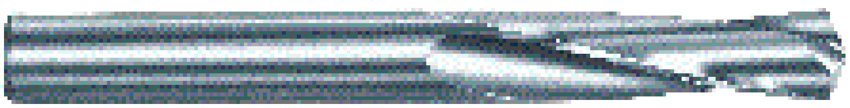
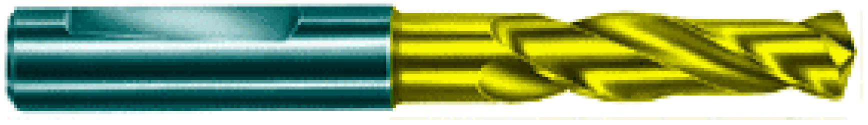
Different Coatings of Ratio Drills

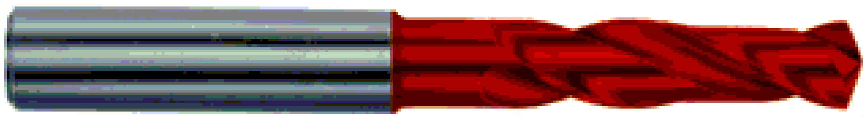
Bright finish



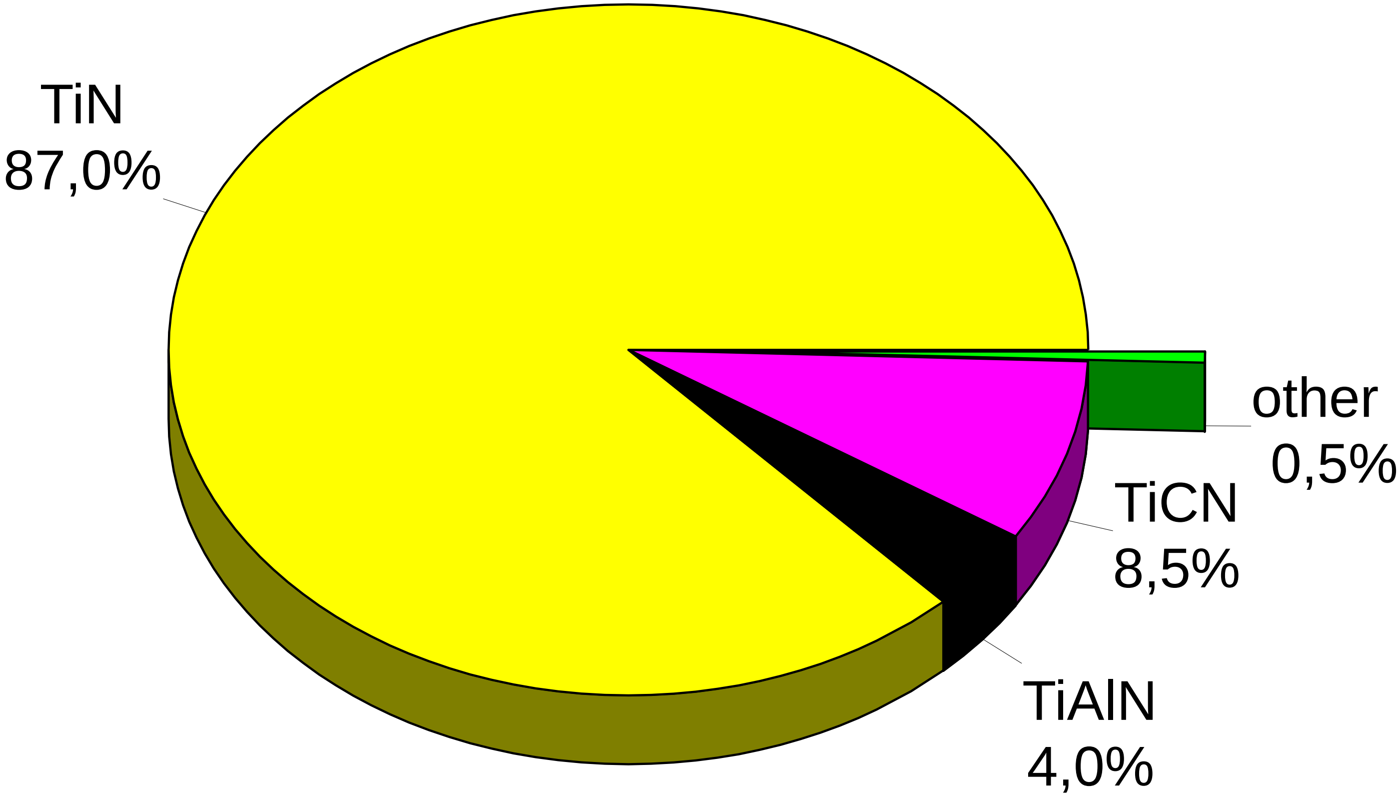
TiN-coated



Fire-coated

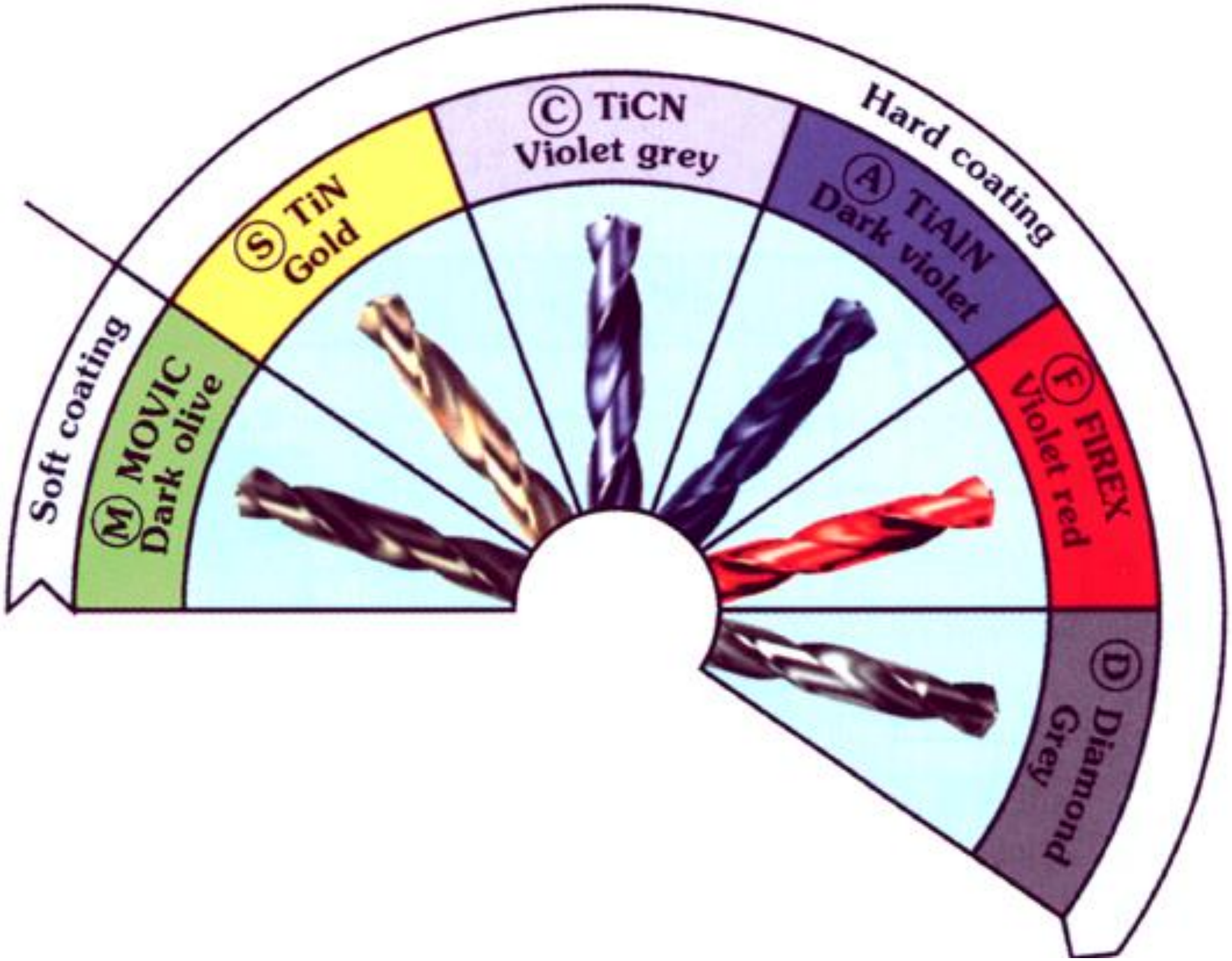


Coating Market Shares
at Rotating Tools



Source: Int. Tagung für Beschichtungen, ICMCFT, San Diego, Mai/1997

The 6 Gühring Surface Coatings



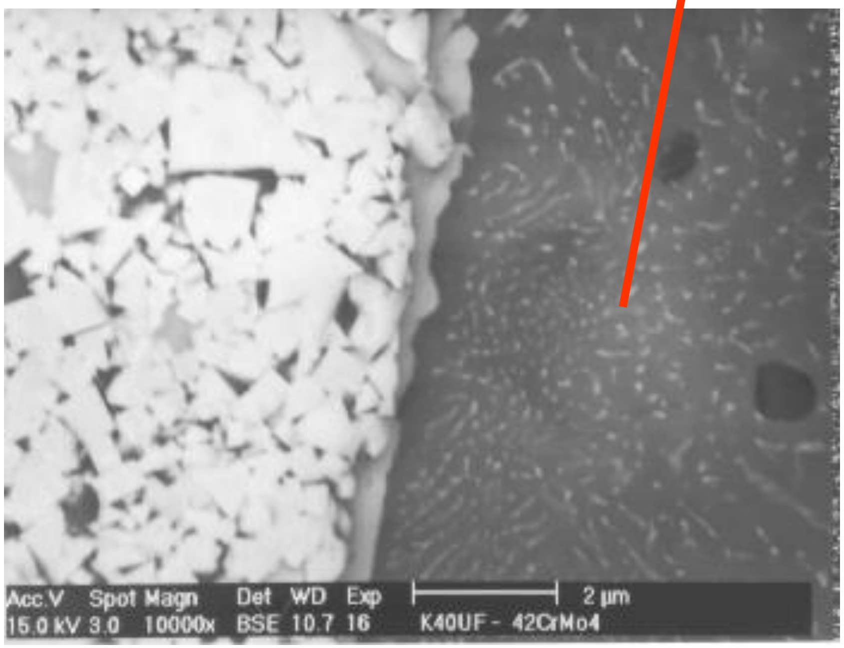
Why Coating for Tools

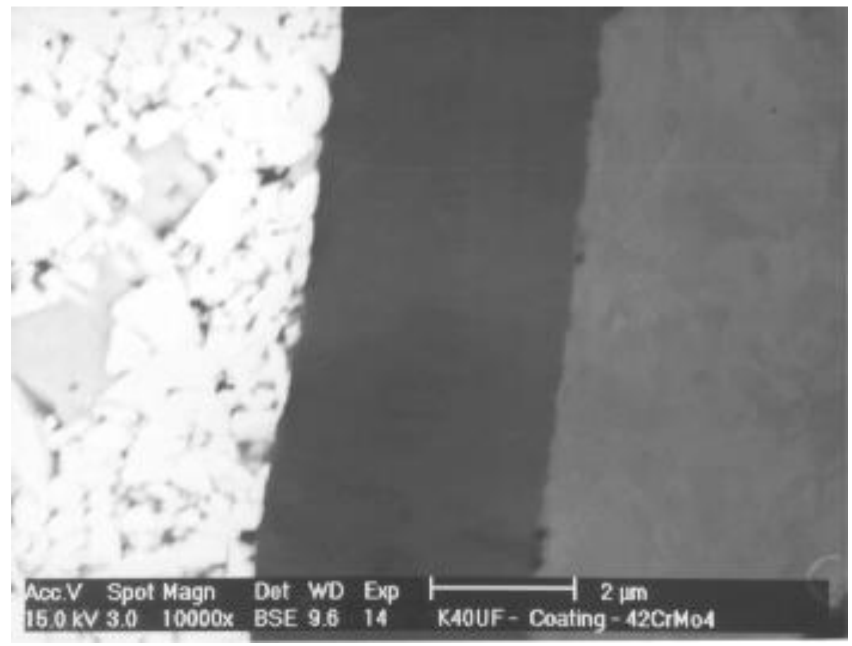
- Higher wear resistance
  - ➔ higher tool life, higher cutting parameters
- Lower friction between tool and chips
  - ➔ deeper drilling, lower cutting forces
- Fancy surface (golden)
  - ➔ easy wear measurement
- Heat and contact insulation
  - ➔ no chemical reaction,
  - ➔ less thermal stress on the tool,
  - ➔ preventing build ups and crater wear

Cobalt-Leching at Higher Temperature

