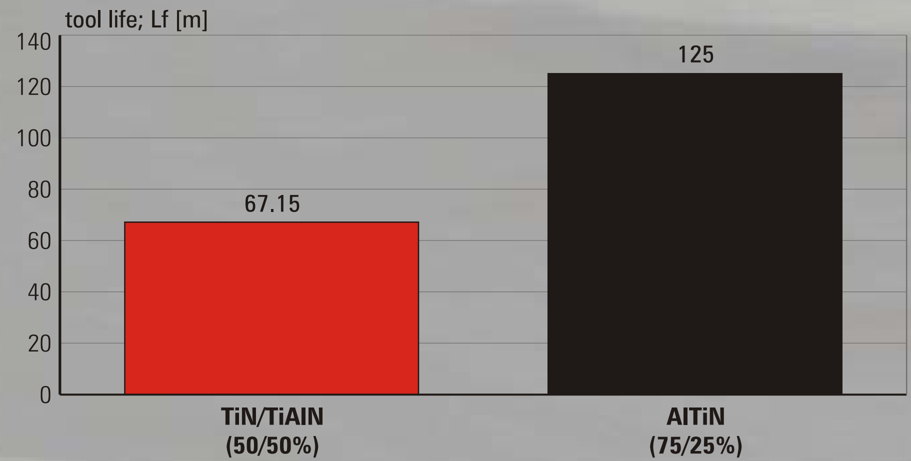


Work piece: wheel hub, Material: 38MnV35, R_m=800 N/mm^2, Ext. coolant: emulsion 7%, carbide K40UF, d=12.6 mm, a_p=13.5 mm, v_c=78 m/min, f=0.25 mm/rev. - Source: Daimler, Germany

Drilling



Tool Life Comparison

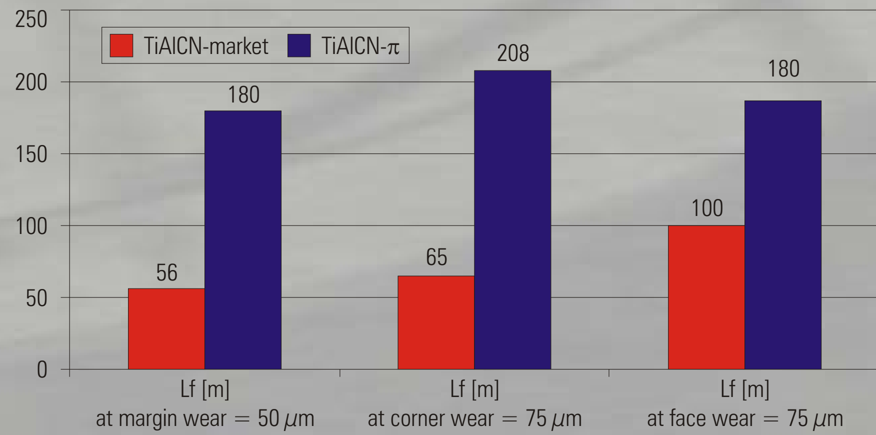


Work piece material: 42CrMo4V - Rm=1000 N/mm2 - Tools: solid carbide drills - d=6.8 mm
vc=110m/min - f=0.174 mm/rev - ap=34 mm - emulsion-IC p=38 bar Q=8l/min

Applications

Form Milling

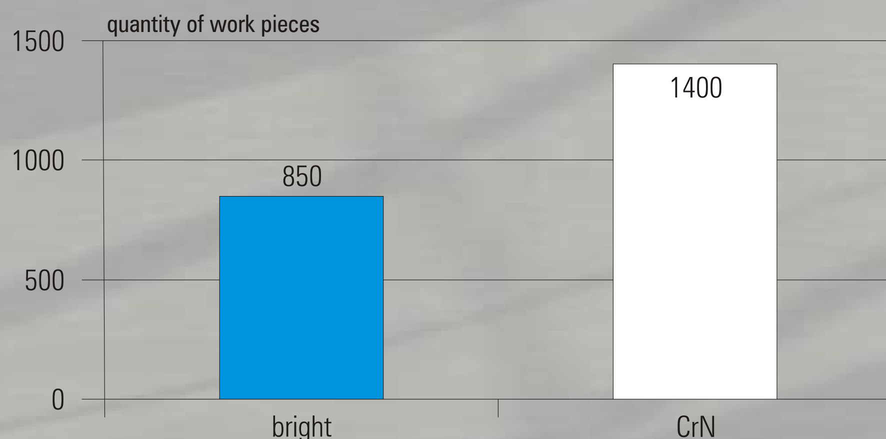
Tool Life Comparison



Carbide End Mills Ø10mm, z=4, steel 34CrNiMo6 (30 HRC), Coolant: MQL; Minimum lubrication - Tested tools: 2x4
Source: Carmex, Maalot, ISR

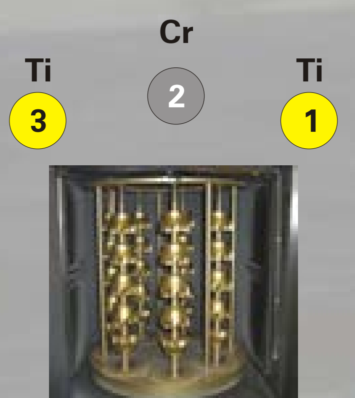
Injection Molding

Tool Life Comparison



Aluminum injection molding, Material: AK12 – Spaltbreite: 2 mm
Tool material: HSS; P6M5 – Source: Technopolice, Moscow, Russia

Multi purpose coating: CrTiN



Coating of milling head holders with CrTiN & golden top color by the π303 configuration.
Source: Fraisa, Bellach, Switzerland

Tool Life Comparison

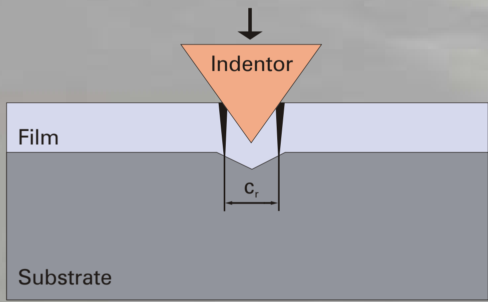
- for molds and dies
- for machine components
- for tool holders
- for aluminium cutting and forming
- with high hardness and toughness
- with very good chemical resistance
- with very fine multilayer structure and surface
- with selectable top color
- deposited by LARC®-technology

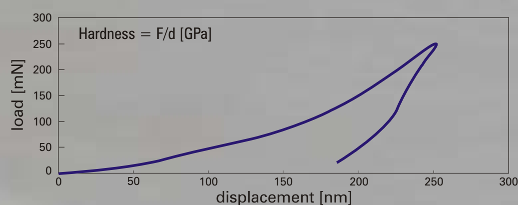
Coating thickness = 4 µm

Mold for mobile phone coated by CrN toplayer

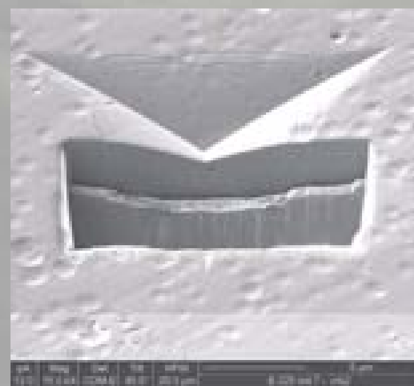
Conventional Coatings

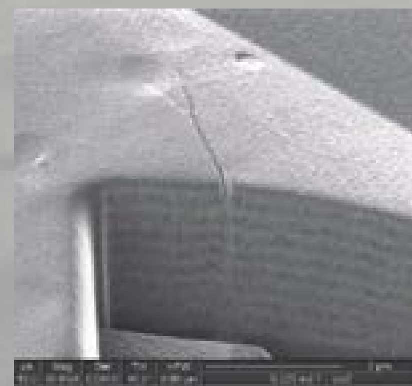
Nanoindentation





Absorption of Cracks by Multilayer Structure

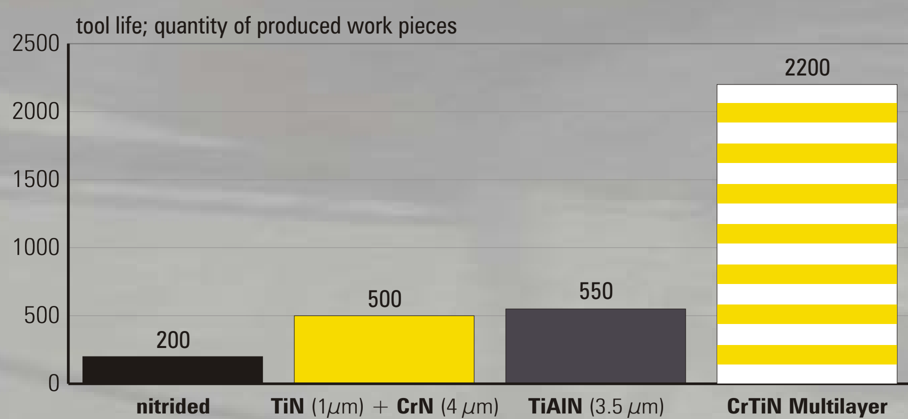




Source: TOPNANO-Project, EPF Lausanne, Switzerland
Measuring hardness by nanoindentation

Aluminium Extrusion

Tool Life Comparison



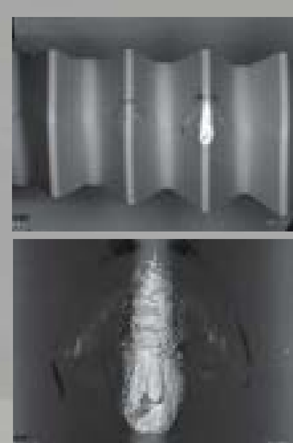
Layer sequence in µm: 1xTiN=1.3 - 9x(TiN=0.25 / CrN=0.4) - 1xCrN=0.35
Mat.: Al 6012; Total coating thickness: 7.5 µm - Source: Metalba, Italy

Fluteless Tapping

Comparison of Coating's Damages at Thread Forming

Tool: Thread former
M10-6HX-InnoForm1-Z
HSSE 23/1 – Ø9.55 – ap=1.5xd
Mat.: 42CrMo4 heat treated
38.5 HRC - Rm= 1220 N/mm2
vc= 15 m/min – n=477 1/min
Outer coolant with emulsion

Manufacturer's ref. coating after 48 threads



Dedicated nanostructured CrTiN after 64 threads

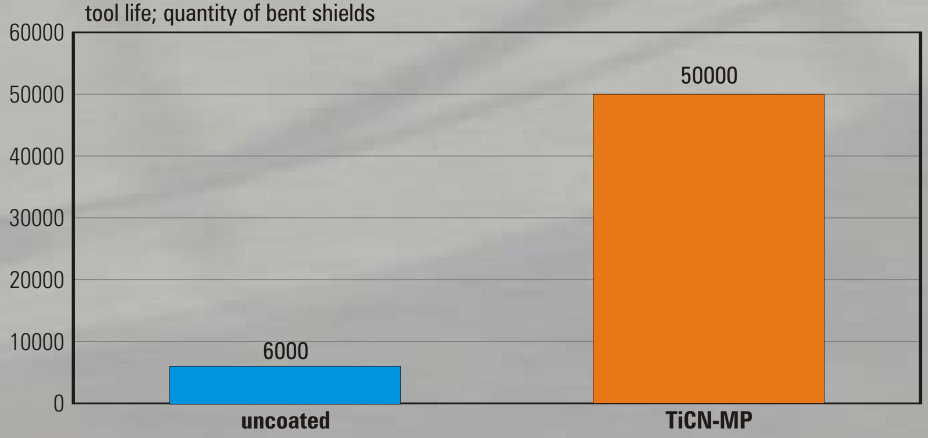
Applications

Bending

After bending with uncoated tools

After bending with coated tools

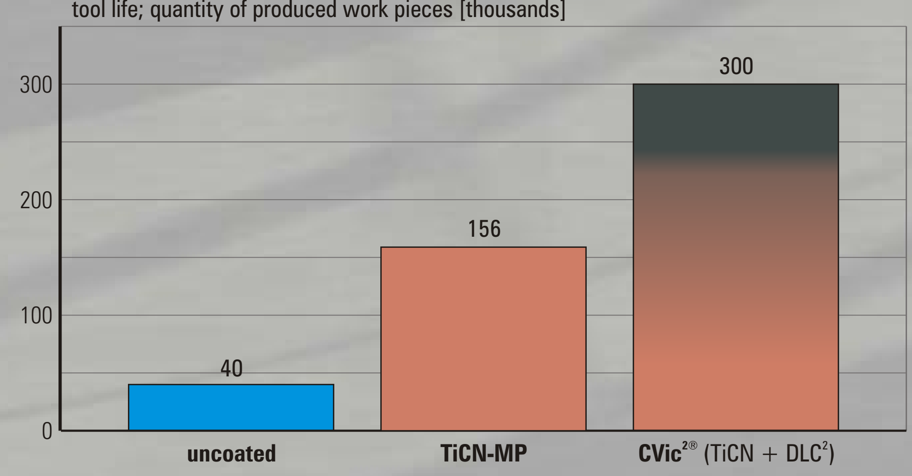
Tool Life Comparison



Mat.: St22-42MC carbon steel, shield thickness: 3-5mm
Source: MKB – GFE, Schmalkalden, Germany

Punching

Tool Life Comparison



Work piece material: INOX 0.8 mm; Source: Thermi-Lyon, France

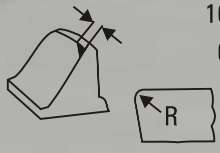
Influence of the Edge Radius on the Tool Life of Fly Cutter

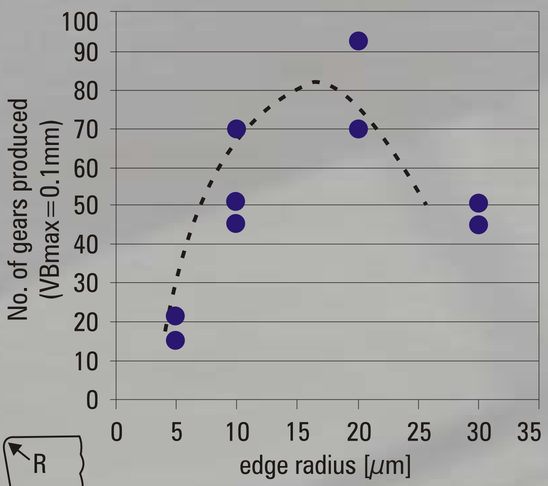
Gear:
- steel 27MnCr5 (270HB)
- Modulus 2

Fly cutter:
- substrate: S290 (1010HV10)
- Coating: AlTiN

Cutting conditions: Vc = 140 m/min, hmax=0.3mm, dry, down hobbing

Edges prepared by Microblasting



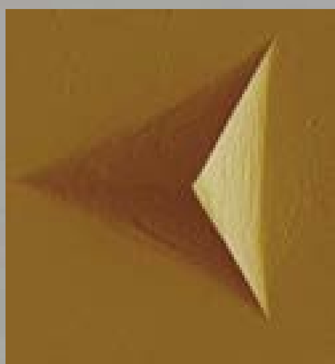


Source: J. Rech, M.-J. Schaff und H. Hamdi, Proceedings of CPI 2005

Applications
Nanogradients

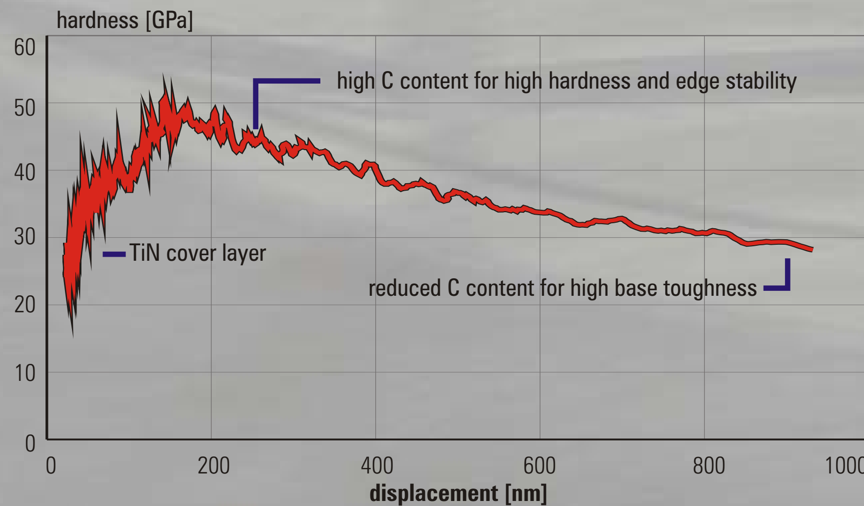
Nanogradients

The coating structure is continuously changed. The coating composition can be modified by gas inlet or metallic content variation.

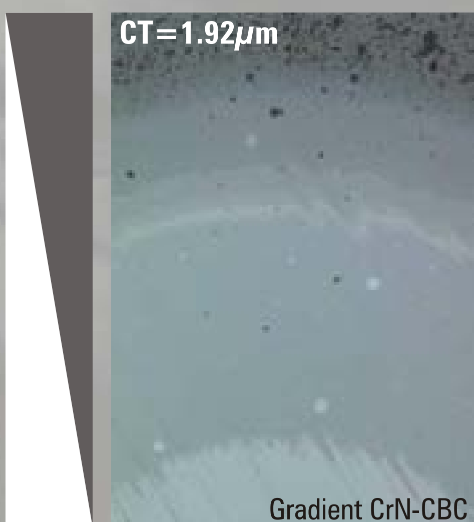


Crack free indentation of nanogradient coating

Variation of Nanohardness by Gas Inlet



Fluteless Tapping

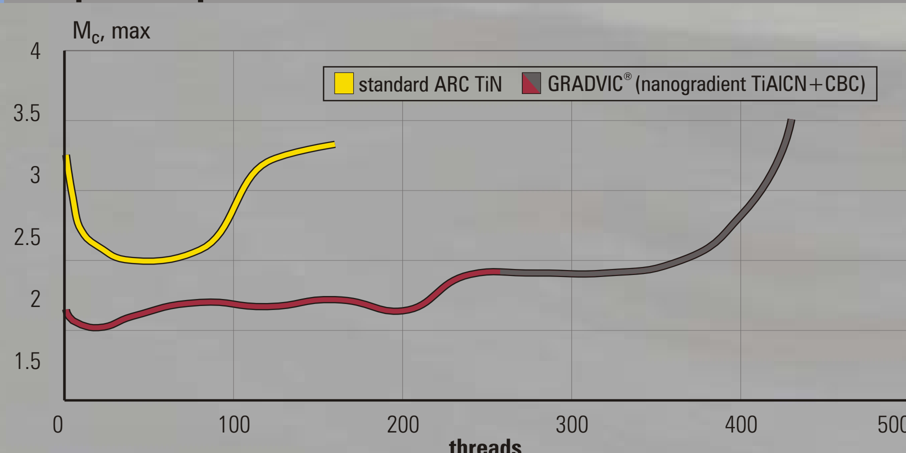


Tool Life Comparison

Workpiece: 356Al (7% Si) - Tools: M10x1.5 HSS - Coolant: emulsion 8%
Source: Hayes Brake, Mequon, WI, USA

Tapping

Torque Comparison

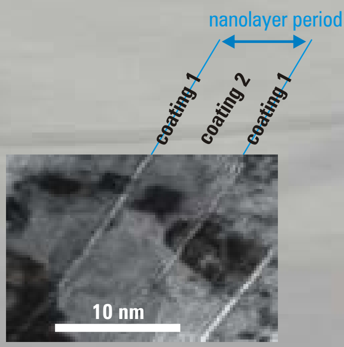


Mat.: C45k - Steeltap-Fraisa - M6 - v_c=10m/min - Emulsion 7%
Measured by iFT, Grenchen, Switzerland

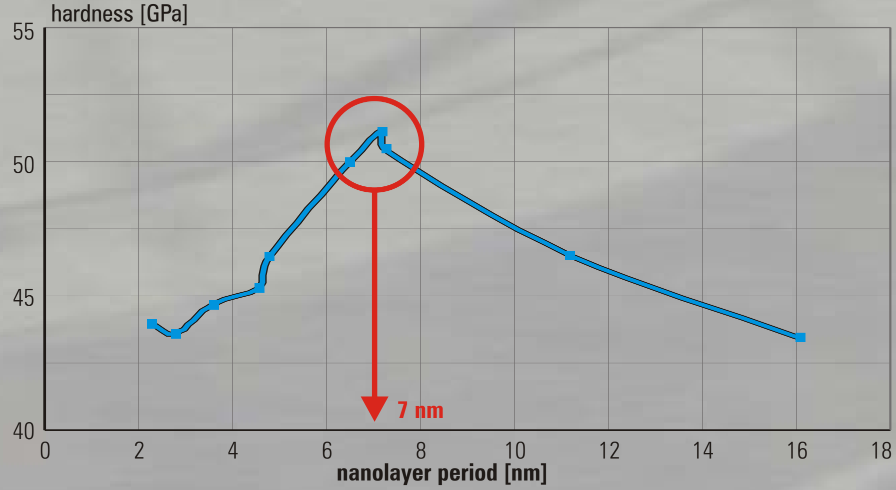
Nanolayers

Nanolayers

The coating hardness depends on the thickness period of the sublayers. The optimum period of the superlattices increases hardness enormously.