Cobalt-leching
from carbide into steel

T: 700°





Carbide-K40UF
uncoated

Steel
42 CrMo 4

TiAlN-
Coating

Source:Eucotooling, Brite-Euram Project, KU Leven

How to make coatings?

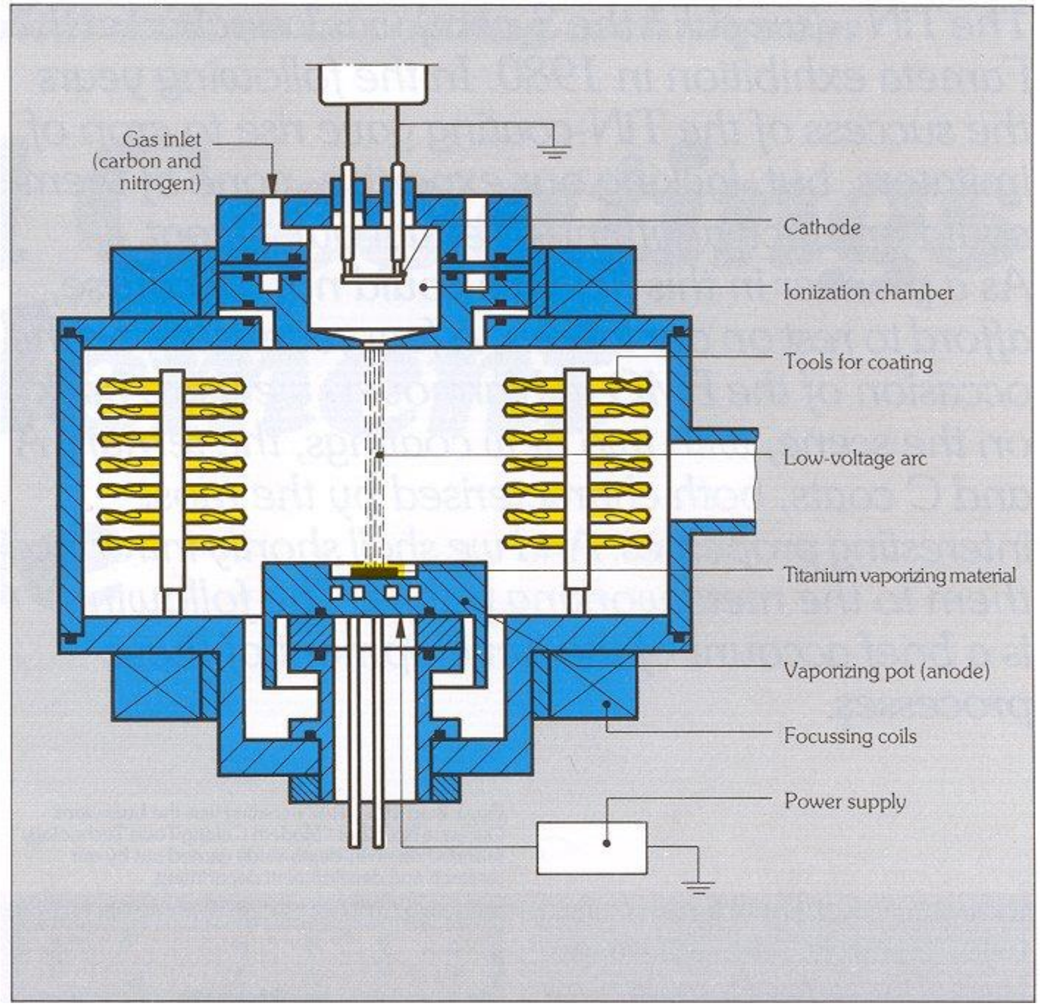
PVD (Physical Vapour Deposition)

- low temperature only 450°-500°C
- HSS and carbide can be coated
- no toughness reduction for carbide
- tools have to be rotated during the coating process

CVD (Chemical Vapour Deposition)

- higher temperature necessary 1100°C
- carbide can be coated only with toughness reduction
- the relatively thick coating is bad for sharp cutting lips

PVD Coating process



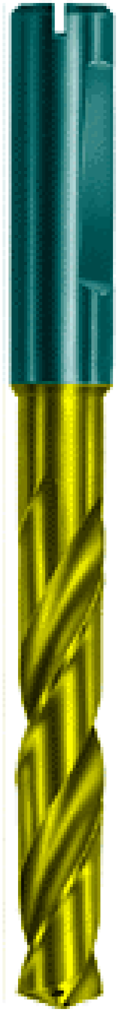
- metal (titanium) is vaporized in a vacuum chamber by an electron beam
- combined with a gas (nitrogen)
- product of reaction, titanium nitride (TiN)
- TiN deposited on tool in a thin, very even coating of about 1,5-3 µm.