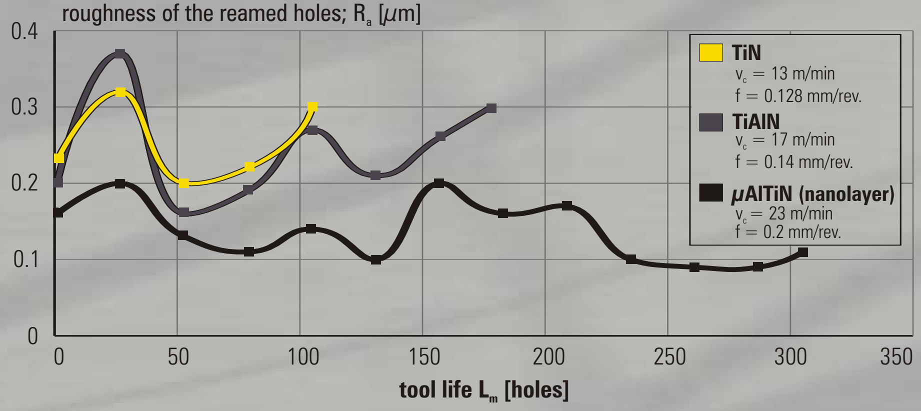


Hardness of Nanocomposite with Nanolayer Structure



Reaming

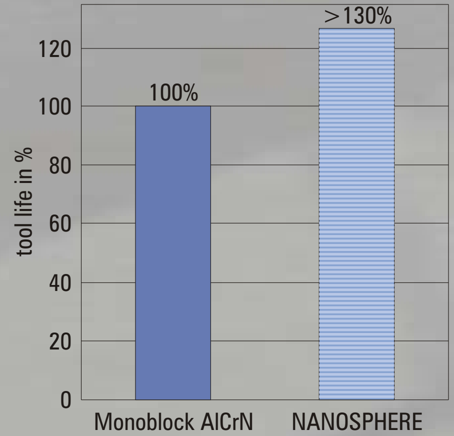
Technology Optimization



Tools: d=6.2 mm, a_p=12 mm; allowance 0.2 mm; coolant: emulsion 7%
Mat.: X155 CrVMo 12-1, cold work steel, DIN 1.2379
Source: Re-Al, Biel, Switzerland

Gear Hobbing

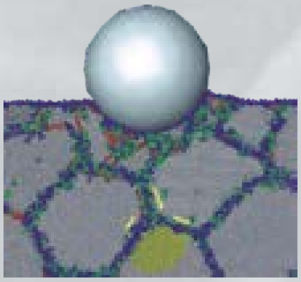
New Dedicated Nanolayer Coating for Hobbing



Hobs:PM-HSS - module=2,7, dry cutting, work piece material: 20MnCrB5
vc=220 m/min - fa = 3,6 mm/work piece rev. - Tool life end at Vbmax = 130μm – Source: LMT-Fette, Schwarzenbek, Germany

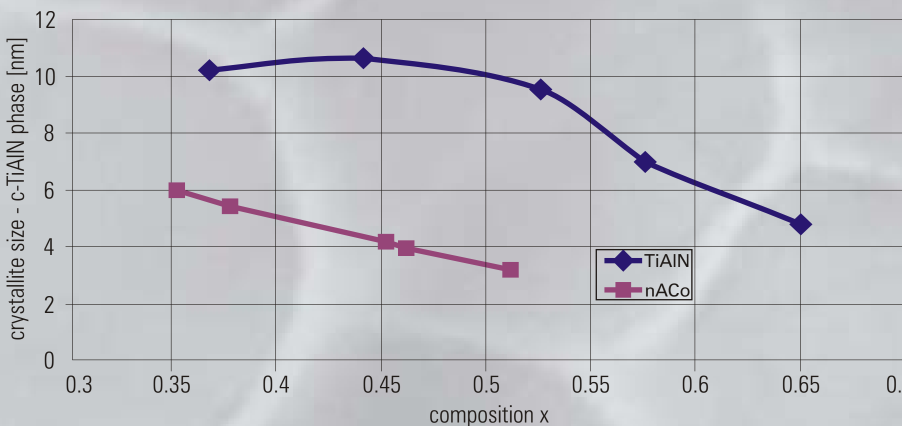
Nanocomposites
Conventional

Nanocomposite Grains



Modelling view of the 5 nm average grain size sample at an indentation depth of 20 Ä.
The Nanocomposite coatings have a higher hardness than conventional coatings. Because the amorphous SiN matrix enwraps (infoldes, covers) the nanocrystallite grains and avoids their growth.
Source: Paul Scherrer Institute, Villigen, Switzerland

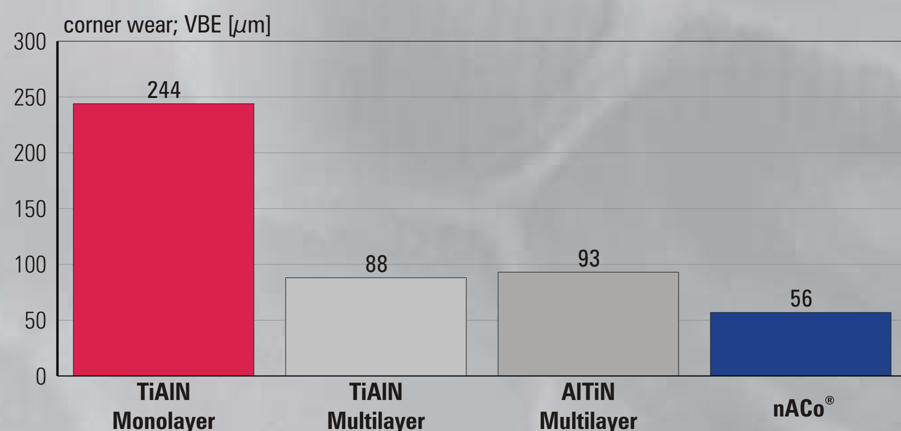
Grain Size Comparison: $Ti_{1-x}Al_xN$ and nACo = $Ti_{1-x}Al_xN/SiN$



Calculated from XRD data using the Scherrer Equation
Same linear behaviour but smaller crystallites than in the Cr-based system

Drilling

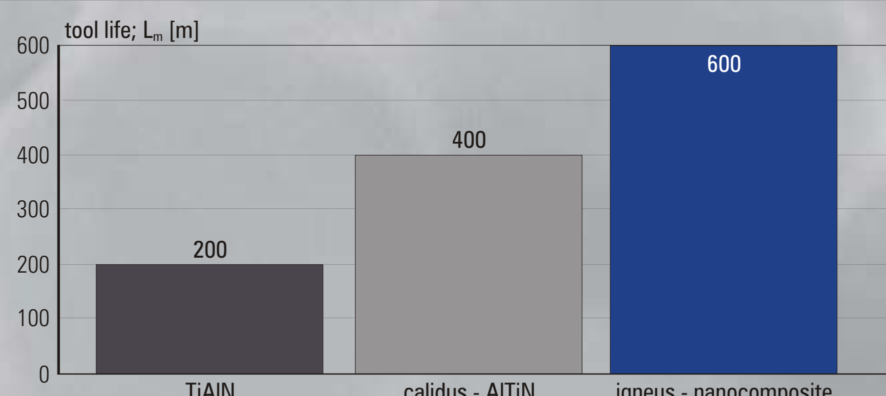
Wear in Heat Treated Steel



Mat.: 42CrMo4 - IC-p=40 bar - emulsion 5% - comparison after L_f=50m drilling distance
Tools: solid carbide drills - d=12mm a_p=5xd - v_c=120 m/min - f=0.35 mm/rev.
Source: Unimerco, Sunds, Denmark

Milling

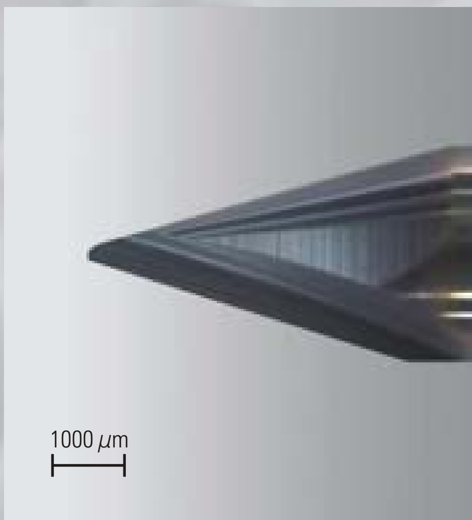
Tool Life in Hot Working Steel



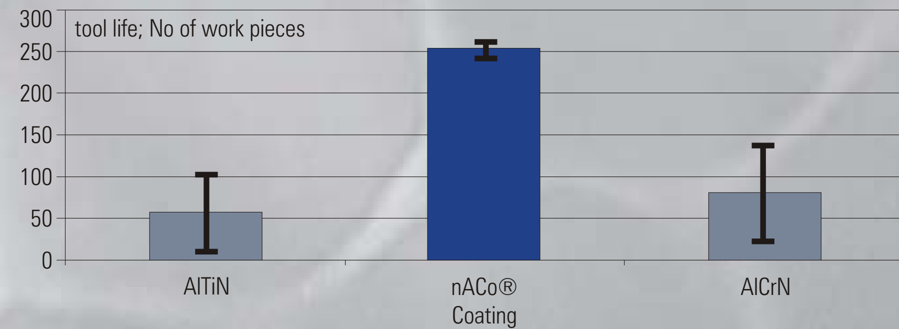
Work piece material: X40CrMoV5 – 1.2344 – R_m=1100 N/mm²
Tools: d=12mm - solid carbide end mill with corner radius r=2mm
v_c= 218 m/min – f=0.26mm - a_p=0.5mm – a_e=8mm – emulsion 7%
Source: Schlenker, Böbingen, Germany

Applications

Engraving



Tool Life Comparison

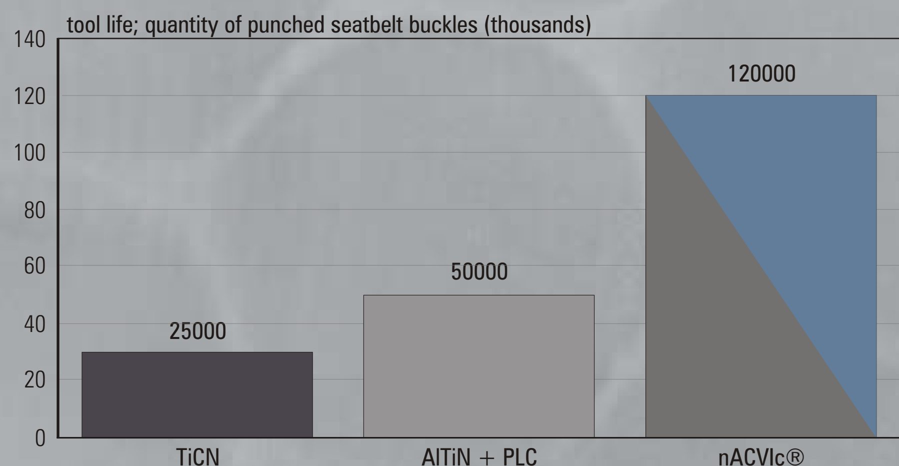


=> nACo-thin coating < 1um -> sharp edge

Tool: d1=0.1mm
Engraving parameters: n=26'000 RPM, vf = 250 mm/min (dive in = 25 mm/min),
Material: stainless steel - ap-depth = 0.25 mm,
Tool life end: tool breakage; Source: DIXI outils SA, Le Locle, CH

Punching

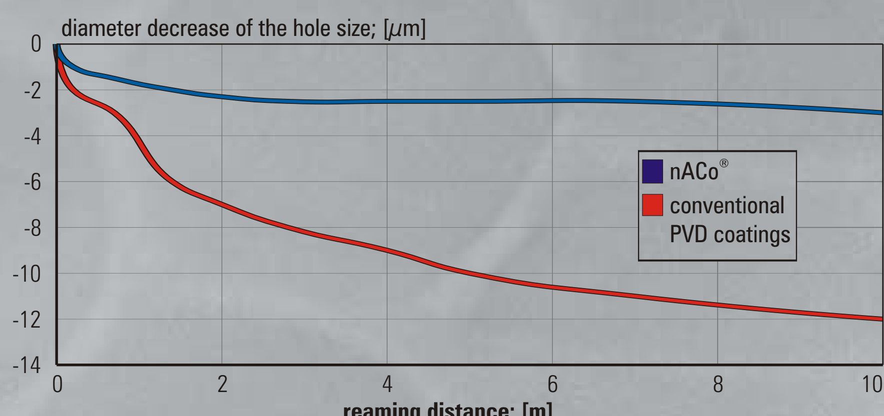
Tool Life Comparison



Material: Ck45, 3.0 mm - Source: Brano - Liss, Roznov, CZ

Reaming

High Speed Reaming

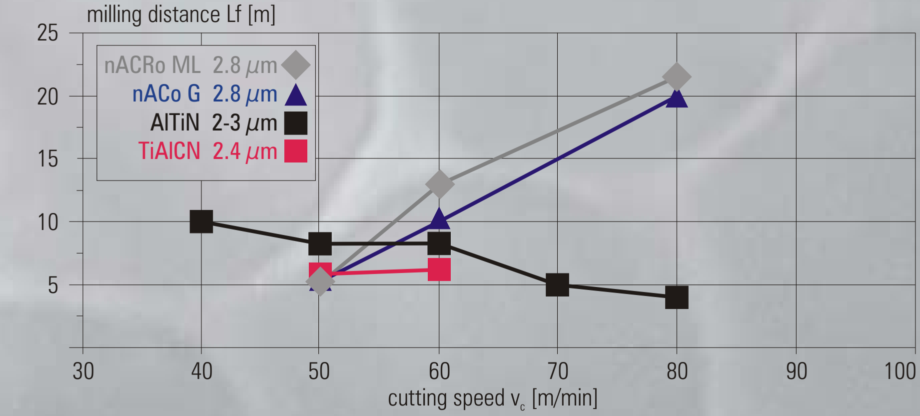


Mat.: GG25 cast iron, v_c= 80 m/min, f=0.4 mm/rev.; Coolant: emulsion 7%
Tools: solid carbide HSC-reamer with internal coolant, z=6 - d=11.5H7
Source: Beck, Winterlingen, Germany

Nanocomposites
Conventional

Milling with HSSCo End Mills

Tool Life Comparison

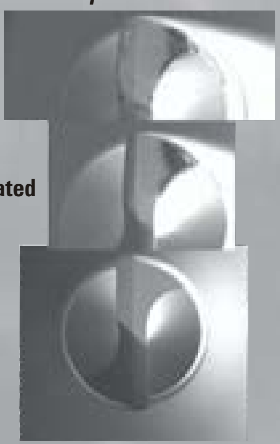


Work piece material: 42CrMo4 heat treated steel, HB 310
Tools: HSSCo8 - d=10 mm, z = 4, ae= 5 mm. ap = 5 mm, fz = 0.05 mm/tooth
Coolant: Emulsion 7% - 8 l/min - VBCmax= 0.6 mm – Source: TH Budapest, Hungary

Micro Drilling

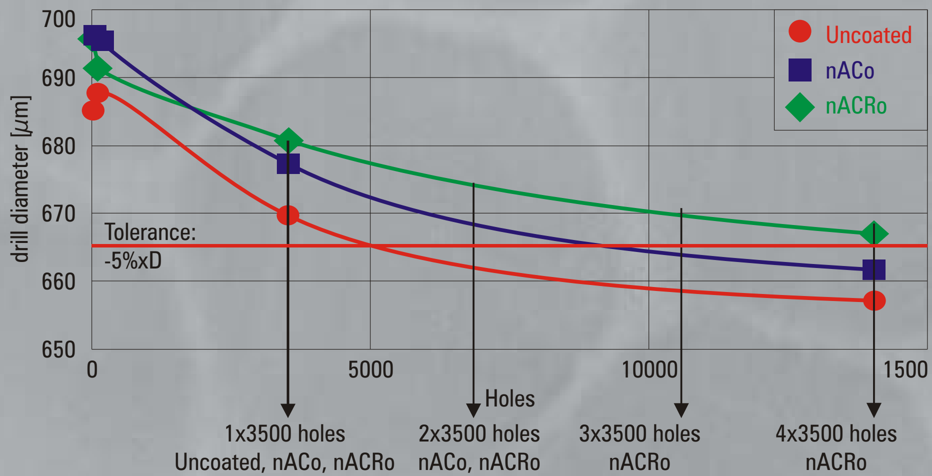
Tool Life Comparison

nACRo: 2.5 µm after 14'000 holes



Uncoated

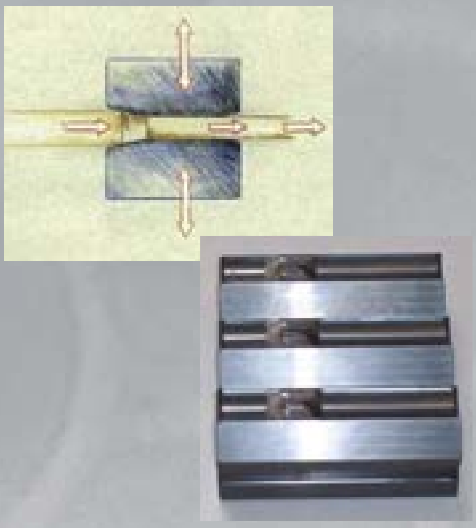
Uncoated before work

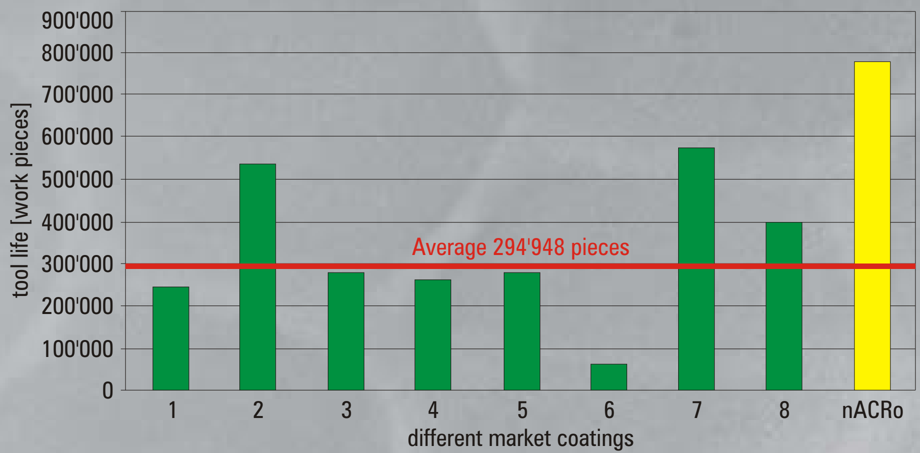


Source: HP-Tec, Ravensburg, Germany

Rotating Stamping

Tool Life Comparison

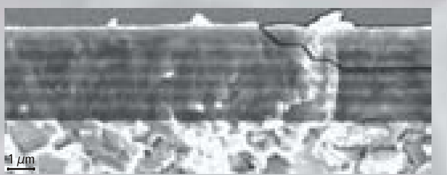




Source; GFE, Schmalkalden, Germany
Fa. Thyssen Krupp Presta Ilsenburg, Germany

Applications

Gear Cutting with Inserts — Influence of the Coating Structure

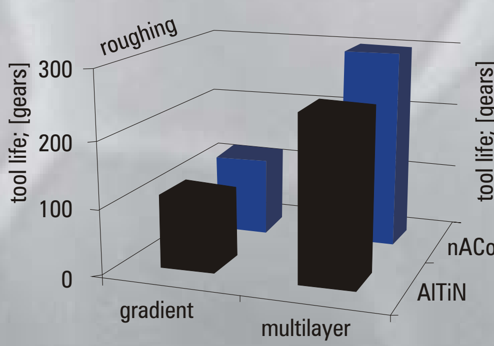


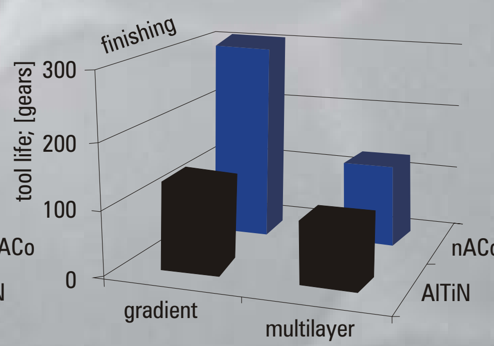
Multilayer for roughing:
At dynamic load the cracks are absorbed at the borders of the sublayers.

Monolayer for finishing:
Higher hardness increases tool life.

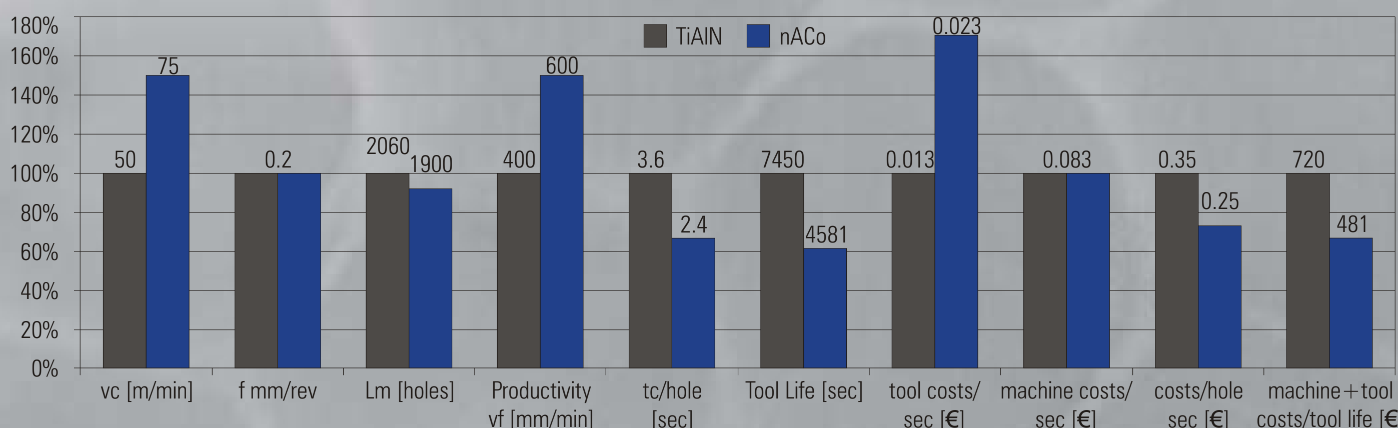
Roughing insert

Finishing insert



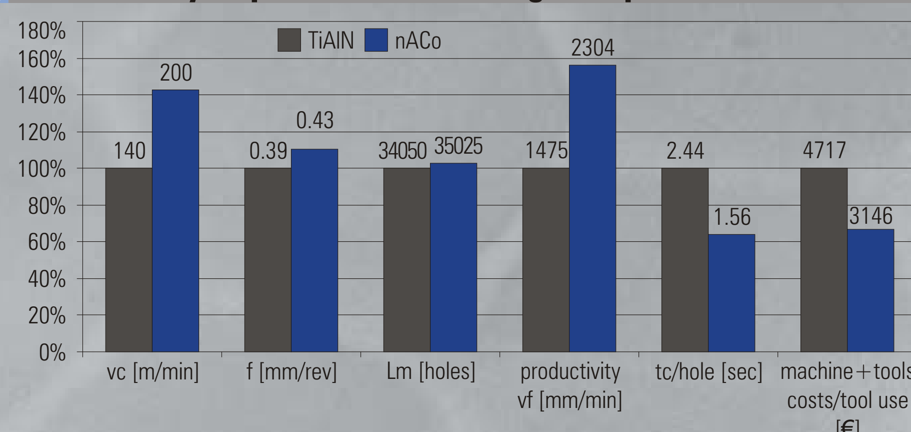


Drilling — Cost Savings with the nACo Coating



Mat. Nodular cast iron – Tool o8/12 mm Unimerco solid carbide drill
The costs for 2.4 tools can be saved during the use of one nACo coated tool
Source: Ford AMTD, Detroit, USA

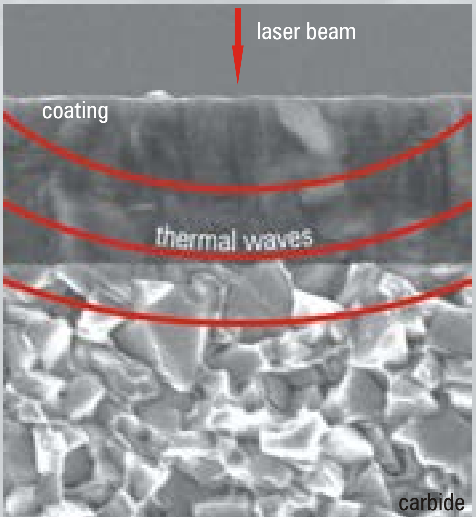
Drilling — Productivity Improvement with Higher Speed and Feed



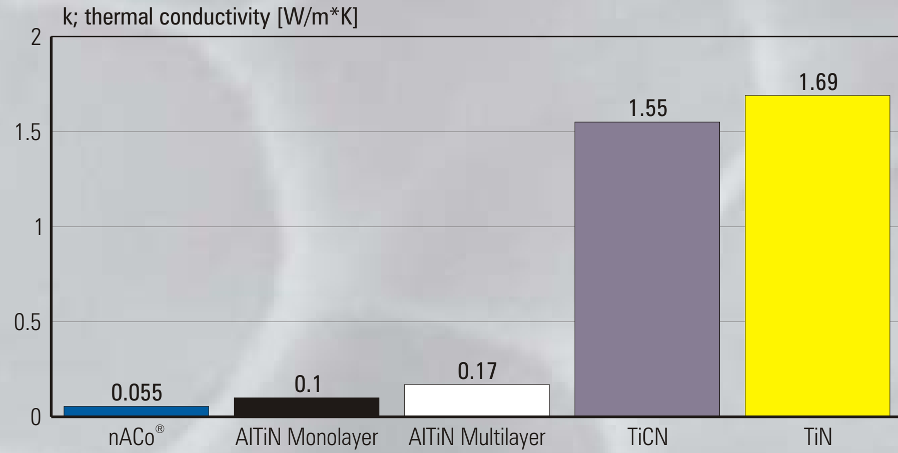
Work piece material: GGG40 – ap=60 mm
Solid carbide step drill: d=7.1/12 mm – Internal cooling with 70 bar - 5 % emulsion
Source: Sauer Danfoss, Steerings, Denmark

Nanocomposites
Applications at High Temperatures

Heat Conductivity



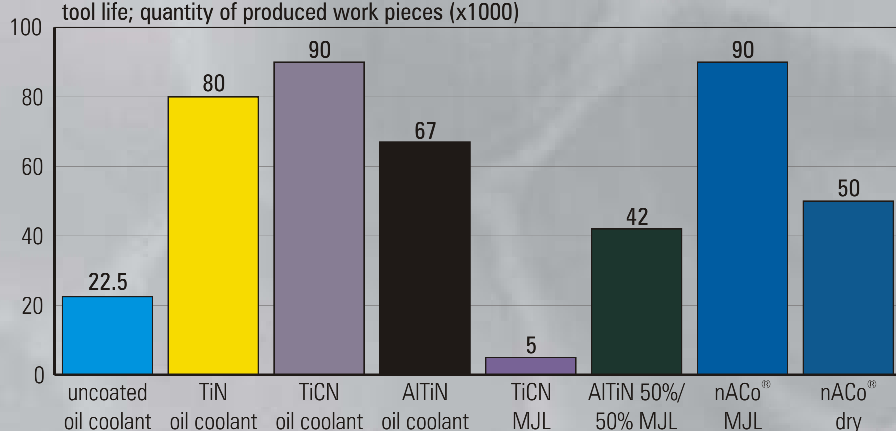
Comparison of Thermal Barrier Features



Measured at the University of Ilmenau, Germany
All coatings on carbide (K40) with the thickness of 2.5 μm

Punching

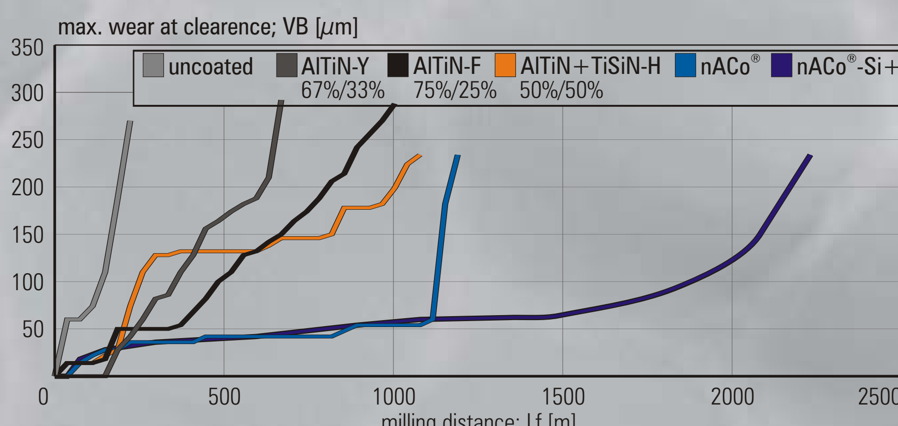
Tool Life Comparison



Mat.: Ck60, 1.122; R_m=550 N/mm^2; thickness: 2.9 mm
Tool: M2 HSS 6-5-2, 1.3343, 63 HRC, 30 hits/min, MJL: Minimum Jet Lubrication

Hard Milling

Wear Comparison



Hard milling in 2D spiral; Mat.: 1.2343, X38CrMoV5-1, warm working steel, 57 HRC,
Tools: solid carbide ball nose end mills, z=2, d=10mm x 57,
RPM=18500, f_z=0.18mm, a_p=0.25mm, a_e=0.6mm, MQL; Measured by iFT Grenchen, Switzerland

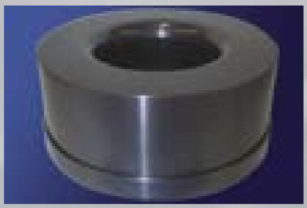
Applications with Cr-Doping

The Camel Curve

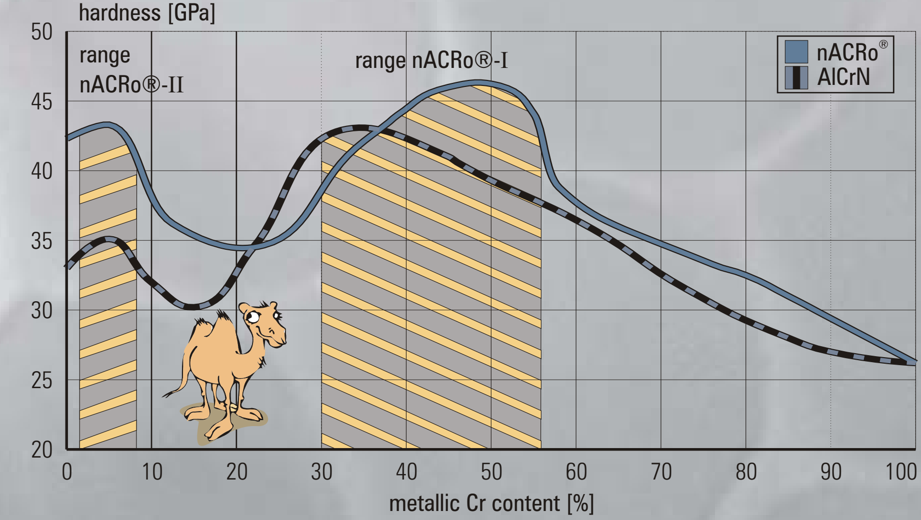
Nanocomposite structure
eliminates disadvantages
of conventional coating:

High hardness
even with low chromium content

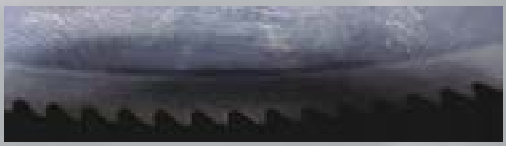
- ▶ more economical production
- ▶ chance to decoat from carbide
- ▶ higher heat stability
- ▶ extremely high thickness for hobs, molds and dies

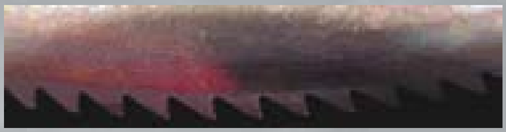


Hardness Comparison of AlCrN and nACRo®

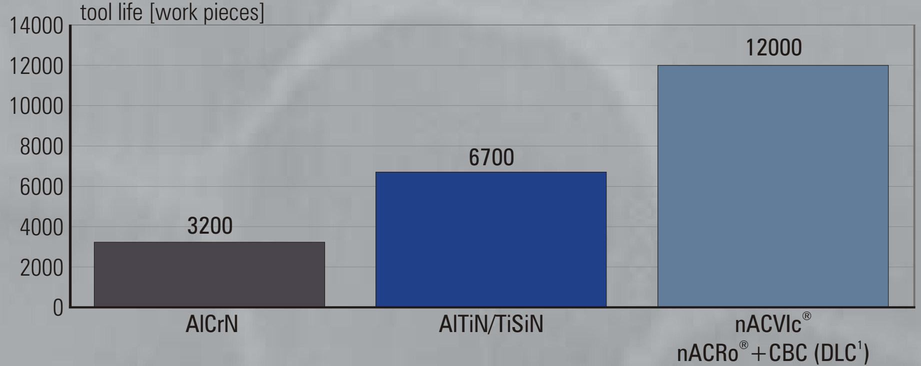


Sawing





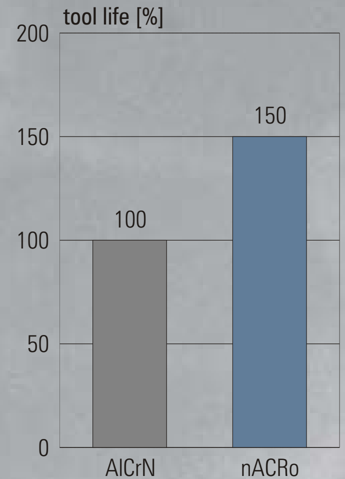
Tool Life Comparison



Precision cutting of 3 mm profiles, stainless steel 904L
Tool: carbide circular saw blade Ø 160mm x 0,8mm, z=200
Cutting conditions: n=400 rev/min, vf=64 mm/min, lubrication: oil
Life time criterion: Burr formation on work piece
Source: Swiss Watch Industry

Injection Molding

Aluminium Injection Mold with Dedicated Multilayer-nACRo

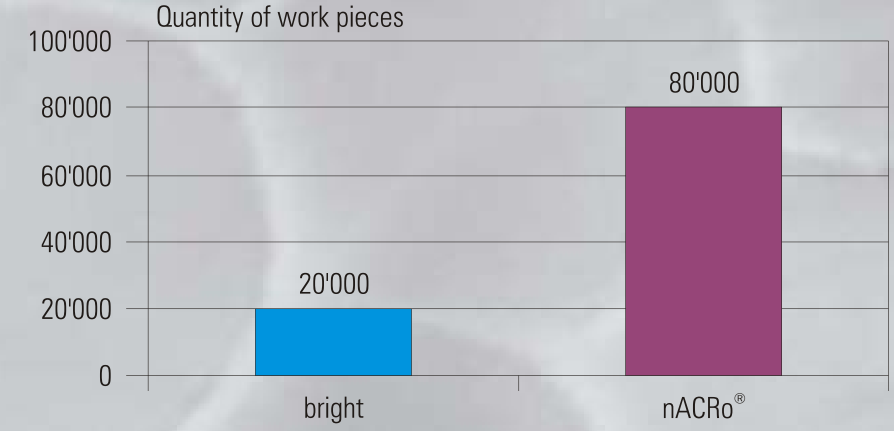


Source: Gibbs Die Casting Ltd. Retsag, Hungary

Nanocomposite Coatings
Difficult Forming Operations

Punching

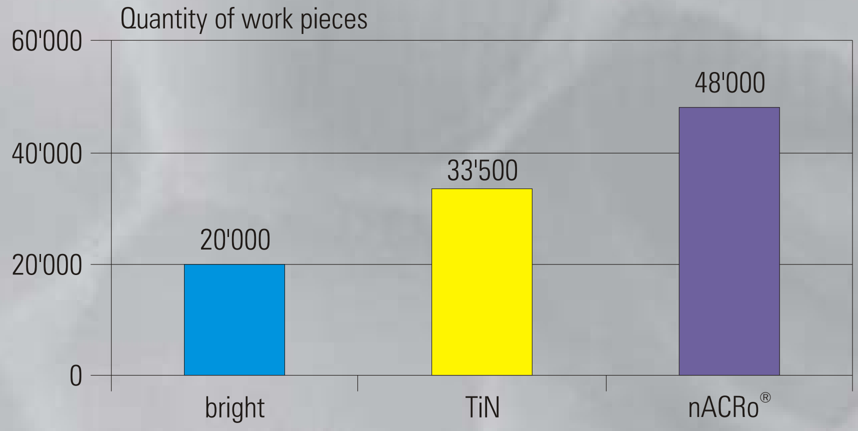
Tool Life Comparison



Work piece material: 5XGuA 50-80 HRB
Punch die - Tool material: HSS; P6M5 – Source: Technopolice, Moscow, Russia