PVD-Coating facility

PVD-Coating facility

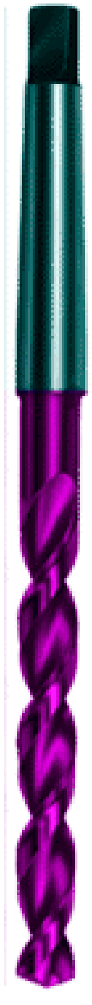
Titanium Nitride (TiN)

- Color: gold
- Well proven, Cost-effective all-round coat, monolayer
- Achieving performance increases of 400% on average.(Higher tool life, cutting speed and feed)
- Optimum bond to the substrate
- Thickness 1,5-3 µm
- 5 times recoatable without decoating

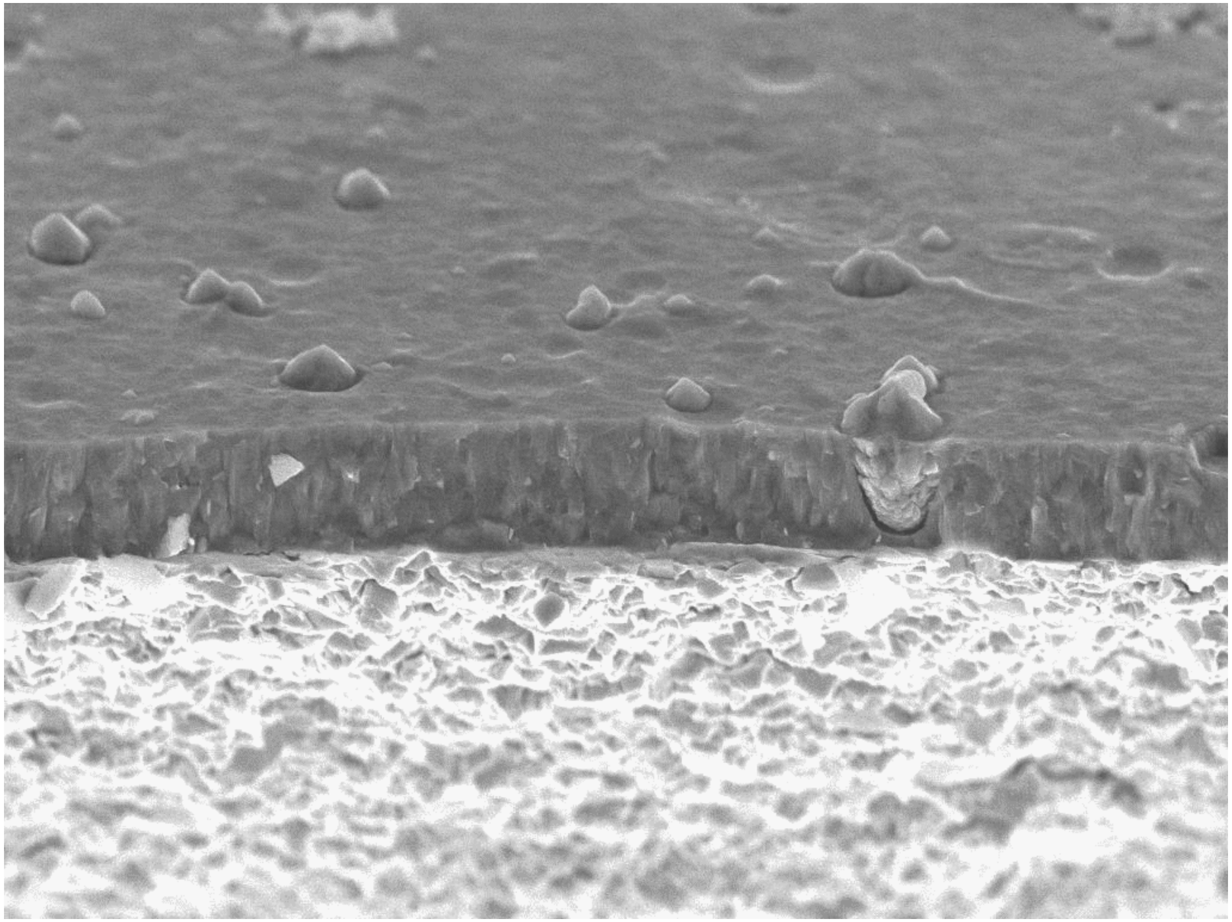


Titanium Aluminium Nitrid (TiAlN)

- Color: black -violet
- Forms a Al_2O_3-cover layer by oxidation
- Up to approx. 800°C applicable,
  with limited coolant facilities (Dry-Machining)
- For machining abrasive materials
  i.e. cast iron, AlSi
- Thickness 1,5-3 µm
- 5 times recoatable without decoating



Monolayer Coating Structure



3 µm

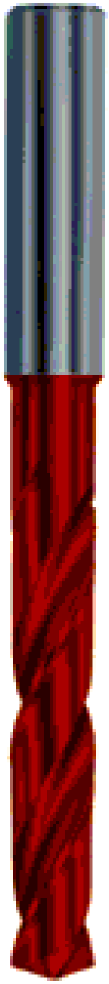
Titanium Carbon Nitrid (TiCN)

- Color: grey-violet
- Multilayercoating up to 7 layer
- Up to approx. 450°C applicable
- well suited for operations with interrupted cutting i.e. milling
- Especially for machining steel
- Thickness 4-7 µm
- Only recoatable after decoating

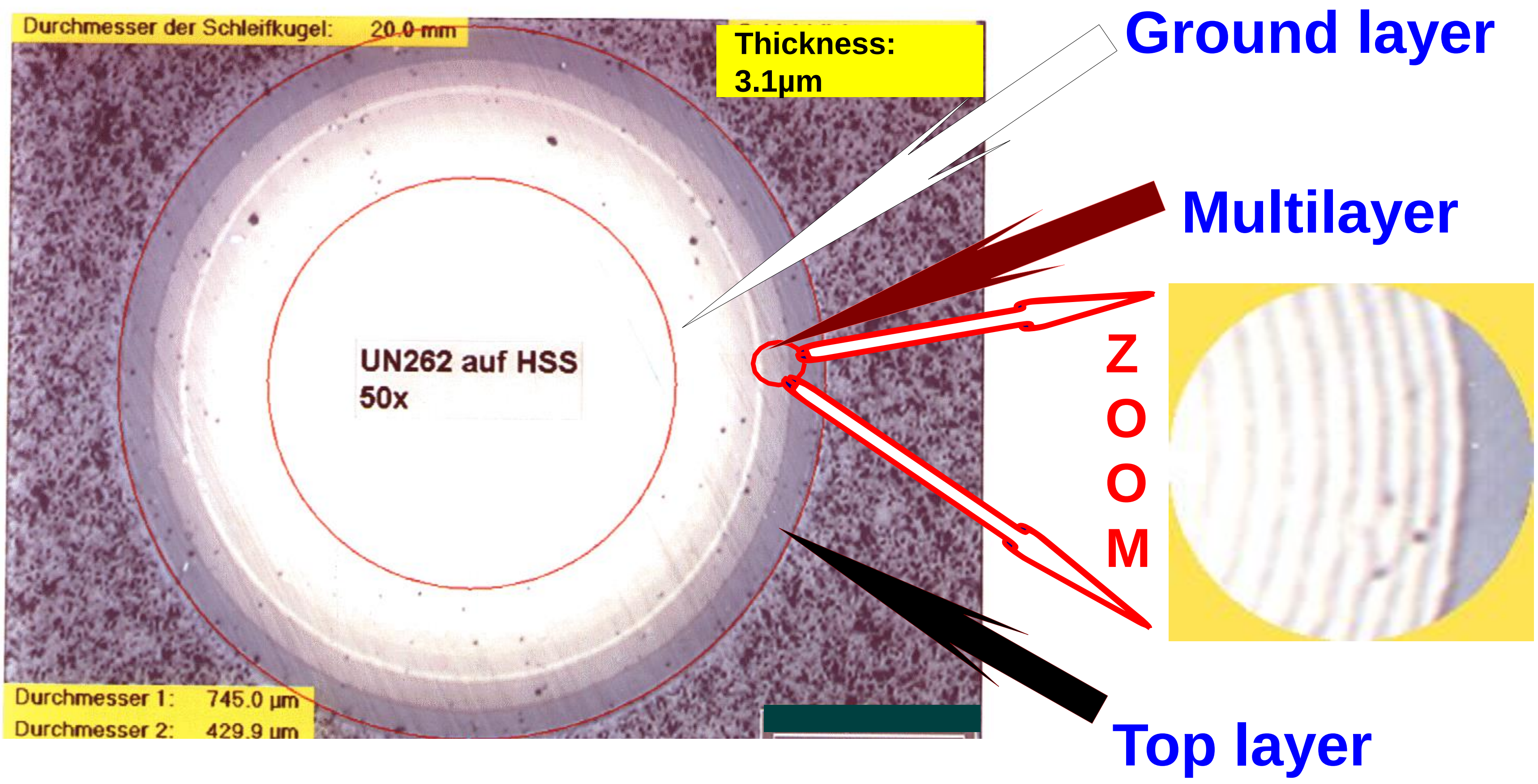
Fire-Coating

FIRE-Coating

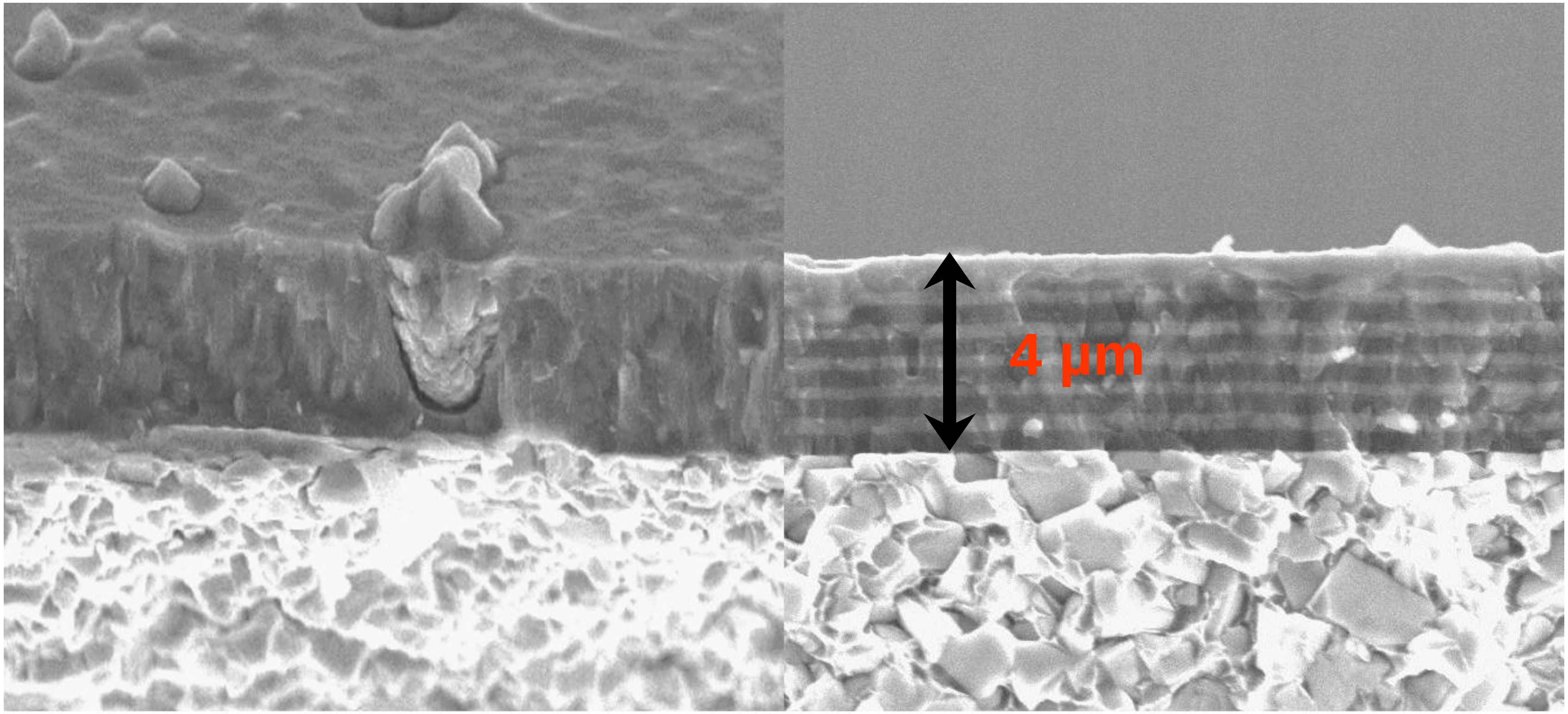
- Color: red-violet
- All-round-, Multilayercoat up to 7 layer
- Up to approx. 800°C applicable
- Very high hardness: 3600 HV $_{0,05}$
- High viscosity, therfore well suitable for operations with interupted cut.
- Thickness 3-4 µm
- Only recoatable after decoating