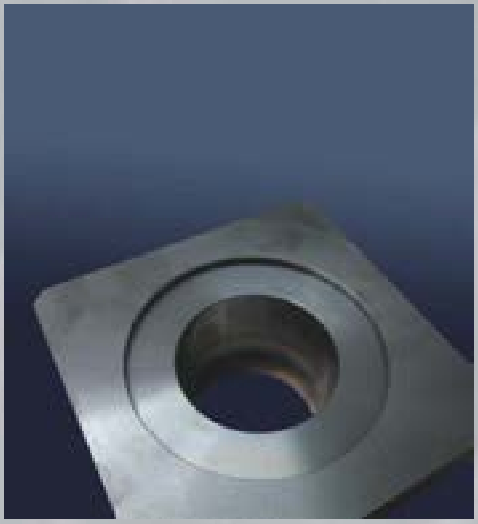
Stamping

Tool Life Comparison

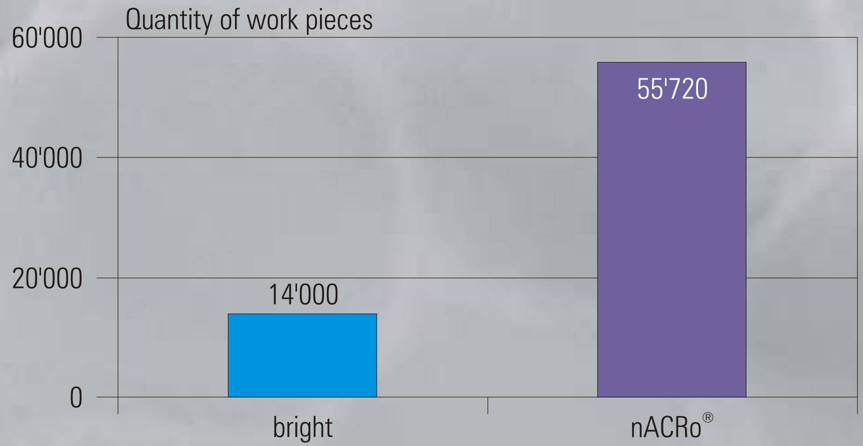


Work piece material: 20G2P – 430-470 N/mm2
Stamp - Tool material: HSS; P6M5 – Source: Technopolice, Moscow, Russia

Form Pressing



Tool Life Comparison



Work piece material: PA- 18-23%
Stamp - Tool material: HSS; P6M5K5 – Source: Technopolice, Moscow, Russia

Difficult Cutting Operations

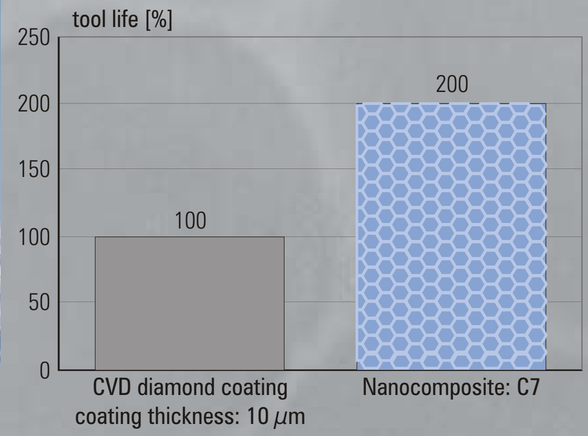
Bevel Gear Hobbing

Tool Life Comparison

Milling of Bevel gears with carbide Tri-Ac hobbing cutters
nACo® can be decoated from carbide without cobalt leaching
and without generating hexavalent hazardous Cr6 waste!
Source: Gleason, Rochester, NY, USA

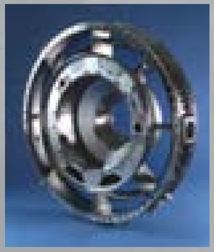
Drilling

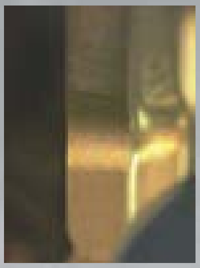
Tool Life Comparison

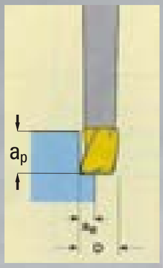


Tool: d=10/12mm solid carbide drill
Material: carbon fiber composite / aluminium
Source: Unimerco, Lichfield, UK

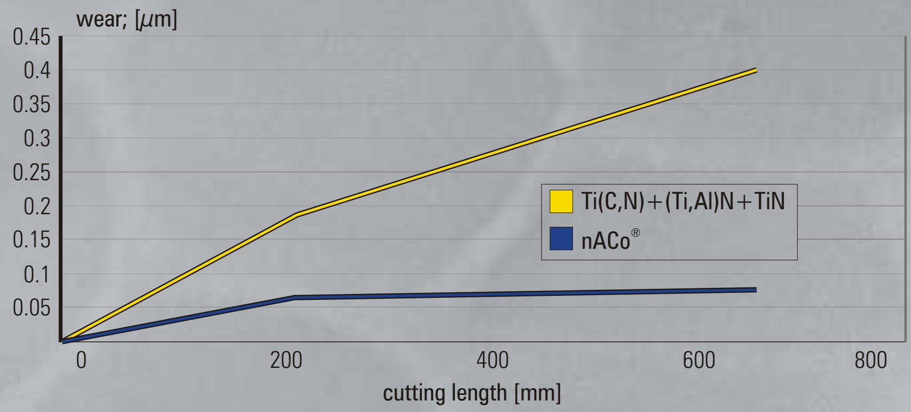
Plunging







Wear Comparison

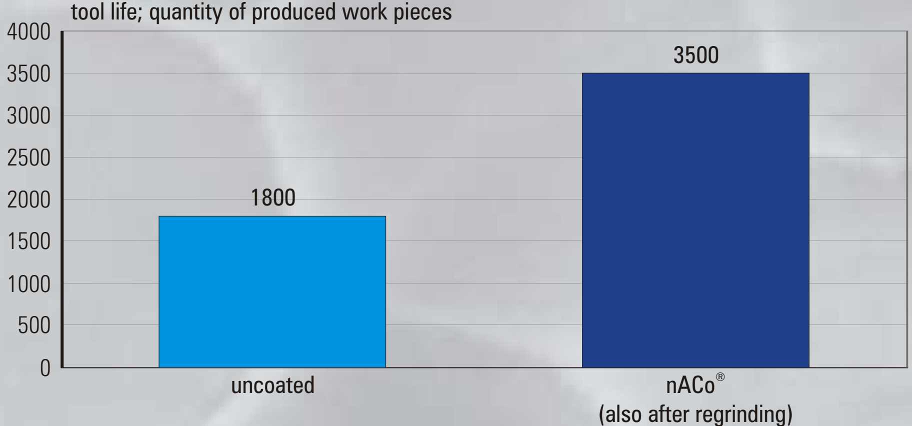


Material: IN100 - Nickel Base - 12Cr-18Co-3.2Mo - 4.3Ti-5.0Al-0.8V-0.02B-0.06Zr
Tool: Carbide insert - Minimaster MM12; D=12 mm, r=2 mm, z=2
v_c= 21 – 30 m/min, fz= 0,05 mm, a_p=20 mm, a_e=3 mm, turbine milling
Source: EU R&D project Macharena - Volvo Aero Norge AS

Nanocomposite Coatings
Difficult Cutting Operations

Grooving

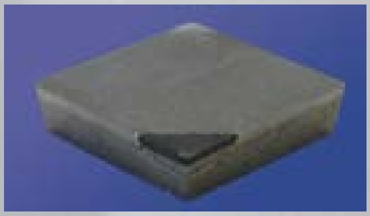
Tool Life Comparison



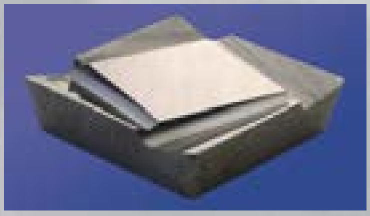
Mat.: Hasteloy - tool manufacturer: Horn
insert – d=30 mm - z = 3 - v_c = 33.5 m/min - f_z =0.052 mm
Source: Hocotechnik, Basel, Switzerland

Turning

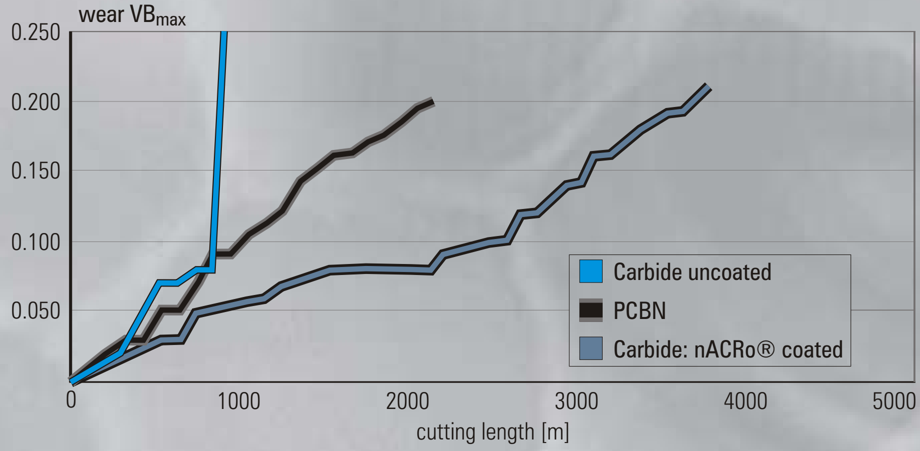
PCBN-insert



Carbide insert



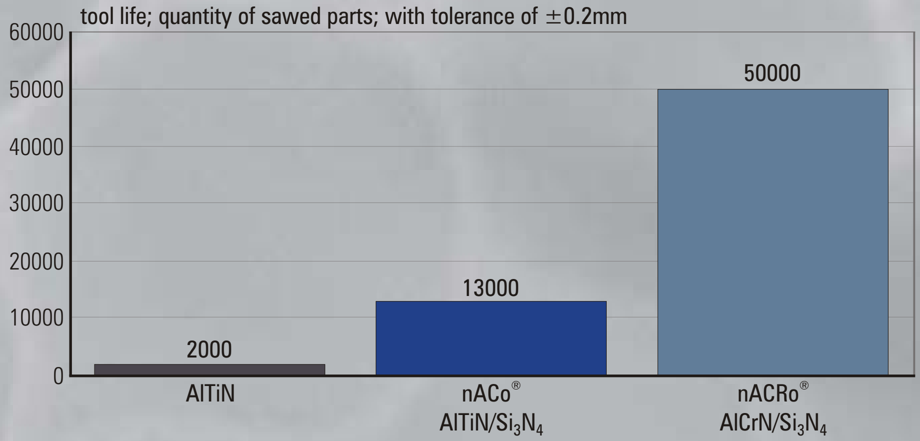
Tool Life Comparison



Material: Somaloy SMC550; Soft Magnetic Composites v_c = 700 m/min, f = 0.1 mm/rev - a_p = 0.2 mm
Measured by IWF, TU Berlin, EU R&D project PM-MACH

Sawing

Tool Life Comparison



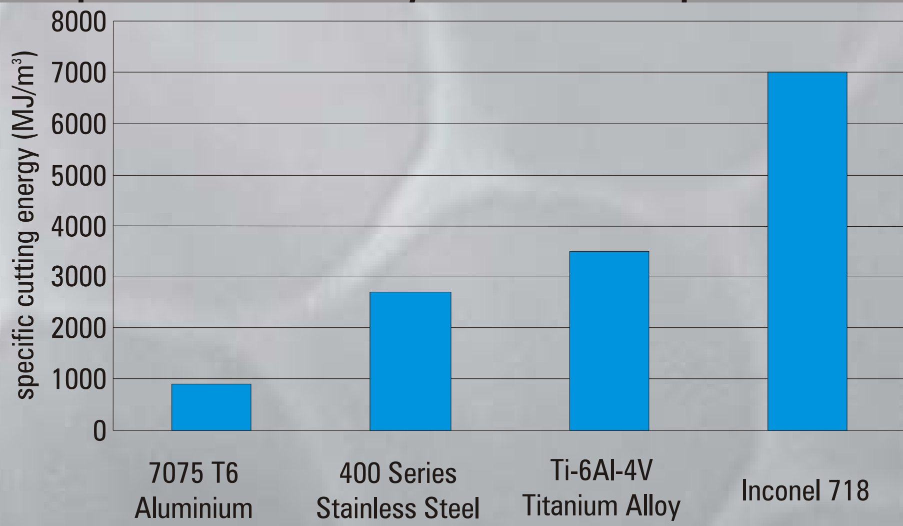
Solid carbide saw blades, Ø 125 x 3.6 mm, z=100 – sintered workpiece material: Co1
n =300 RPM - v_f=800 mm/min - a_p = 35 mm, coolant: emulsion 7% - Source: Prétat, Selzach, CH

PLATIT®

Applications

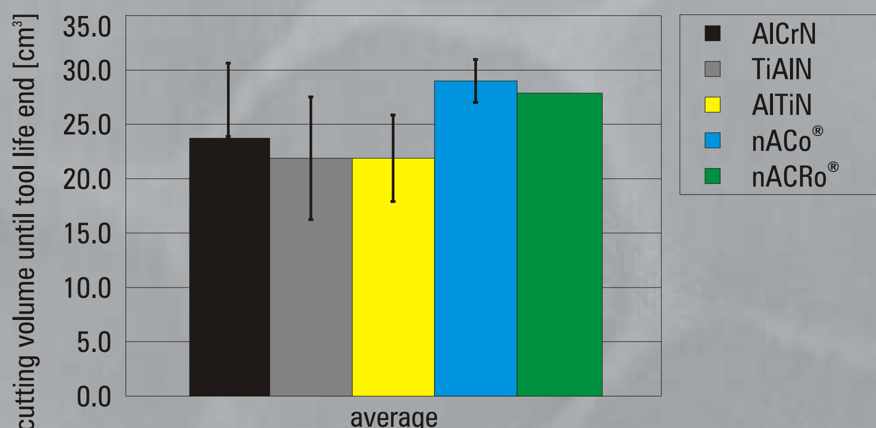
Machinability

Comparison of Machinability of Different Workpiece Materials



Slotting

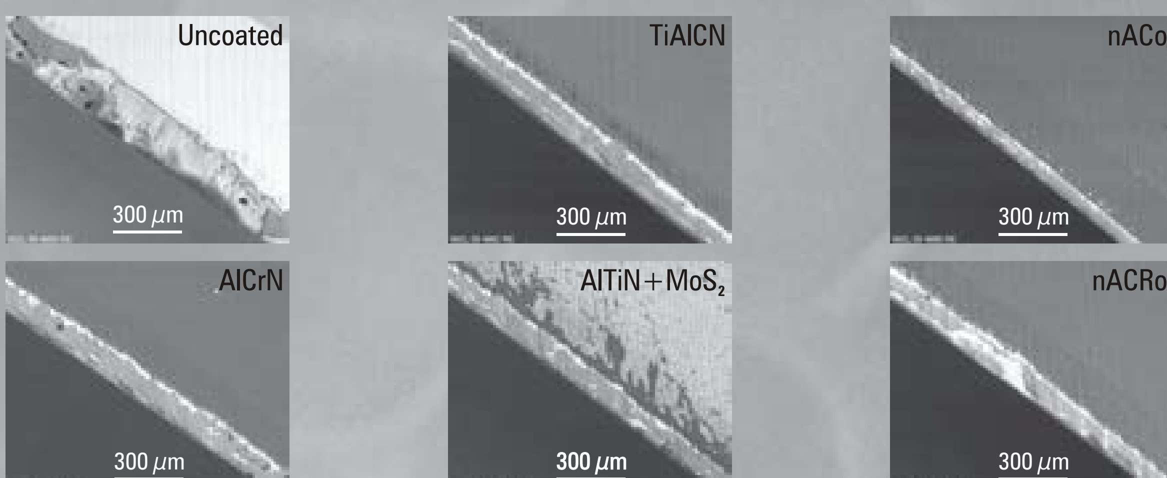
Tool Life Comparison in Inconel 718



Tools: FRAISA 5325.450 NX-V, Ø10 mm z=4, helix angle 38/41°
Conditions: a_e=10 mm, a_p=2.5 mm, v_c=25m/min, f_z=0.025 mm
Source: EU R&D project MACHERENA

Milling - Finishing

Land Wear after 1200 mm Milling Length in Inconel 100

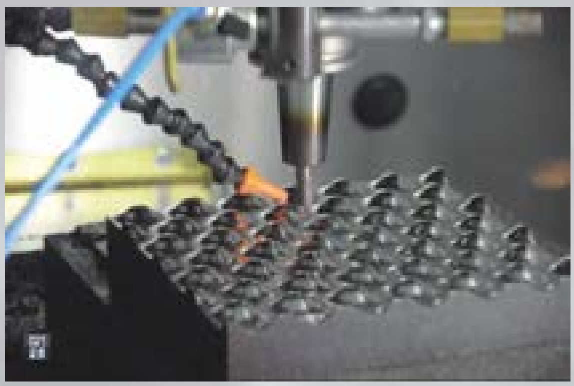


Material: Inconel, IN100 - Source: WZL Aachen, Germany

TripleCoatings3® Deposited by the π311

Dry Hard Milling at 60.5 HRC with nACo3®

After milling Lf= 444 m = 3.5 hours



Special market coating-1 for hard milling AlTiN-D

Special market coating-2 for hard milling AlTiN-X

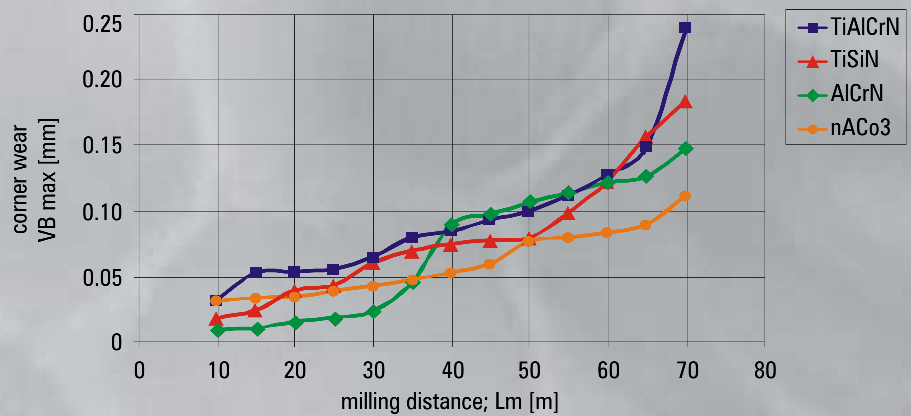
nACo3®

After milling Lf= 888 m = 7 hours

Material: 1.2080 - X210Cr12 (Hardness = 60,5 HRC)
Tools: Solid carbide ball nose end mills - d=10 mm – z=2
n =10445 min-1, vc=0-328 m/min - ap = 0.14mm, ae = 0.1mm, fz = 0.1mm, external cold air nozzle