Gradient Structure of FIRE Coating

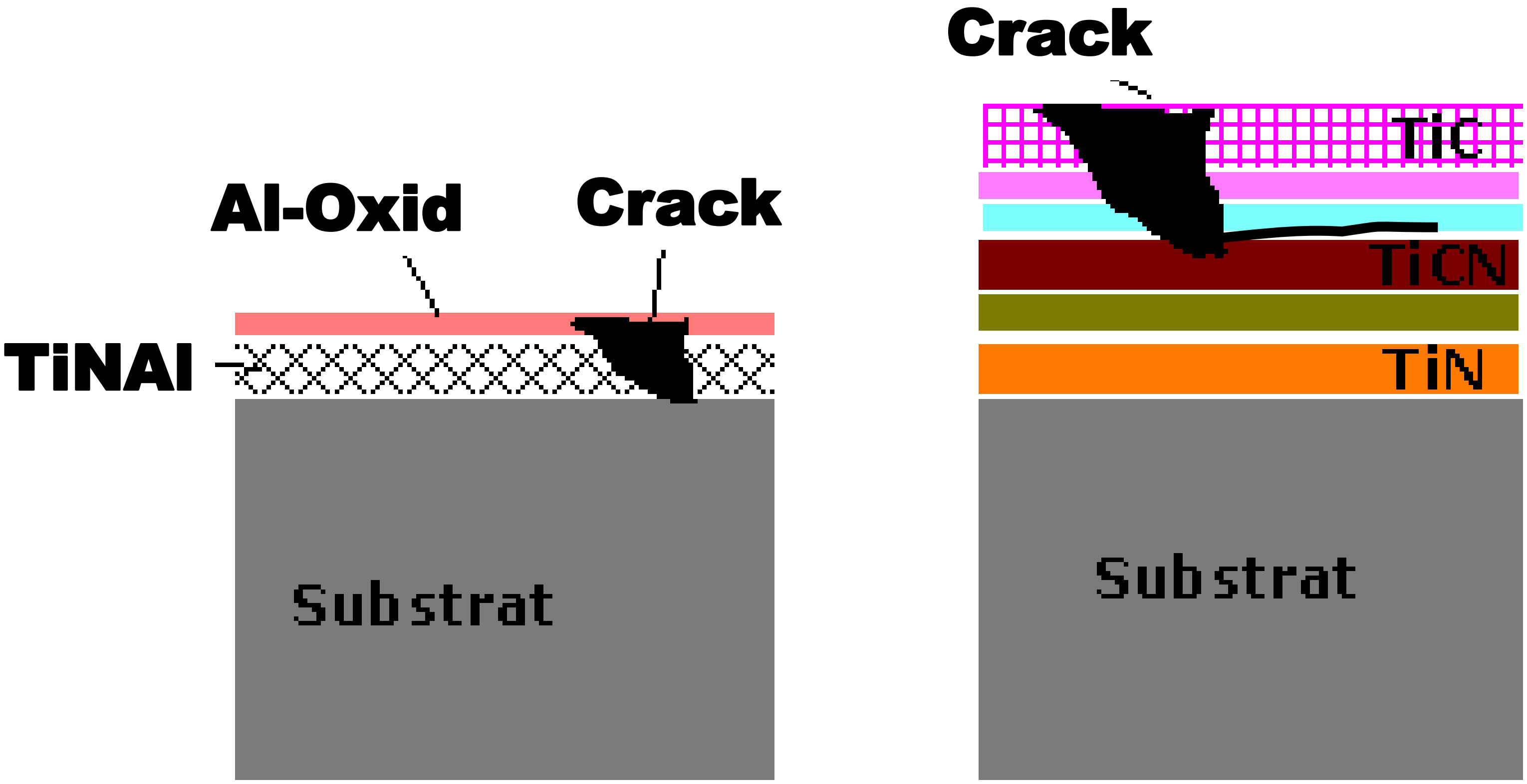


Comparison
Monolayer ⇔ Multilayer

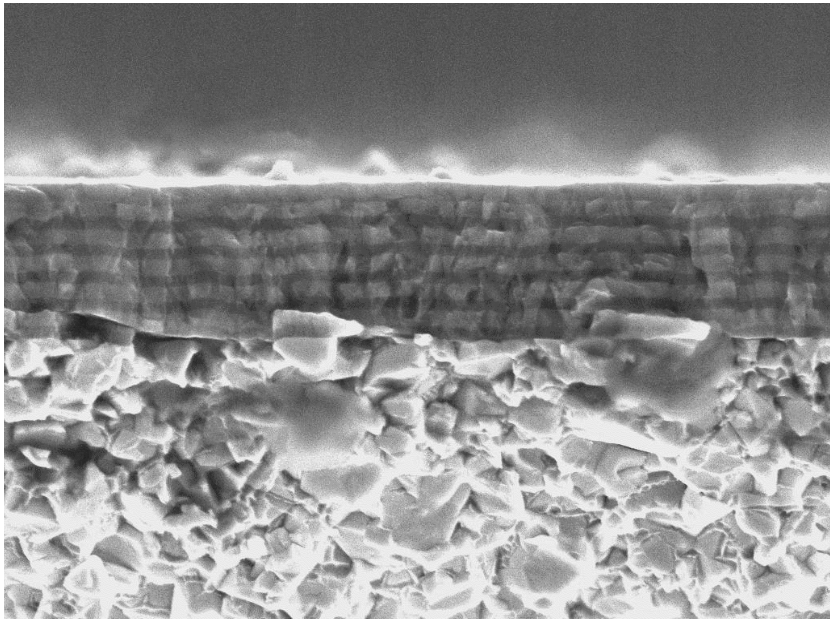


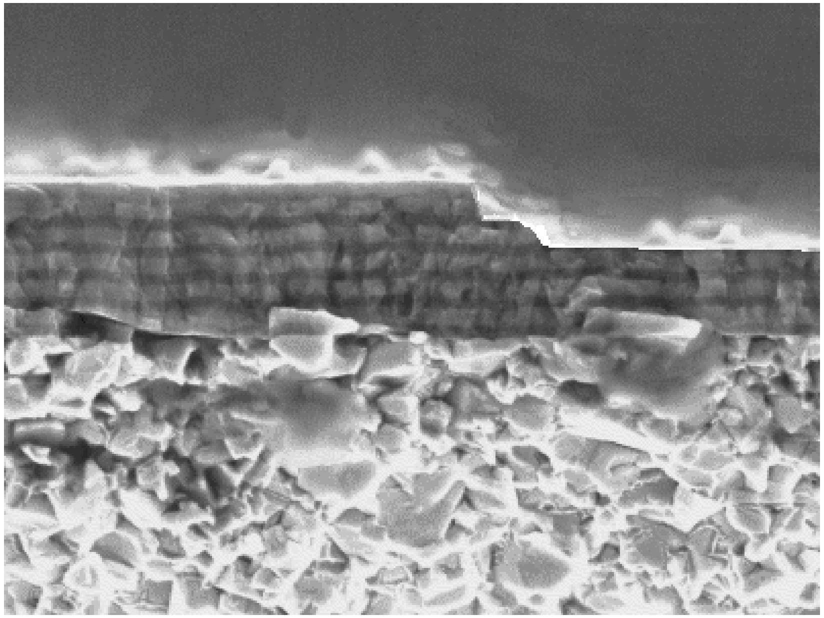
Source: Aptodry, Brite-Euram-Projekt, JRC, Ispra