Milling

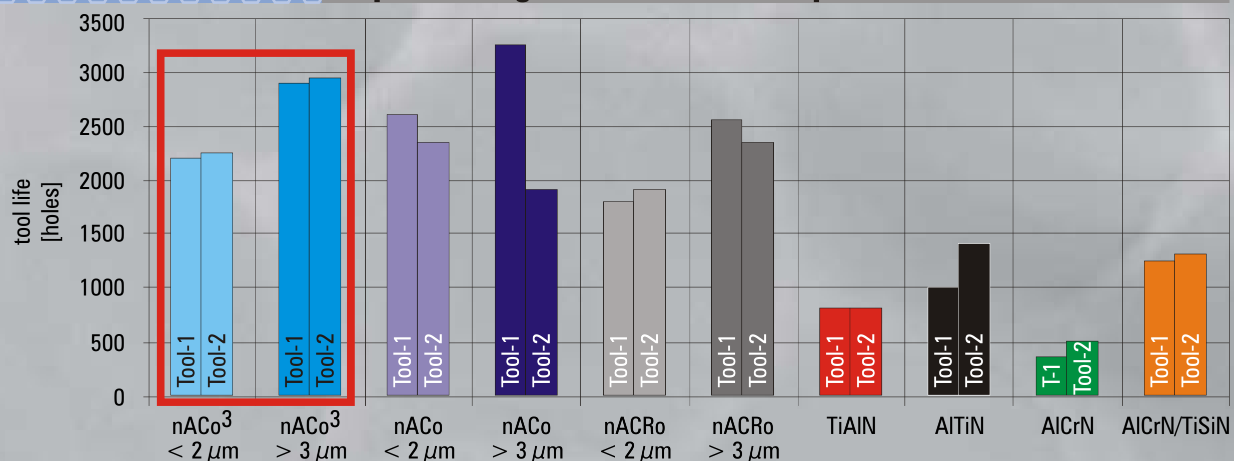
TripleCoating® in Tool Life Comparison



Material: STC3 – heat treated steel - HRC45 - Solid carbide end mill - d=10 mm
RPM= 4515 1 /min - vc=141 m/min - vf=845 mm/min - f=0.05 mm/tooth
Source: Widin, Shinchon, South Korea

Drilling

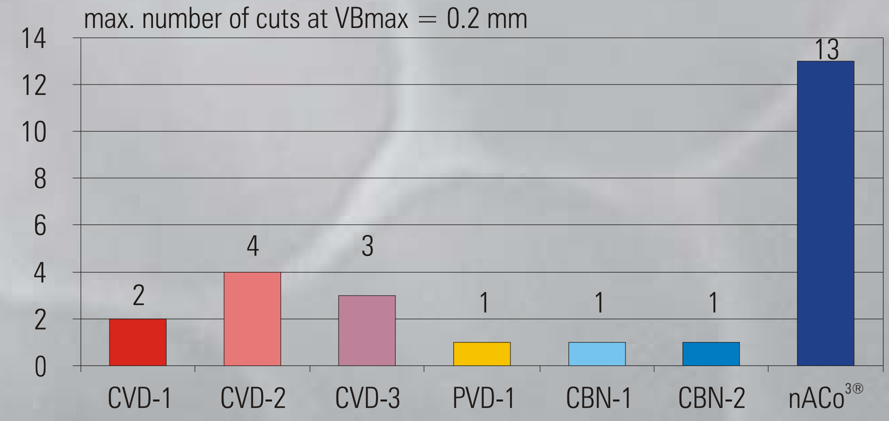
TripleCoatings® in Tool Life Comparison



Material:X155CrVMo12-1 - 1.2379 - Solid carbide drill: d=5.2mm - ap=15mm
vc=74.5 m/min - f=0.15 mm/rev - Internal coolant: Emulsion 7% - 30 bar

Applications

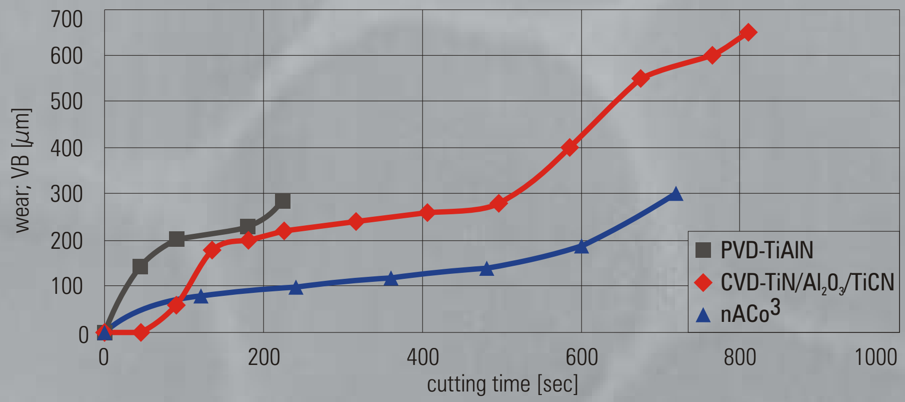
Interrupted Dry Turning with Coated Ceramic Inserts by nACo3®



Material: Austempered Ductile Cast Iron, ADI 900, ≈325 HBWT2,5/187,5
Inserts: CNGX 120716 ceramic - vc=270 m/min, f = 0.4mm - ap=2mm, dry
Tested by GFE, Schmalkalden, Germany

Turning

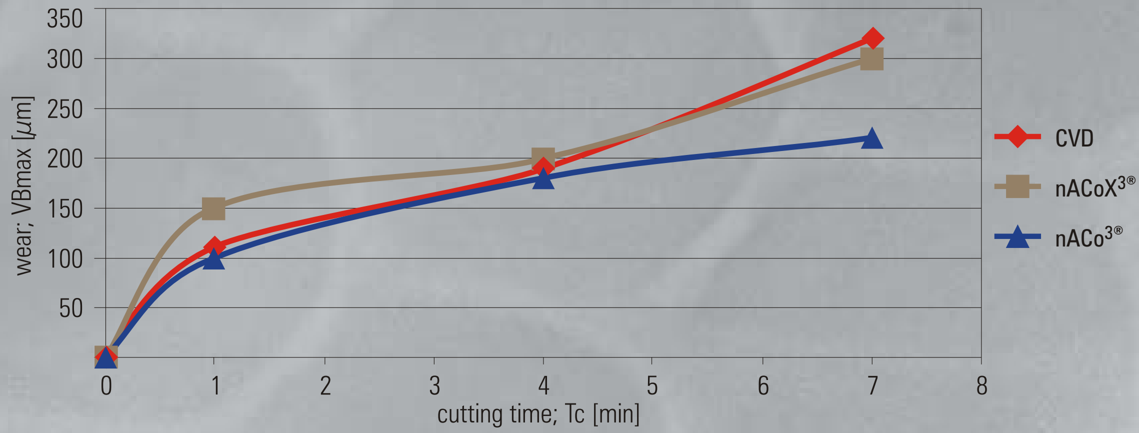
TripleCoating® in Tool Life Comparison to CVD-Coating



Material: stainless Steel AISI 316L - Inserts:Sandvik CNMG 12 04 08
v_c=290 m/min- ap=0.8 mm - f=0.24 mm/rev - Dry
Tool life criteria: VBmax ≤ 300 µm - KTmax ≤ 130 µm - N8 (Ra<3.2µm – Rz<12.5µm)
Source: EIG, Geneva, Switzerland

Cooled Turning with nACo3® and nACoX3® in Comparison to CVD Coated Inserts

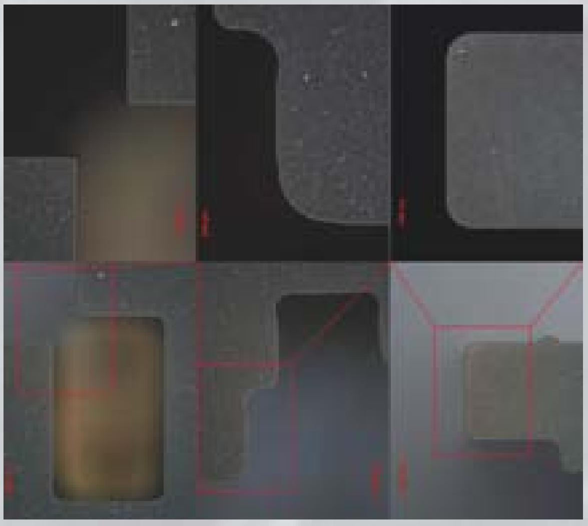
Worn inserts after
7 min of cutting

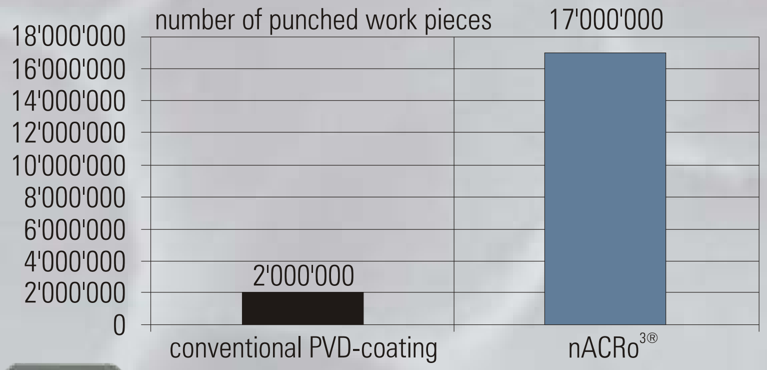


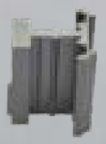
Reference inserts: Sandvik GC GC2025-MM coated with CVD: TiN/TiCN-multi/Al2O3/TiN - Thickness 6 µm
Material: Stainless steel - X5CrNi18-10 - 1.4301 - vc=170 m/min ap=1-3mm - f=0.35 - Coolant with emulsion
Source: Ceratizit, Mamer, Luxemburg

TripleCoatings3®
Deposited by the π311

Punching — Fine Punching with nACRo3®

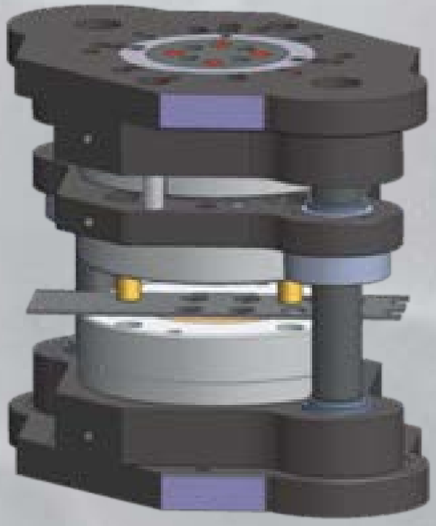


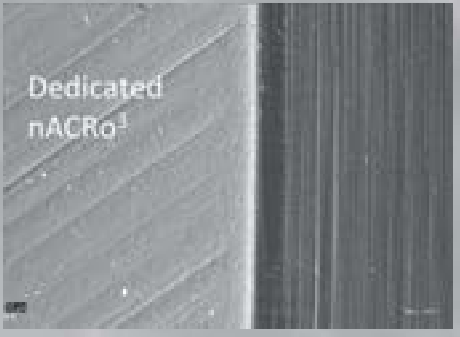




Source, Stepper, Pforzheim, Germany

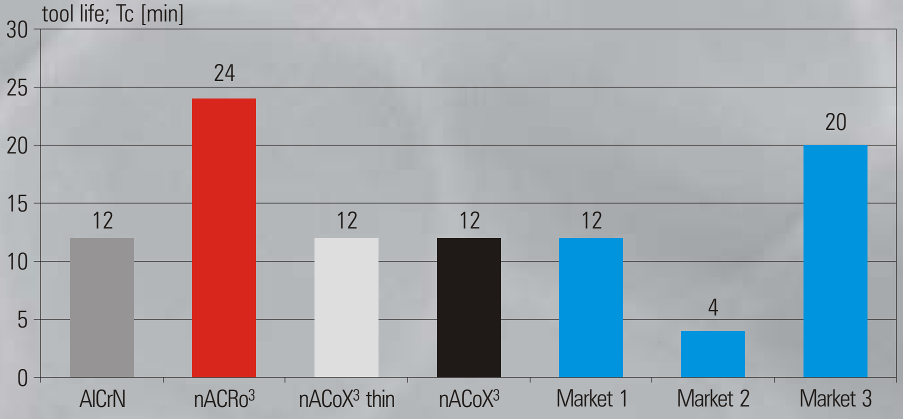
Fine Blanking — Wear Comparison





Work piece material: CP complex phase steel - CPW-800-steel 27 HRC
PM-HSS-Tools with minimum lubrication
Developed with Feintool, Lyss, Switzerland

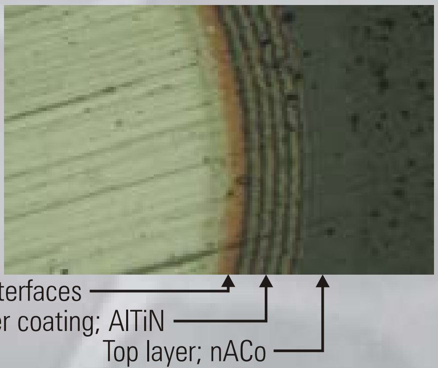
Cooled Milling in Stainless Steel — nACRo3®: Highest resistance against temperature changes

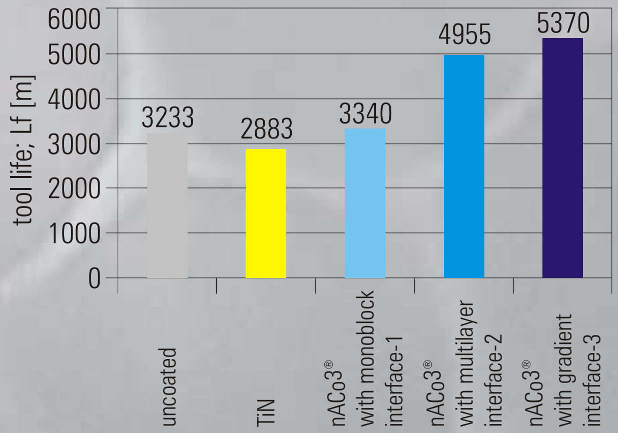


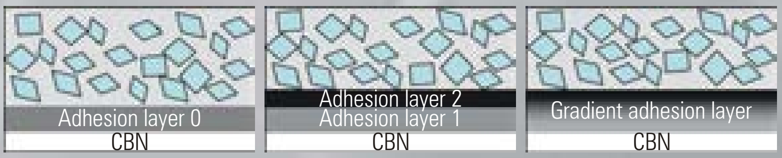
Tool: Milling head with SDMT inserts - Cooling: Emulsion
Material: Stainless steel - A500 = <1.4301> X5CrNi18-10
vc = 200 m / min - n = 1273 U/min - ap = 3 mm - ae= 32 mm - fz = 0,2 mm

Applications

Hard Turning using Coated CBN-Inserts with Special Adhesion Structure for nACo3®



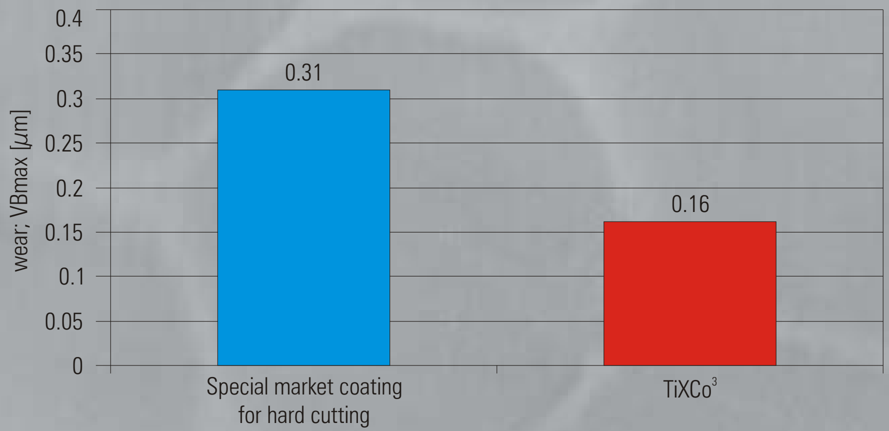




Mat: 100Cr6 - 63 HRC - vc=140 m/min - f=0.12mm - ap=0.2mm dry
Source: GFE, Schmalkalden, Germany

Super Hard Milling

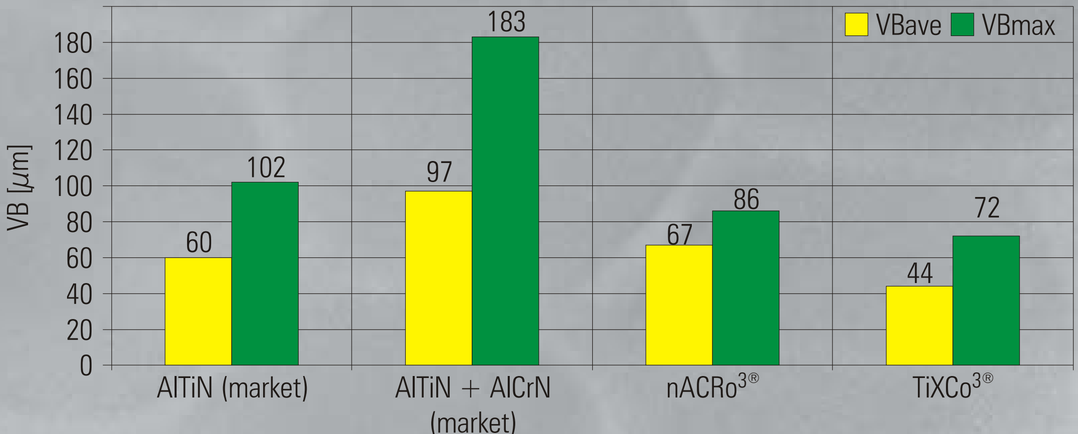
Wear Comparison



Work piece material: X210Cr13, 1.2080, 64 HRC – Tool: Ball nose end mill – d=6mm
n= 16'820 1/min – ap=0.09 mm – ae=0.06 mm – f=0.1 mm/rev
Coolant: cold air 5 bar – Developed and tested for HyoShin, South Korea

Super Hard Milling

Wear Comparison

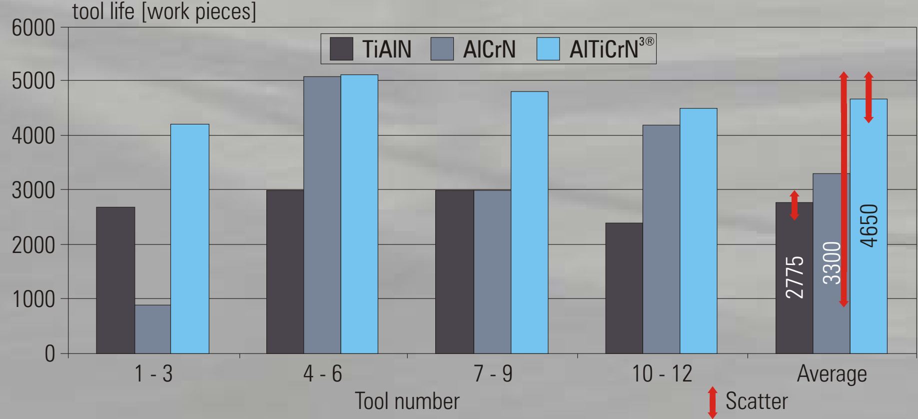


Torus end mill in cold-working steel X210Cr12 (1.2080) - 61.5 HRCØ 8 mm - z=4 - ap=0.1mm - ae=3mm vc=100m min-1 - n=4000min-1 - fz=0.2mm - vf=3200mm min-1 - dry - Source: Development project LMT Fette-PLATIT