Fissure propagation in a Monolayer- and Multilayer Coating



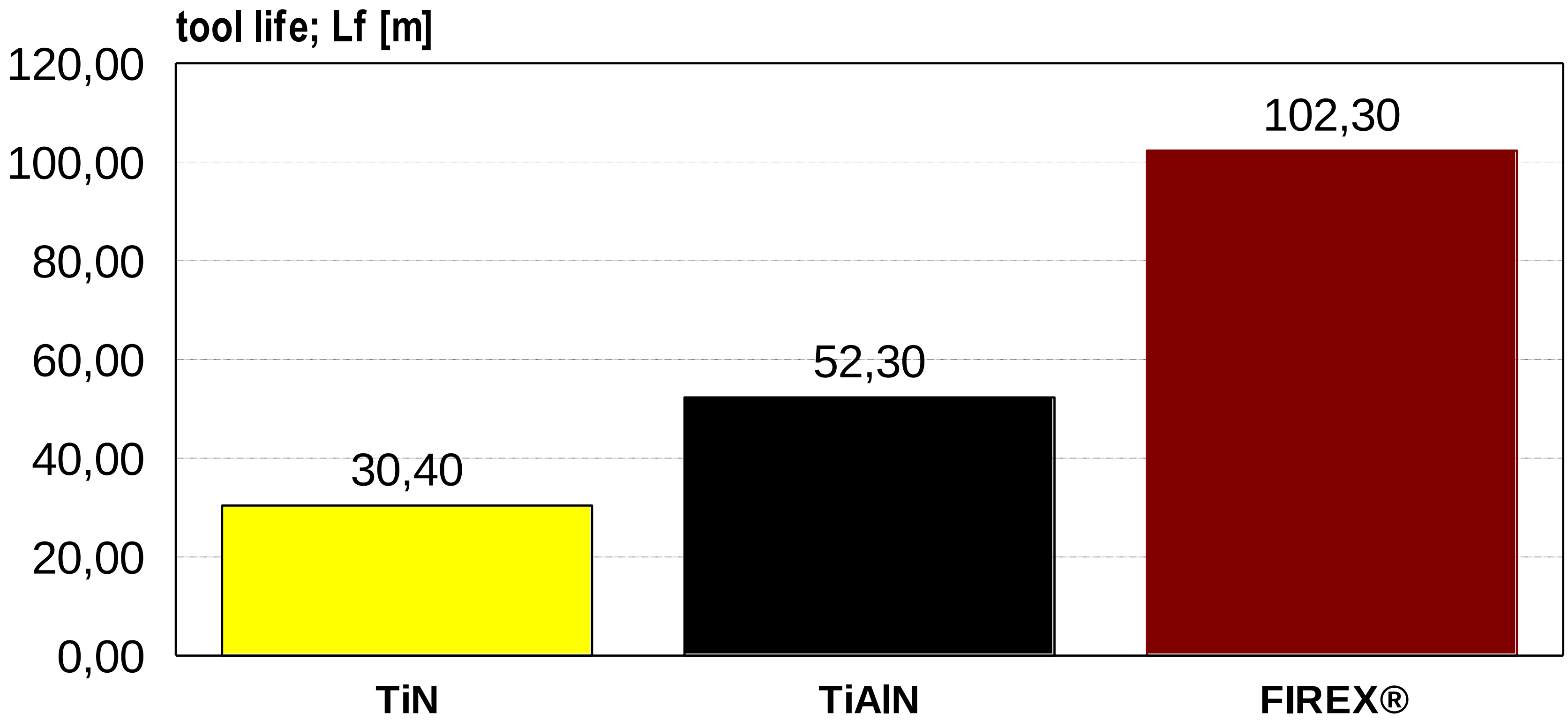
Crack Absorbtion at Multilayer-Coating





Cast Iron Motor Block to be Machined Dry

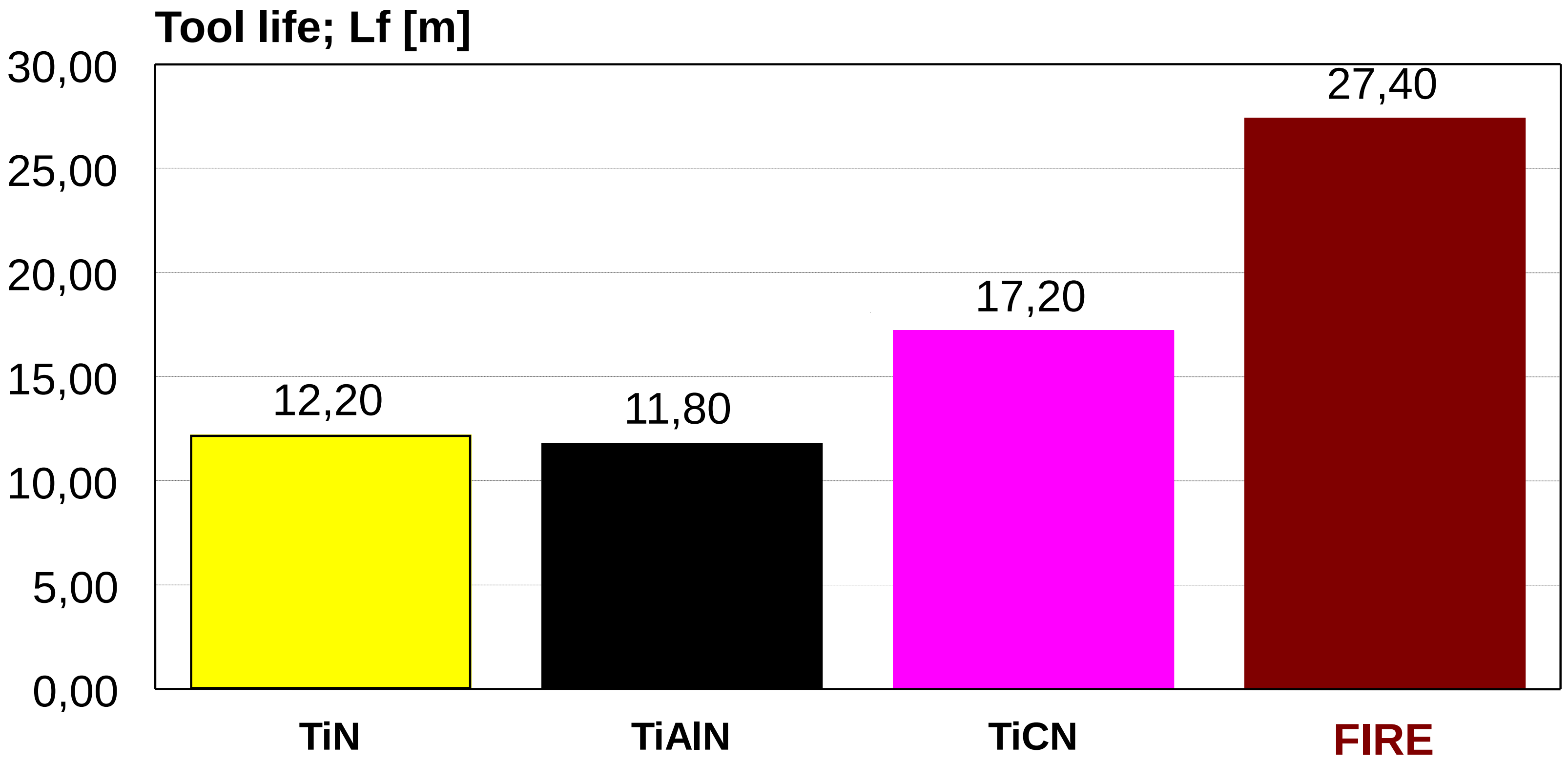
Tool Life Comparison when Drilling Dry in Cast Iron



Matt.: GG25 - d=11,8 mm - vc=110m/min - f=0,4mm/U - ap=3xD
blind holes - VB-max.=0,8mm

Tool Life Comparison for HSS Drills

with Different Coatings



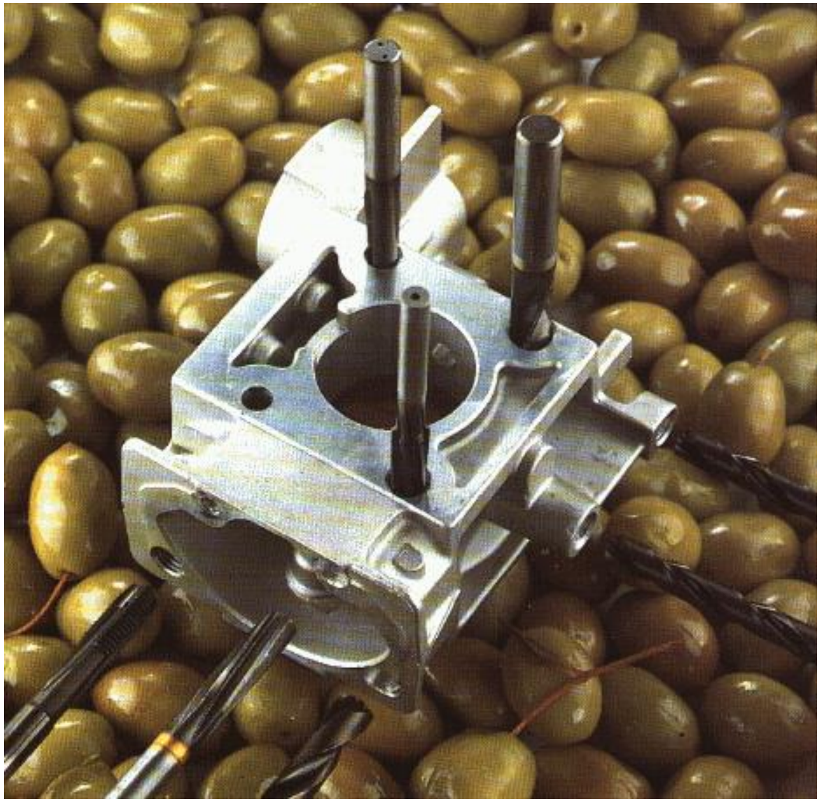
Mat.:42CrMo4V Rm=1000-1200 N/mm² - #205 - d=8 mm

vc=25m/min - f=0,14mm/rev - ap=30mm

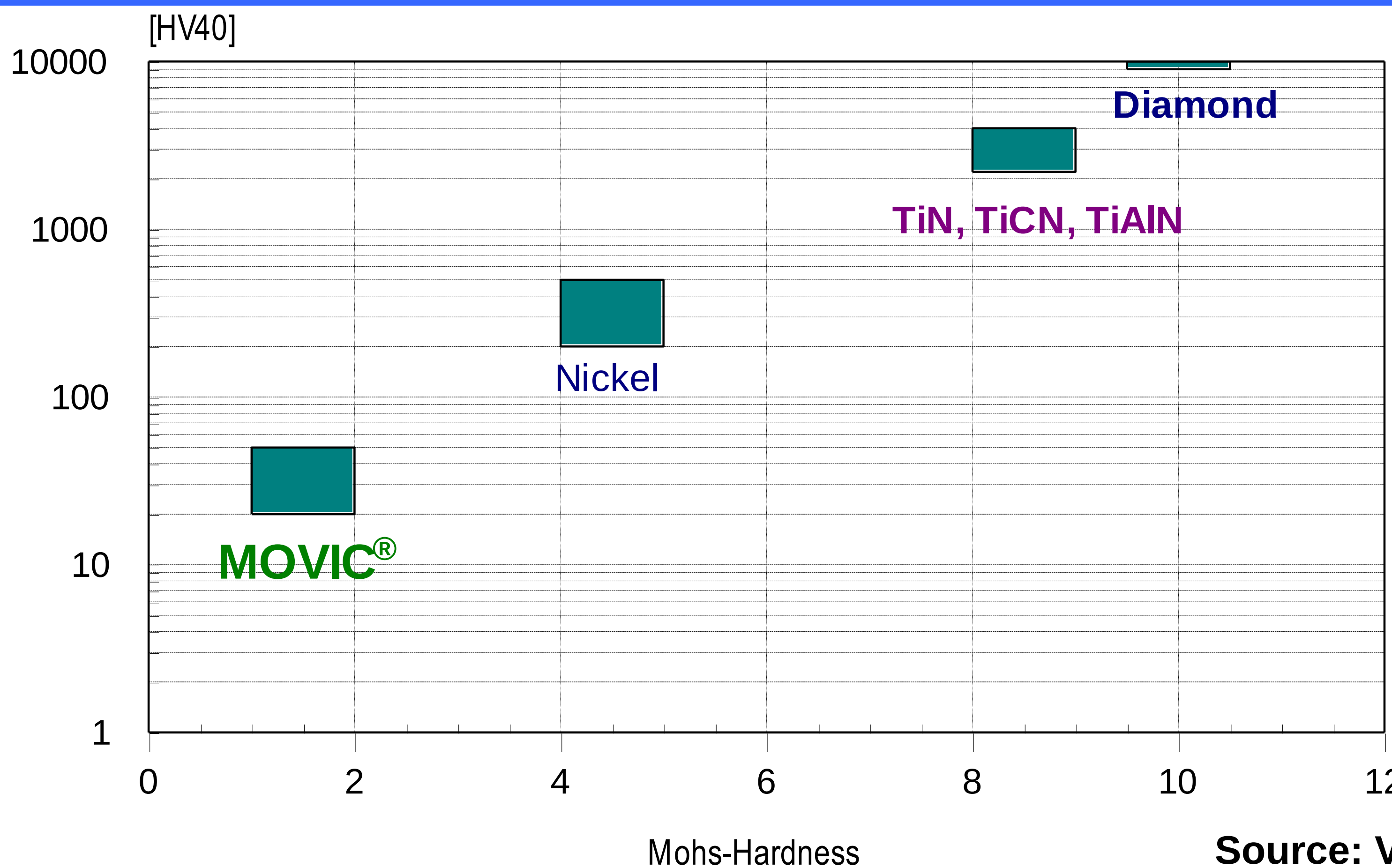
Main Advantages of Coatings

- TiN: ➔universal
  ➔good adhesion
  ➔recoatable
- TiCN: ➔ multilayer: crack absorbtion
- TiAlN: ➔high heat insulation
- Multilayer-TiN+TiAlN (= FIRE)
  ➔integration of advantages

Movic® the Lubrication Coating



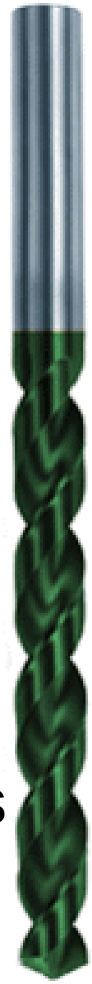
Hardness Comparison for Various Coatings



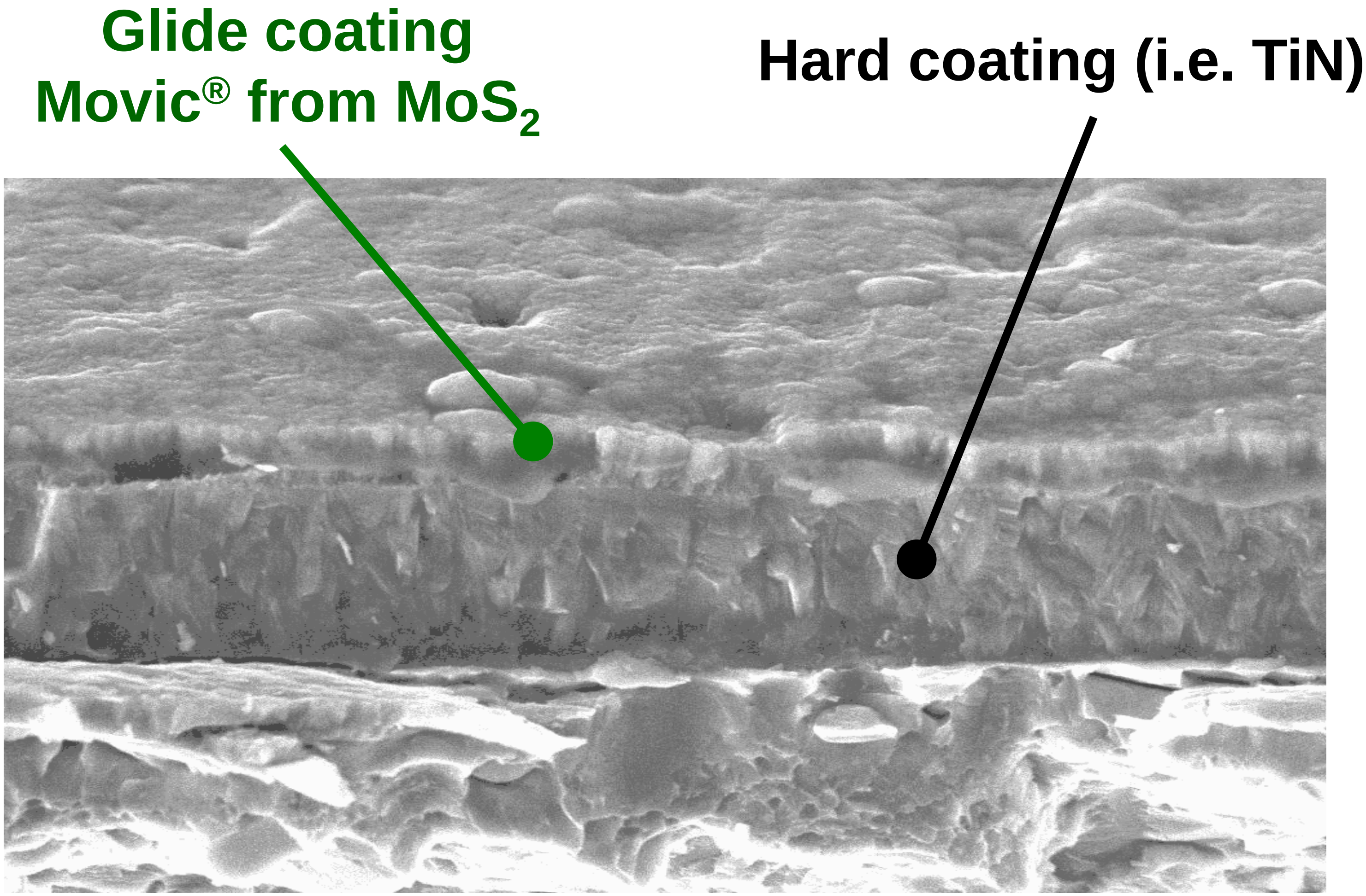
Source: Vilab, Bern

Movic®- Soft- Coat

- Color: dark-olive
- Soft coating, non-stick, lubricating coating
- Up to approx. 800°C applicable
- Hardness only 20-50 HV $_{0,05}$
- Avoids edge build up, oil and water resistant
- Thickness 0.2 - 0.5 µm
- Combined with hard coating Movic® offers the most advantages when applied in Al-alloys, light metals, soft and high alloyed steels, as well as titanium alloys
- 5 times recoatable without decoating