TripleCoatings³®
Deposited by PL1001

Hobbing

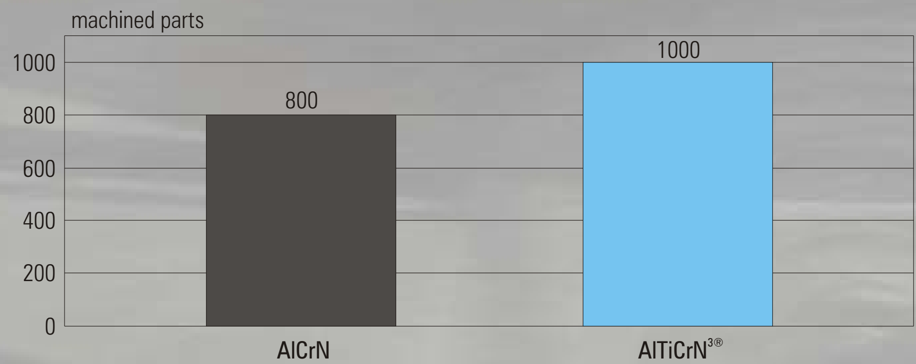
Tool Life Comparison



Work piece material: 34CrNiMo6 (1.6582)
vc=45m/min, fn=0.12 mm/rev, RPM=500
Coolant with oil - Source: Unimerco, Sund, DK

Gear Cutting

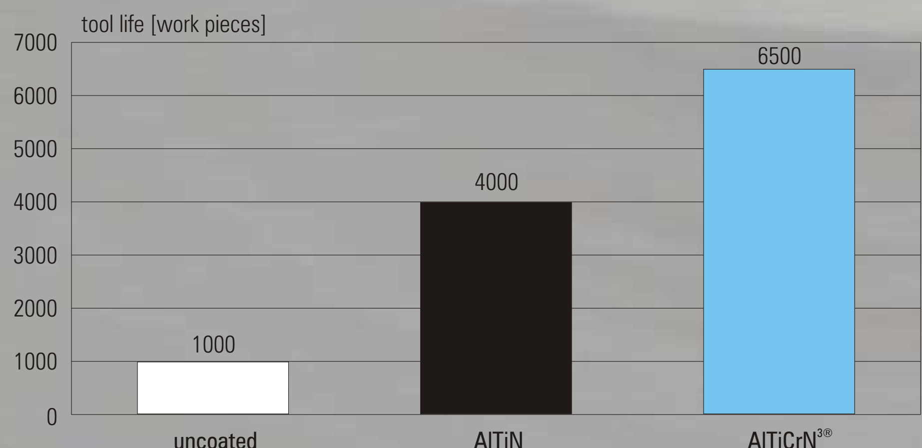
Tool Life Comparison



Machining of planet gears; Work piece material: 212 M; Width of work piece: 63 mm
Tools: HHS gear cutter ø95 x 150 mm
Roughing: vc=120 m/min - f=2 mm/RPM
Finishing: vc=140 m/min - f=1.5 mm/RPM
Criteria of tool life: Series of 200 parts without profile failure (very tight tolerances)

Sawing

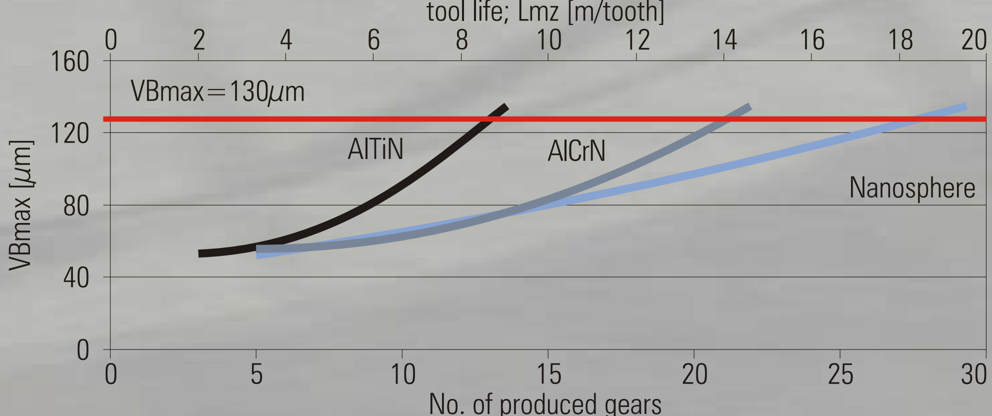
Tool Life Comparison



Material: 4140, H13, S7, D2, A2, Steel plates Tools: Saw blades, Carbide tipped 22" x 70"
RPM=42; SFPM=242 coolant emulsion; Source: Tru-Cut, Cleveland, USA

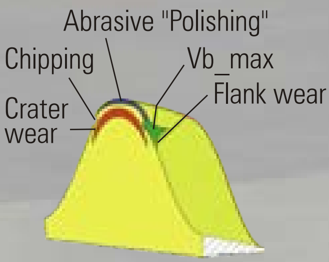
Dedicated Coating for Hobbing Deposited by π311

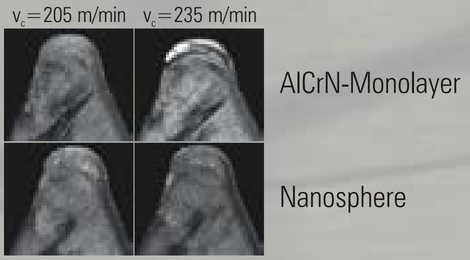
Wear Comparison at Hobbing with PM-HSS Tools

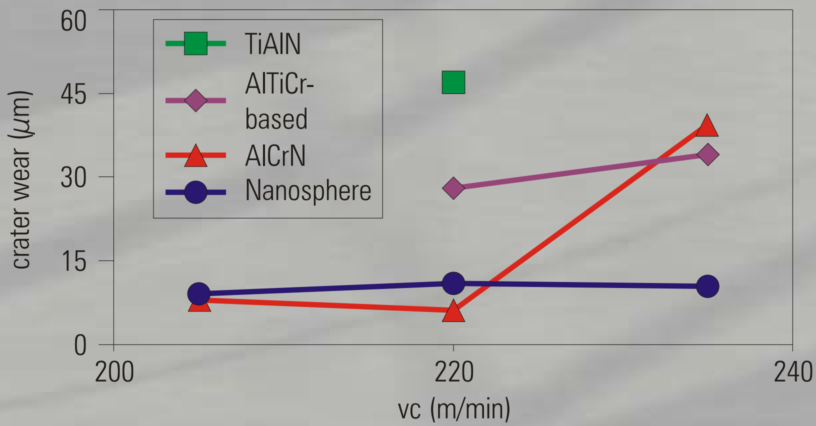


Mat.: 20MnCrB5 - Tool: PM-HSS - m=2.7 - Down hill milling - vc=220 m/min - fa=3.6 mm – dry
Source: IFQ Magdeburg in the development project LMT-Fette - PLATIT
The patented Nanosphere coating is a result of a common development project, exclusively for LMT-Fette

Crater Wear Comparison at Hobbing with PM-HSS Tools

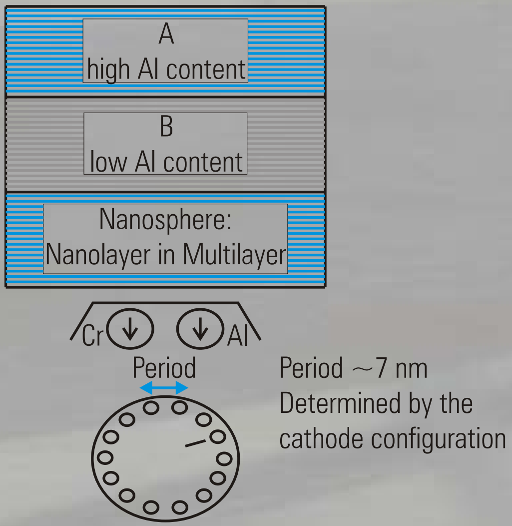


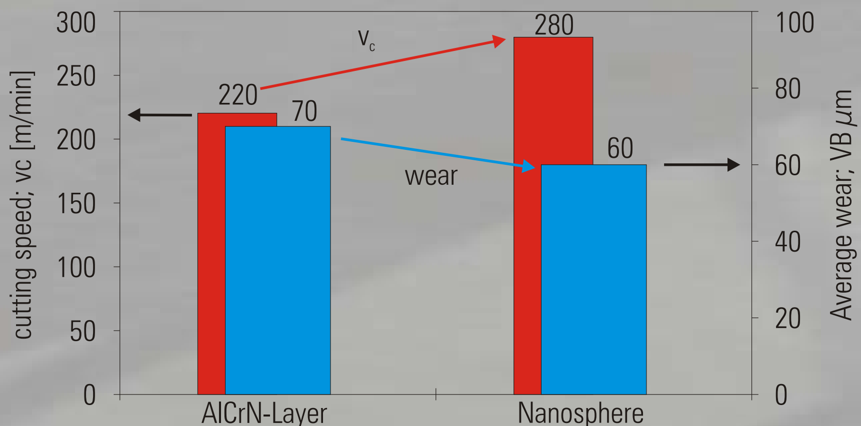




Mat.: 20MnCrB5 - Tool: PM-HSS - m=2.7
Down hill milling - vc=220 m/min - fa=3.6 mm - dry
Source: IFQ Magdeburg in the development project LMT-Fette - PLATIT

Technological Comparison at Hobbing with Solid Carbide Tools





Mat.: 16MnCr5 - Tool: Solid carbide K30 - m=3 - b=40.5 mm - z=27
f=2.0 - 2.1 mm - wet cooling with emulsion
Source: Fette-LMT - Industry test at German car manufacturer

π^{411}-POWER Coating Unit
Most Important Features

High Power Coating

- 4 cathodes run simultaneously
- High deposition rate
- Fast heating and cooling
- Short cycle time
- Up to 6 batches / day

QUADCoatings4®

nACRo4®
nATCRo4®
AlCrTiN4®
nACoX4®

High Loadability

- Robust and easy change of loads

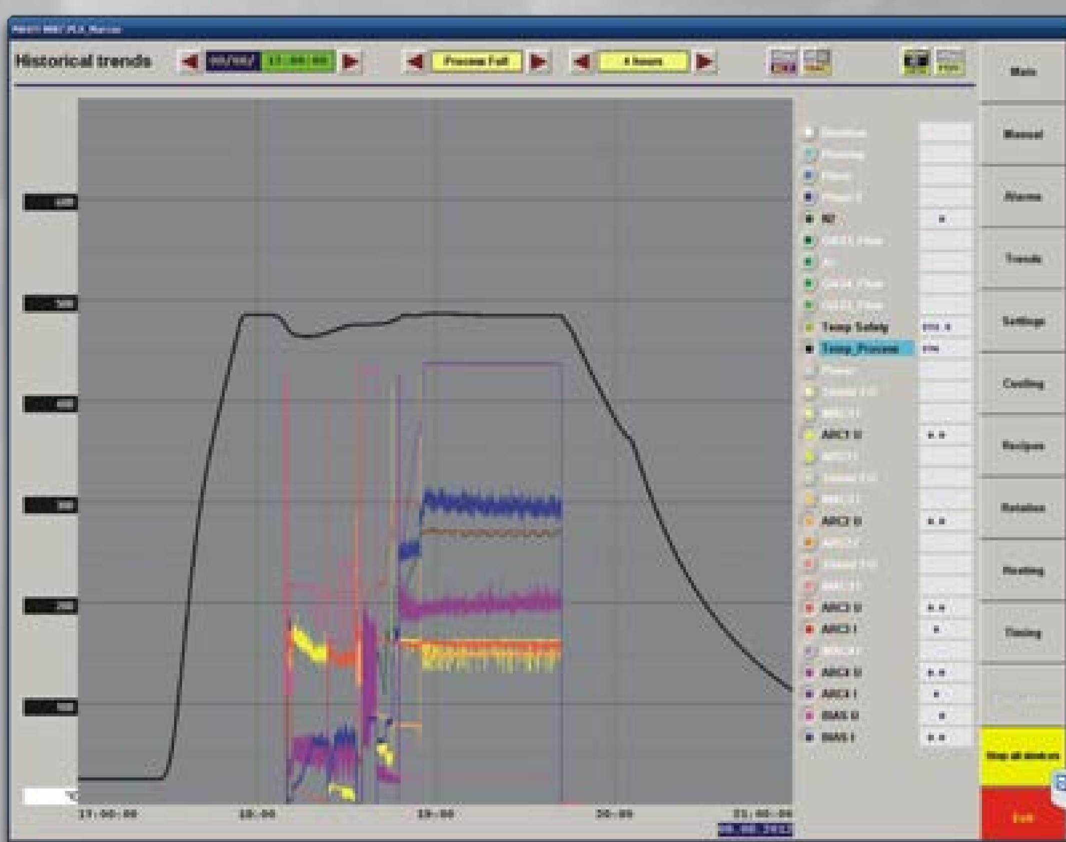
Optimal adhesion

With:

- VIRTUAL SHUTTER® and TUBE SHUTTER®
- LARC GD®

Trend Curves of a QuadCoating4®-Process

- Door to door time under 3.5 hours

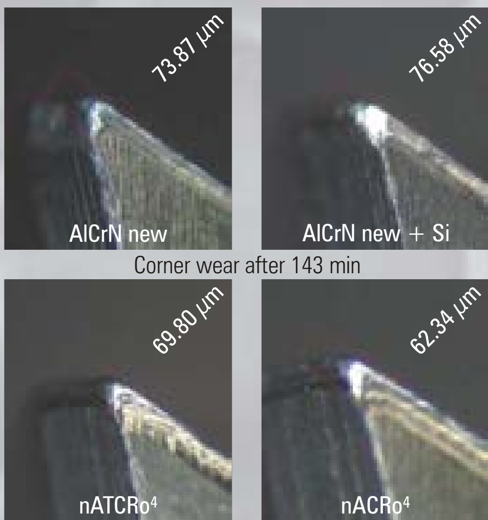


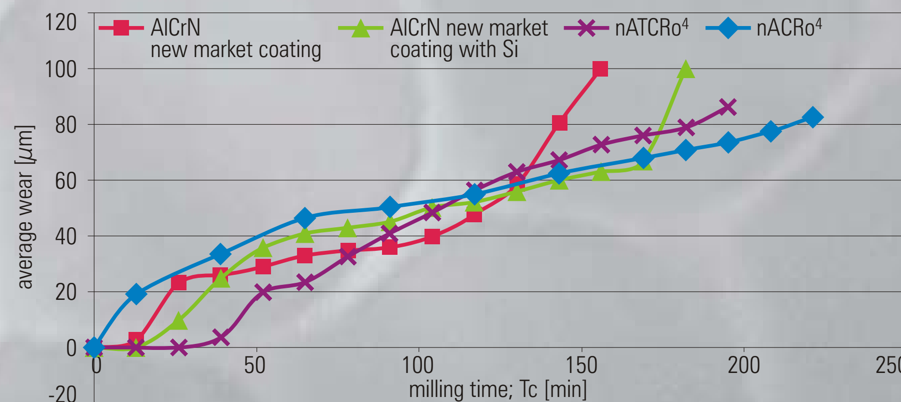
3 hours

Applications of QUAD Coatings⁴®

Milling

Wear Comparison at Semi-Dry Cutting with Solid Carbide End Mills

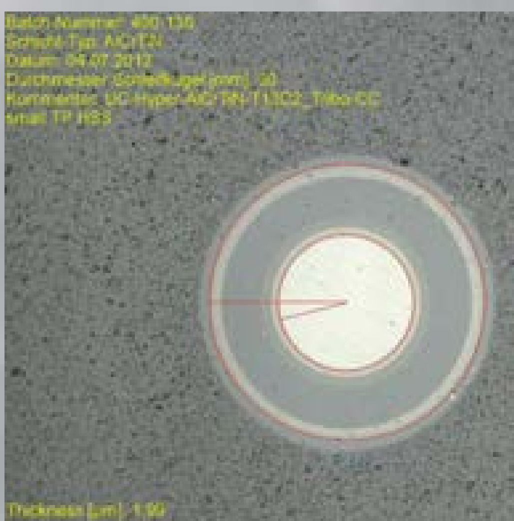


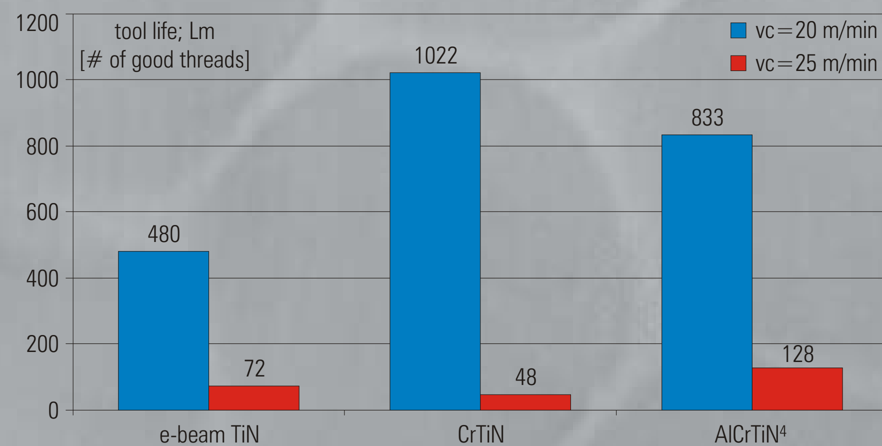


Mat.: Tool steel - X33XrS16 - 1.2085 - Rm=1000 N/mm2
ap=5mm - ae=3.5 mm - Tool: Fraisa NX-V - d=8mm - z=4
Average wear measured on all teeth: [max margin wear + VBmax + front wear + corner) / 4
Vc= 110 m/min – n=4365 1/min – fz= 0.06 mm/z - f=0.24 mm/rev - MQL

Thread Forming

Tool Life Comparison at Semi-Dry Fluteless Tapping

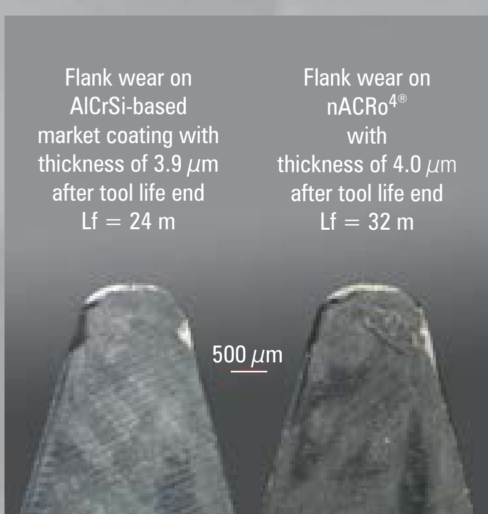


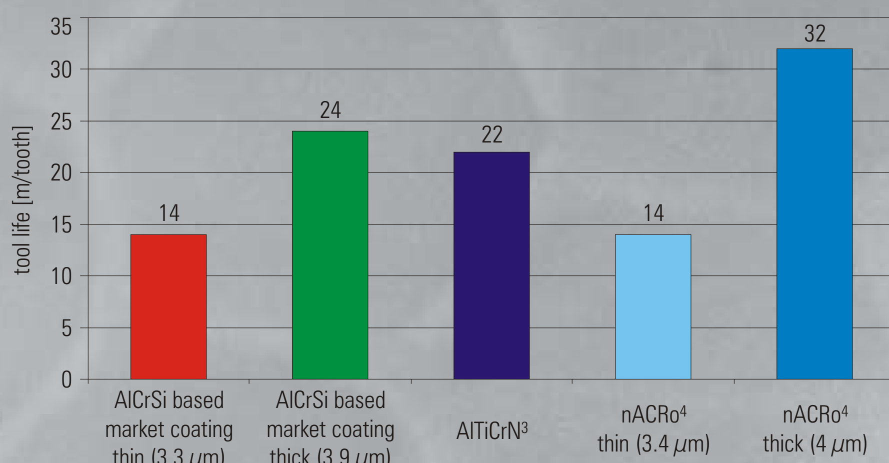


Work piece material: 40CrMnMo7 - Rm= 945 N/mm2
Tool: M8-6HX-InnoForm1-Z - HSSE 23/1 – Ø7.4 – ap=1.5xd - MQL

Hobbing

Tool Life Comparison at Dry Hobbing



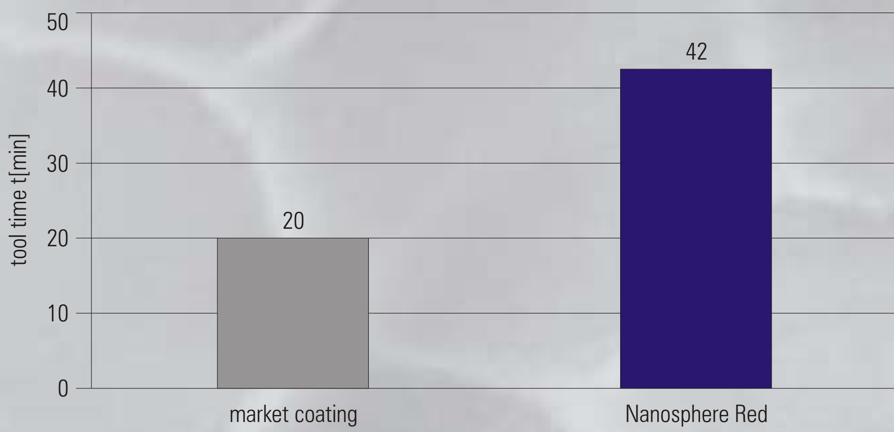


Mat. : 20 MnCrB5 - m=2.7
Tool: 2-teeth - PM-HSS - vc=220 m/min - fa=3.6/work piece revolution
Measured at the University of Magdeburg, Germany

Applications of TripleCoatings³®
Developed by/with PLATIT's User

Hard Milling of Molds and Dies

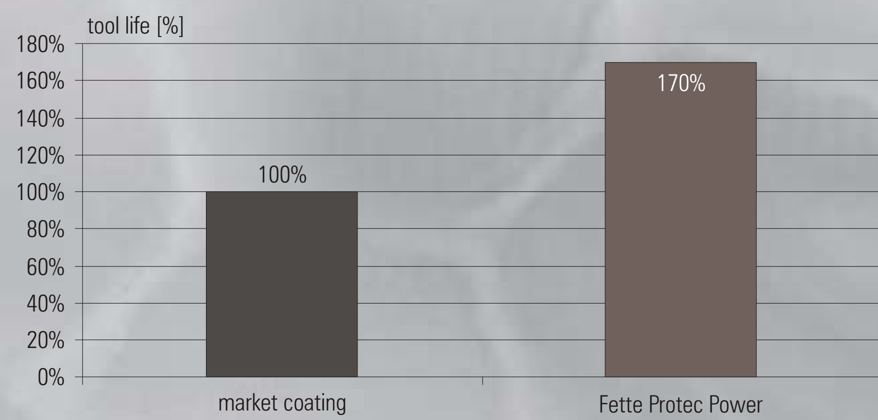
Tool Life Comparison



Work piece material: 1.2379 (HRC 57-58) - Tools 1431C MultiEdge 4Feed HSC - d=10mm - z=4
vc=120 m/min n=3800 1/min - fz=0.29 mm - vf=4400 mm/min - ae=3 mm - ap=0.25 mm
Developed by LMT Fette, Schwarzenbek, Germany

Thread forming

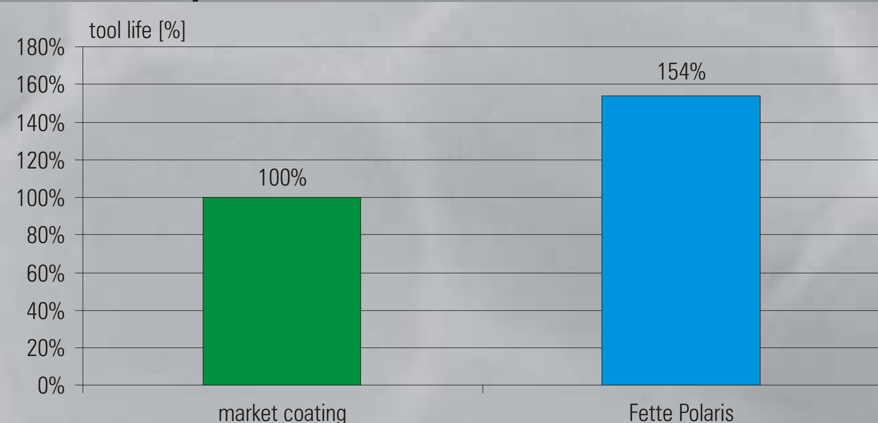
Tool Life Comparison



Work piece materials: Materials with high strengh
Developed with LMT Fette, Schwarzenbek, Germany
Source: Werkzeugtechnik: 117 – Nov/2010 – p.71

Tapping

Tool Life Comparison

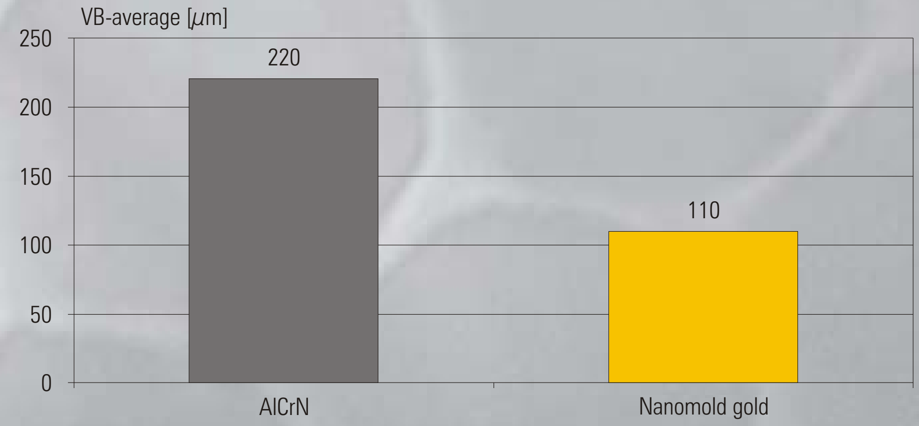


Work piece materials: cast iron and non steel materials
Developed by LMT Fette, Schwarzenbek, Germany
Source: Werkzeugtechnik: 117 – Nov/2010 – p.71

Applications

Mold and Die Milling

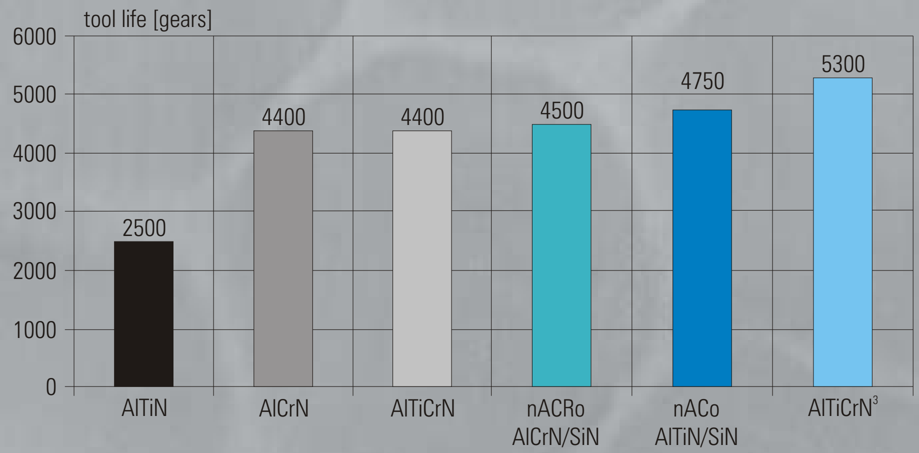
Wear Comparison after 1.0 h of Roughing



Work piece material: cold working steel - Rm=1000 N/mm^2 - Insert: WPR 16 AR - vc=240 m/min
n=4775 1/min - fz=0.4 mm - vf=3820 mm/min - ap=1.5 mm - ae= 1.0 mm
Developed with LMT Kieninger, Lahr, Germany

Hobbing

Tool Life Comparison



Material: 100Cr6 800-900 N/mm2 - Tools: HSS-PM4 - Modul=2.5 - vc=150 m/min
Developed by Liss, Rosnov, Czech Republic

Injection Molding

Wear Comparison

Molds for aluminum alloys for automotive industry after the fabrication of 15 000 parts

Plasma nitrided tool

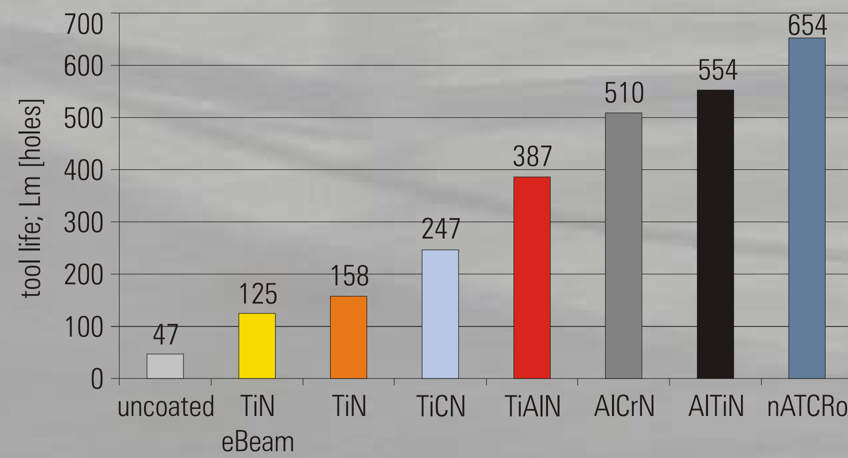
Coated tool by ALLWIN, Cr-Al-Si based coating
Thickness: 2 to 3 μm

The lengths of the tools 180-200 mm - Diameters of tools: 15-25 mm
Developed by SHM, Sumperk, Czech Republic

Applications
Standard Tests

Drilling

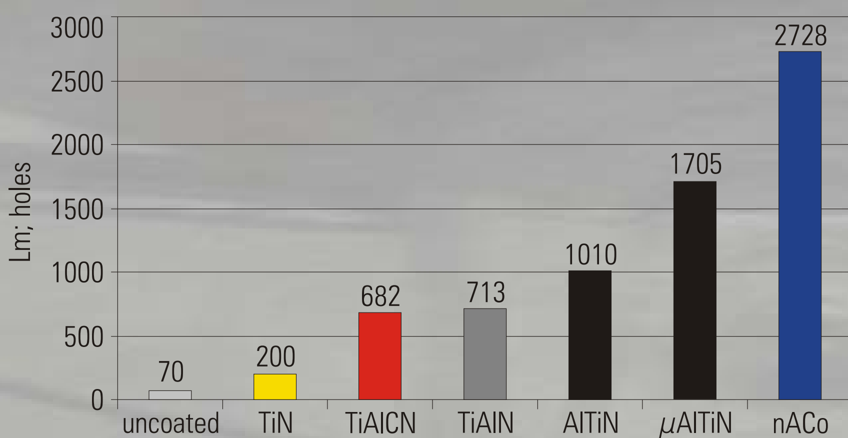
Tool Life Comparison of HSS Drills



Mat.: Tool steel - X155CrVMo12-1 - 1.2379 - HB290 - ap=18mm - blind holes
Tools: HSS-drills - Type N - DIN 338 - d=6mm - vc=22 m/min - f=0.1 mm/rev - emulsion 7%

Drilling

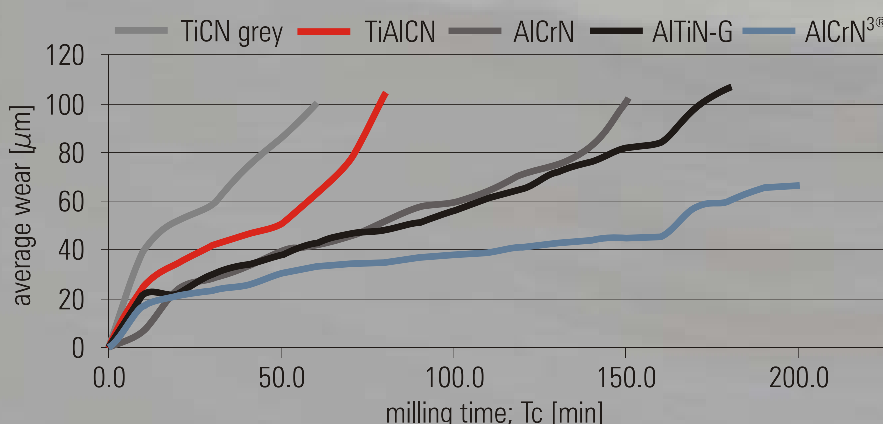
Tool Life Comparison of Solid Carbide Drills



Mat.: Tool steel - X155CrVMo12-1 - 1.2379 - HB290 - Tools: Solid carbide drills - KF40UF
d=5mm - ap=15 mm - vc=70 m/min - 4750 RPM - f=0.16 mm/rev - emulsion 7%

Milling

Wear Comparison of Solid Carbide End Mills



Mat.: Tool steel - X33XrS16 - 1.2085 - HB300 - ap=ae=4 mm - Tool: Fraisa NX-V - d=8mm - z=4
Average wear: (max. margin wear + VBmax + front wear + corner wear)/4
vc=120m/min - n=4775/min - fz=0.05 mm/teeth - vf=1146 mm/min - MQL=Minimum Quantity Lubrication

Coating Guide

Coating Usage Recommendations

	Cutting						Chipless Forming		
	Drilling	Turning	Milling	Tapping	Sawing	Reaming Broaching	Injection Molding	Stamping Punching	Forming
Steels	nACo µAlTiN	nACo AlTiN	nACRo AlTiN	nACVIc GRADVIC	TiAlCN STiN	nACo µAlTiN	nACVIc CrN	nACVIc GRADVIC	nACVIc TiCN-MP
Hardened steels	nACo	nACo	nACo	nACo	nACo	nACo		nACo	
Cast Iron	nACo µAlTiN	nACo AlTiN	nACo AlTiN	nACo TiAlCN	TiAlCN STiN	nACo µAlTiN			
Aluminium (> 12% Si)	nACo TiCN	nACo TiCN	nACo TiCN-MP	nACVIc TiCN-MP	TiCN-MP STiN	µAlTiN TiCN-MP	STiN CrN	nACo TiCN	nACVIc GRADVIC
Aluminium (< 12% Si)	cVIc ZrN	cVIc ZrN	cVIc ZrN	CROMVIC TiCN-MP	TiCN-MP STiN	cVIc TiCN-MP	cVIc CROMVIC	cVIc CROMVIC	cVIc GRADVIC
Super alloys	nACRo GRADVIC	nACo GRADVIC	nACRo GRADVIC	nACRo GRADVIC	nACRo TiAlCN	nACo GRADVIC	nACVIc GRADVIC	nACVIc GRADVIC	nACVIc GRADVIC
Copper	CrN	CrN	CrN	CrN	CrN	CrN	CrN	CrN	CrN
Bronze, Brass Plastics	TiCN-MP TiCN	TiCN-MP TiCN	TiCN-MP TiCN	TiCN-MP TiCN	TiCN-MP TiCN	TiCN-MP TiCN	STiN CrN	TiCN-MP TiCN	TiCN-MP TiCN

Primary Recommendation: If available, use this coating for the application. — coating A

coating B — Alternate Recommendation: Use this coating when the primary recommendation is not available.

Application Recommendations for TripleCoatings3®

		Cutting									Chipless
		Drilling		Turning	Milling		Hobbing	Tapping	Reaming		Forming
		HSS	HM		HSS	HM			HSS	HM	
Steels	wet	nACRo^{3}	nACo^{3}	nACo^{3}	AlTiCrN^{3}	AlTiCrN^{3}	AlTiCrN^{3}	nACVIc^{2}	nACRo^{3}	nACo^{3}	AlTiCrN^{3}
	dry/MQL	nACRo^{3}	nACo^{3}	nACoX^{3}	AlCrN^{3}	AlCrN^{3}	AlCrN^{3}	nACVIc^{2}	nACRo^{3}	nACo^{3}	AlTiCrN^{3}
Hardened steels	wet		nACo^{3}	nACo^{3}		AlTiCrN^{3}	AlTiCrN^{3}	nACRo^{3}		nACo^{3}	
	dry/MQL		nACo^{3}	nACoX^{3}		TiXCo^{3}	AlCrN^{3}	nACRo^{3}		TiXCo^{3}	
Cast iron	wet	nACRo^{3}	nACRo^{3}	nACo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	
	dry/MQL	nACRo^{3}	nACRo^{3}	nACoX^{3}	nACRo^{3}	nACo^{3}	nACo^{3}	nACo^{3}	nACRo^{3}	nACo^{3}	
Aluminium (>12% Si)	wet	nACRo^{3}	nACRo^{3}	nACo^{3}	AlTiCrN^{3}	AlTiCrN^{3}	nACRo^{3}	nACVIc^{2}	nACRo^{3}	nACo^{3}	nACVIc^{2}
	dry/MQL	nACRo^{3}	nACRo^{3}	nACVIc^{2}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACVIc^{2}	nACRo^{3}	nACo^{3}	nACVIc^{2}
Super alloys	wet	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACo^{3}	AlTiCrN^{3}
	dry/MQL	nACRo^{3}	nACRo^{3}	nACoX^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACRo^{3}	nACo^{3}	AlTiCrN^{3}

The TripleCoatings3® can replace the classic Nanocomposite coatings. Due to the tougher core layer, they can be used even more universally.

Coating Properties

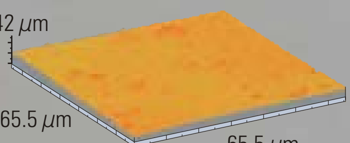
PLATIT's Standard Coatings 2012

Group	No.	Coating	LT	PL70	π80+	π111	π311	π411	PL 1001	Color	Nanohardness up to [GPa]	Thickness [µm]	Friction (fretting) coefficient	Max. usage temperature [°C]	Symbol color
Conventional Coatings	1	TiN	*	√	√	√	√	√	√	gold	24	1 - 7	0.55	600	
	2	TiCN-grey	*	√	√	√	√	√	√	blue-grey	37	1 - 4	0.20	400	
	3	cVIc®	*	√	√	√	√	√	√	grey	37 - 20	1 - 5	0.15	400	
	4	TiAlN-ML			√	√	√	√	√	violet-black	28	1 - 4	0.60	700	
	5	AlTiN-G		√	√	√	√	√	√	black	34	1 - 4	0.70	900	
	6	CrN	*	√	√	√	√	√	√	metal-silver	18	1 - 7	0.30	700	
	7	CROMVIc^{2}®	*		√	√	√	√	√	grey	25	1 - 10	0.10	450	
	8	CrTiN-ML	*		√	√	√	√	√	metal-silver/ gold	30	1 - 7	0.40	600	
	9	CROMTIVIc^{2}®	*		√	√	√	√	√	grey	25	1 - 10	0.10	450	
	10	ZrN	*	√	√	√	√	√	√	white-gold	20	1 - 4	0.40	550	
	11	AlTiCrN					√	√	√	blue-grey	34	1 - 4	0.55	850	
Nano-composites	12	nACo®-G			√	√	√	√		violet-blue	45	1 - 4	0.45	1200	
	13	Fi-VIc®			√	√	√	√		grey	45 - 20	1 - 6	0.15	400	
	14	nACRo®			√	√	√	√		blue-grey	40	1 - 7	0.35	1100	
	15	nACVIc®			√	√	√	√		grey	40 - 20	1 - 10	0.15	400	
TripleCoatings3®	16	nACo^{3}®					√	√		violet-blue	34 / 45	1 - 7	0.45	1200 / 900	
	17	nACRo^{3}					√	√		blue-grey	34 / 40	1 - 7	0.35	1100 / 900	
	18	TiXCo^{3}®					√	√		copper	40 / 47	1 - 5	0.55	1200	
	19	nACoX^{3}®					√	√		black	40 / 30	4 - 18	0.40	1200	
	20	AlCrN^{3}®			√	√	√	√		black	32 / 35	1 - 7	0.40	900	
	21	AlTiCrN^{3}®				√	√	√	√	blue-grey	32 / 34	1 - 7	0.50	900	

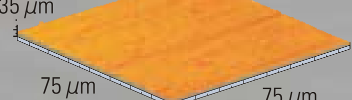
***LT:** Low temperature processes possible.

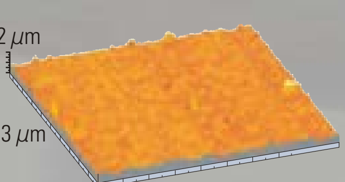
Typical Coating Surfaces (measured by AFM, at 2µm coating thickness)

LARC®
S_a = 0.09-0.25 µm

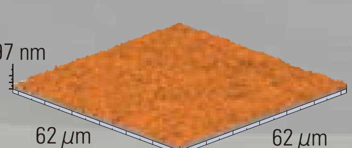


s-LARC®
S_a = 0.03-0.08 µm
requires π coating unit with special software





ARC
S_a = 0.15-0.45 µm



µ-LARC®
S_a = 0.003-0.008 µm
requires µ-π coating unit or post-polishing

Main Application Fields of PLATIT's Standard Coatings

			Cutting	Forming	Machine Component
1	TiN	*	universal use	molds and dies	universal use, also for decorative purposes
2	TiCN-grey	*	tapping, milling for HSS and HM with coolant	molds and dies, punching	
3	cVIc®	*	aluminium machining to avoid built-up edges	molds and dies, punches for lower friction	
4	TiAlN-ML		drilling and universal use, also for weak machines		
5	AlTiN-G		milling, hobbing, high performance machining, also dry		
6	CrN	*	cutting wood, light metals like copper, and Al alloys with low Si	molds and dies	
7	CROMVIc^{2}®	*	cutting wood, light metals like copper/ Al alloys with low Si, also for MQL	universal use for forming with lower friction	car parts, blisks, sawing parts, copper parts
8	CrTiN-ML	*	cutting and forming high alloyed materials with HSS tools	molds and dies with higher hardness, extrusion	tool holders, corrosion prot., medical tools
9	CROMTIVIc^{2}®	*	cutting high alloyed materials with HSS tools also with MQL	molds and dies with lower friction	car parts, blisks, sewing parts
10	ZrN	*	machining aluminium magnesium, titanium alloys		for decorative purposes
11	AlTiCrN		enhanced wet hobbing and milling		
12	nACo®-G		hard machining on stable machine, drilling, reaming, grooving		
13	Fi-VIc®				car parts with high load
14	nACRo®		tough wet cutting of difficult materials (superalloys), micro tools	friction welding, extrusion, die casting	
15	nACVIc®		cutting of high alloyed materials and titanium	molds and dies, punching	
16	nACo^{3}®		hard machining, drilling, dry turning, reaming	stamping, punching	
17	nACRo^{3}		tough cutting of superalloys, fine punching	friction welding, extrusion, die casting	for components with high abrasive load
18	TiXCo^{3}®		for superhard cutting		
19	nACoX^{3}®		HSC dry turning and milling		for components with highly abrasive load
20	AlCrN^{3}®		dry milling, hobbing, sawing		
21	AlTiCrN^{3}®		universal; wet and dry cutting	molds and dies, stamping, deep drawing, bending, fine punching	

***LT:** Low temperature processes possible.

World Wide Service

WWS PLATIT®
World Wide Service

Installation, Training
Operator's training
Machine manuals on CD
Maintenance DVD

Technical Service
Warranty
Post warranty
Upgrades
Cathode exchange
Annual service

Technological Support
Technological training
Remote diagnostics
Dedicated coatings

Service Activities

Service Teams
Service request

24 h

Start of service
Remote diagnostics
Service visits

HOTLINE
service π-units
PLATIT®

World Wide Service

R&D Teams
Research and development
- New machines
- New coatings

Dedicated coatings
Service assistance

Teams

PLATIT®

Service for continuous support of users of over 340 coating systems in 36 countries

Training Programs

Training Certificate


Advanced Coating Systems
SWISS QUALITY

PI 300 Operator Basic Certificate

Subjects

- Basic vacuum technology
- Operation of the PI 300
- Maintenance of the PI 300
- Characterization of coatings

Installation Training

The installation trainings are carried out by our service team on location of our users.

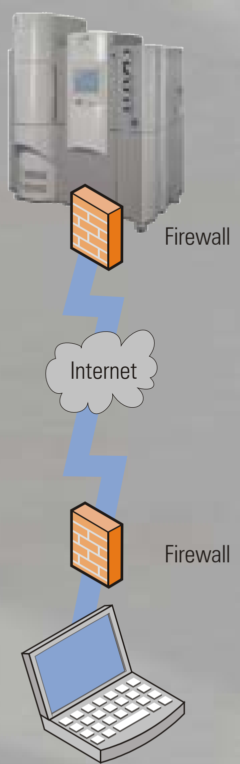
Training on Demand

Our project engineers give dedicated trainings on a wide range of subjects from the basics to special fields.

Advanced Training

The advanced trainings take place on location of the user, or in our headquarters by our project engineers or our R&D people, typically for the installation of dedicated coatings.

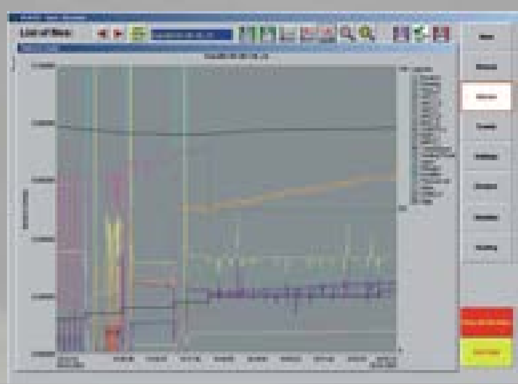
Internet Connection



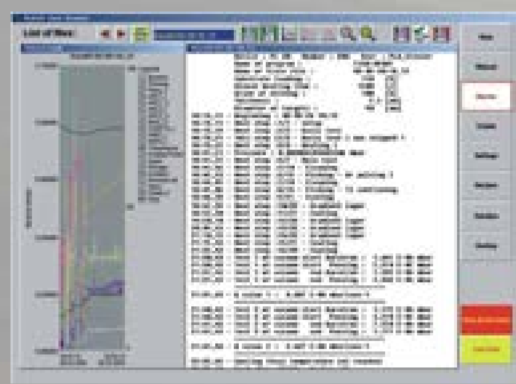
Features and Advantages

- Cost-effective support within minutes over the Internet
- Online help for analysis of new recipes
- Updates, new software releases and recipes are transmitted
- Firewall protection should be installed by user's IT
- Fast and secure online connection between PLATIT and customers worldwide
- Remote and on-site diagnostics of all components and processes with graphical trace files
- Static IP required when using PCAnywhere
- No static IP required using TeamViewer; Remote diagnostics only possible with user's assistance

Chart View

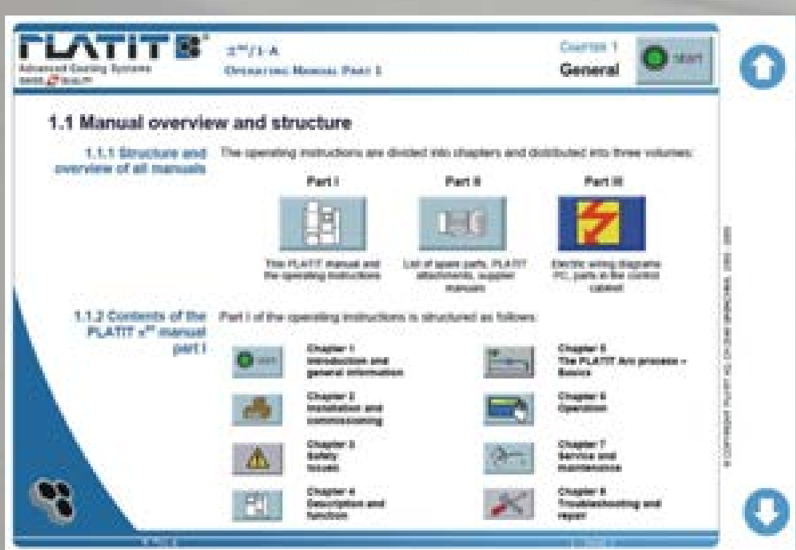


Report View



CD Manual

Example Page



Overview

A highly detailed, interactive manual on CD-ROM helps support machine operators. Contents include:

- operations, usage of purchased recipes
- maintenance and spare part management
- mechanical and electrical documentation

Maintenance

Multimedia Maintenance Manual on DVD

We provide a Multimedia Maintenance Manual on DVD with full interactive features.

The chapters explain in words (in several languages) and with video movies all the steps of the most important maintenance works. The DVD can be run on the controller PC of the π units or on external laptops

Annual Service

We strongly recommend the annual service on regular basis, regulated by a service contract.

Our service engineer will carry out the following actions:

- Disassembling of all vacuum parts from chamber
  - Cathodes, gauges, strikers, shields, valves, TMP (Turbo molecular pump), heaters, anodes, gas showers, rotary drive etc.
- Cleaning of the following parts:
  - Chamber, door, anodes, strikers, ceramics, gauges, shields, heaters, valves
  - TMP, rotary drive etc.
- Exchanging of the following parts:
  - TMP lubricant ampoule, rotary pump oil and filter, compressor oil, all VITON O-ring
  - Door O-ring, PC processor fan, ceramics tips, bearings in rotary drive
- Reassembling of all parts
- Vacuum testing
- Precise adjustment and checking of the following parts:
  - Pirani gauges, baratron gauge, mass flow controllers for gases, PC setting, backup for old files, door
- Running test batches with dummies
- Running batches with real tools

Estimated time for an annual service: 3 - 5 days (depending on cooperation of the user).

Cathode Exchange Centers

Customer with PLATIT equipment
π80, π111, π300 & π311

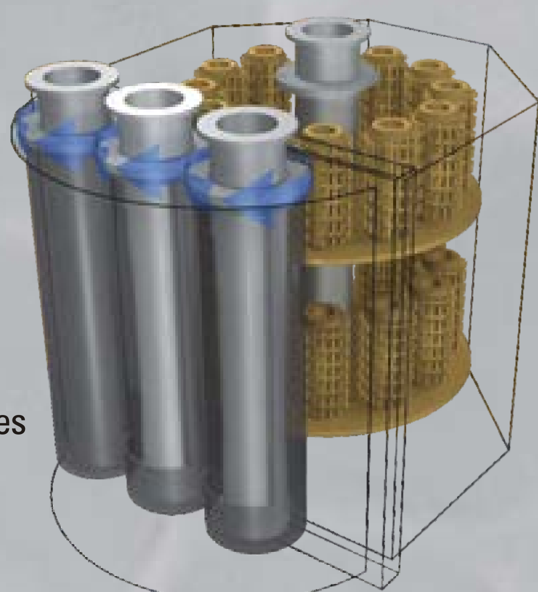
1. Customer requests for a refurbished cathode to CEC by email or fax

PLATIT's Cathode Exchange Centers (CEC):
- Sumperk, Czech Republic (EU)
- Libertyville, IL, USA
- Seoul, South Korea
- Curitiba, Brazil
- Shanghai, China
- Nagoya, Japan
- Moscow, Russia

2. CEC dispatches cathode within 24 hours from stock

3. Customer ships used cathode back to CEC within 8 days

CERC® Cathode

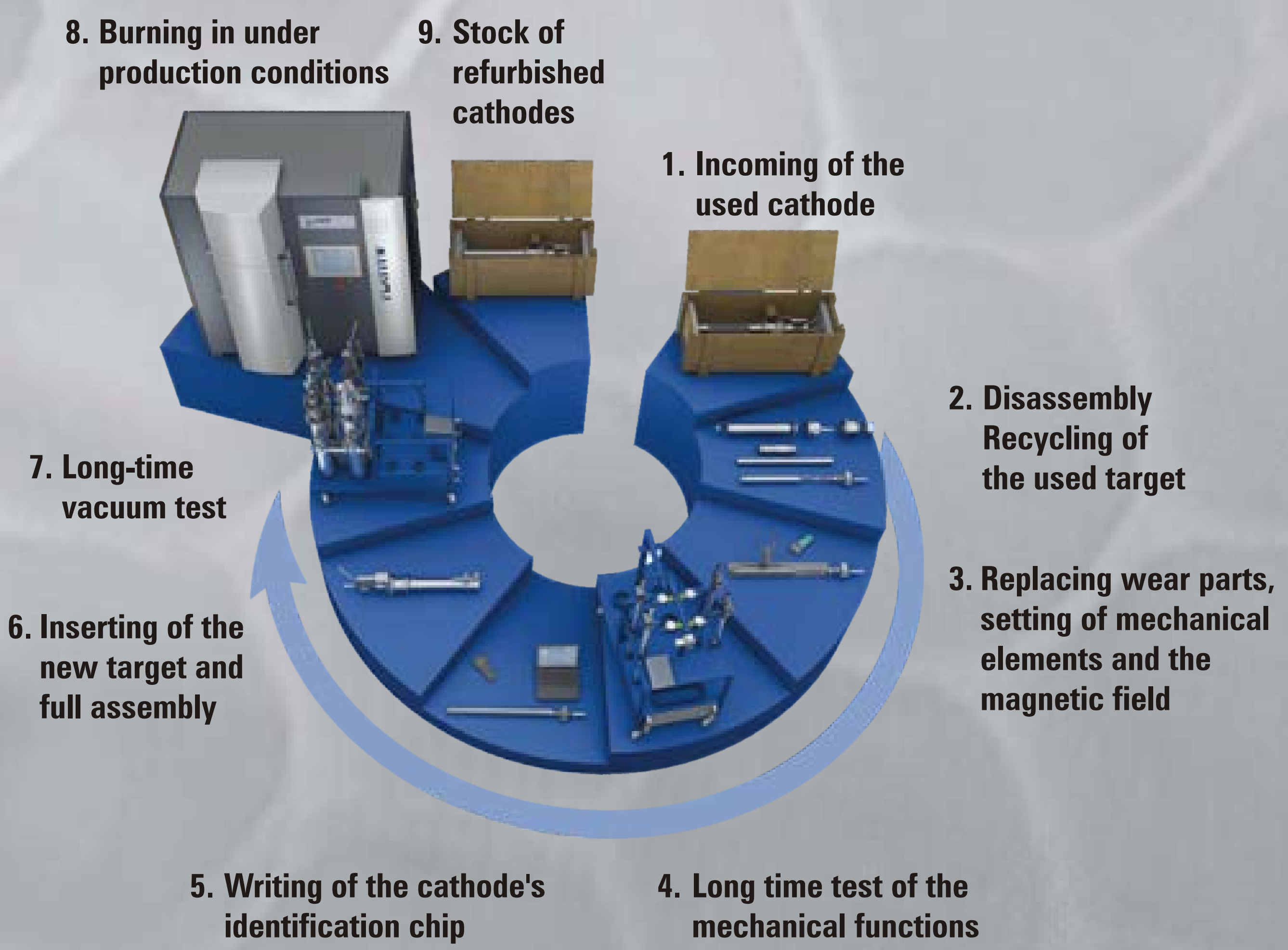


LARC® Cathodes

Stock of cathodes:
- Ti-LARC®
- Al-LARC®
- AlSi-LARC®
- AlSi+-LARC®
- Cr-LARC®
- Zr-LARC®
- AlTi-LARC®
- AlCr-LARC®
- AlCrOXI-LARC®
- TiSi-LARC®
- Al(Ti)-CERC®
- Al(Cr)-CERC®

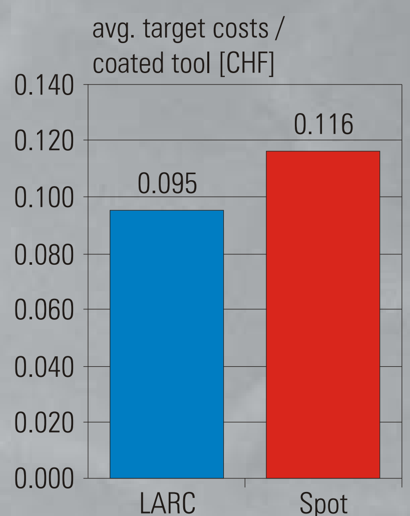
PLATIT®

Technical Process of Target Exchange in CEC



Advantages for the Users by PLATIT's Cathode Exchange Principle and Centers

- PLATIT's warranty for exchange quality
- No stocking costs for the users
- Cathodes are renewed by CEC at every change to state of the art
  - All wear parts are new after every change by CEC
  - Cathodes are long-time vacuum tested at CEC after every change
  - Optimum setting and burn in by CEC
  - User just quickly changes the cathodes
    - no setting, no weighing, no burn in by user
- Minimum transport costs and duties around the world
- Always high quality target material
- Environment friendly recycling of used target material by CEC
- Low target costs (see figure)
- The CEC system has been working at high satisfaction of users for many years



Calculated for the basis coatings: TiN, CrN, TiAlN, AlTiN, AlCrN,
Tools: Ø10mm end mills
LARC-cathodes, Ti, Al, Cr – Ø96 x 510 mm
Machine with spot targets: 6 cathodes, Ti, Cr, AlCr, TiAl, AlTi; Ø150 mm

PLATIT®

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Service for the units PL70, π80, π111, π300, and π311

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