Double Coating : Hard + Soft

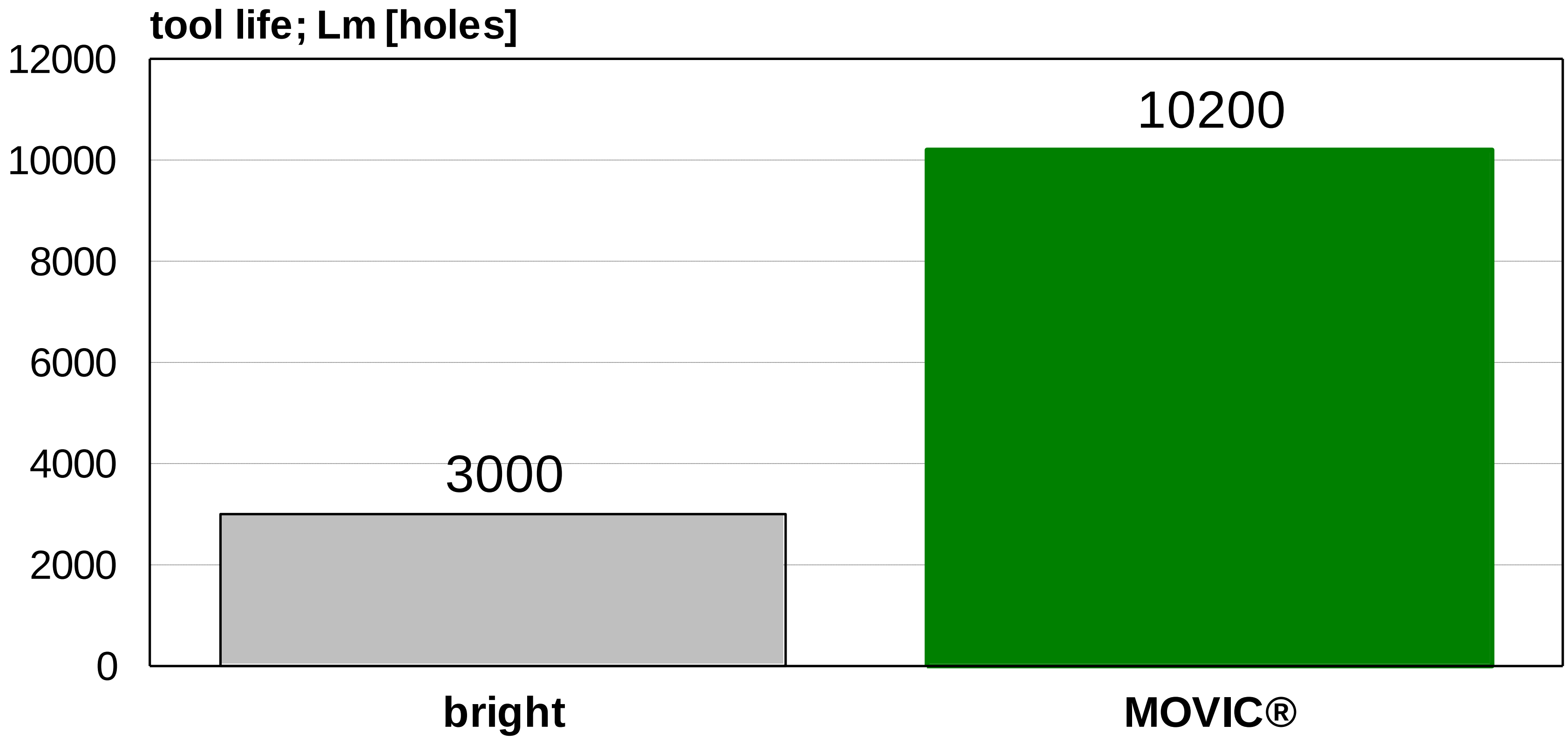


Built Up Edge when Drilling Alu

Built Up Edge when Drilling Alu

Movic® prevent build up edges and chip jam

Near-Dry Drilling Casted Aluminium



n=3500 U/rev - vc=85 m/min - f=0.2mm/rev - ap=3xd - externel beam sparkling

Diamant-ARC coated tools and parts

Source: DIARC, Helsinki

Diamond-Coating

- Under development
- Color: grey
- Only for Carbide with ≤ 6% Co contend(DK 120 F, K10)
- Up to approx. 600°C applicable
- Highest hardness (10.000 HV $_{0,05}$)
- Machining of steel not possible, because of the affinity of carbon to diamond
- Thickness 3-10 µm
- Not recaotable
- Special process

The Difference
on Ways of Regrinding and Recoating

Usual process by job coater

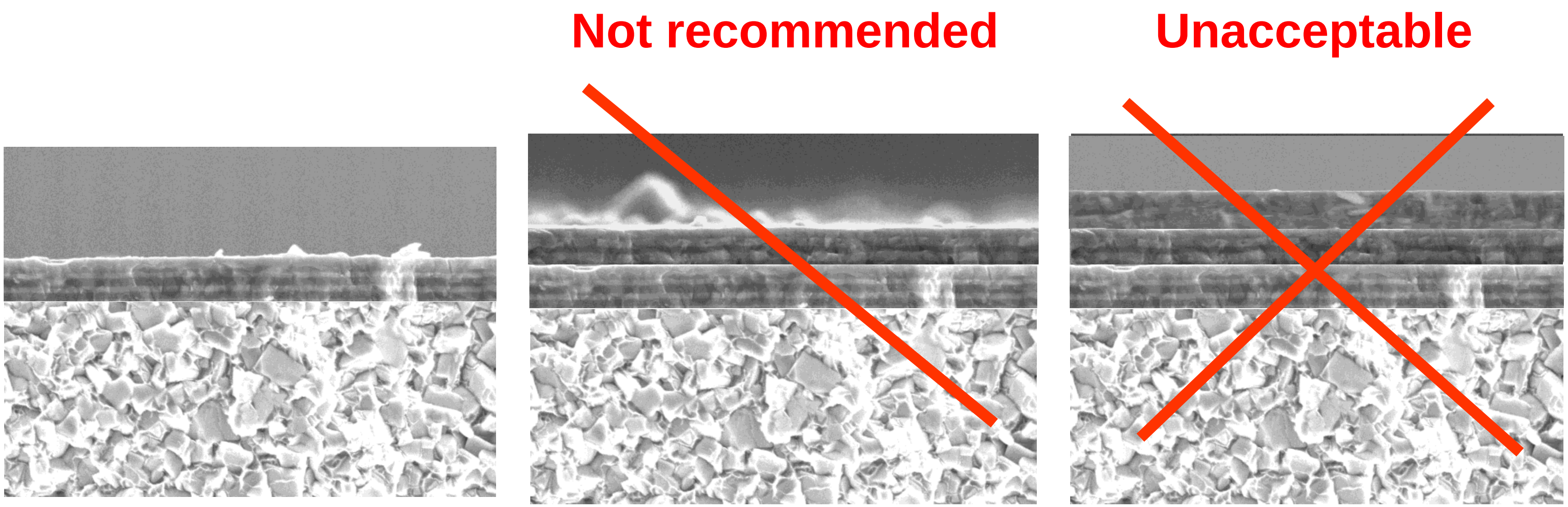
- new tool
  - ➔ using by customer
- worn tool back
- transport to regrinder
- regrinding
- transport to job coater
- stripping
- blasting
  - ➔ edge rounded
- recoating
- back to customer

Guhring way

- new tool
  - ➔ using by customer
- worn tool back
- stripping
- blasting
  - ➔ edge rounded
- regrinding
- recoating
- back to customer

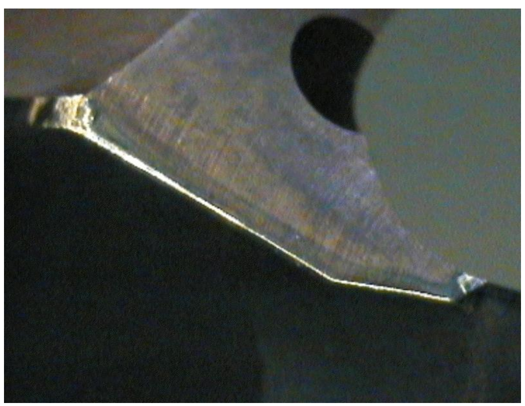
- in one hand
- no damaging before recoating
- shorter time and transports
- manufacturer quality

Because of Internal Strength
No Recoating without Stripping

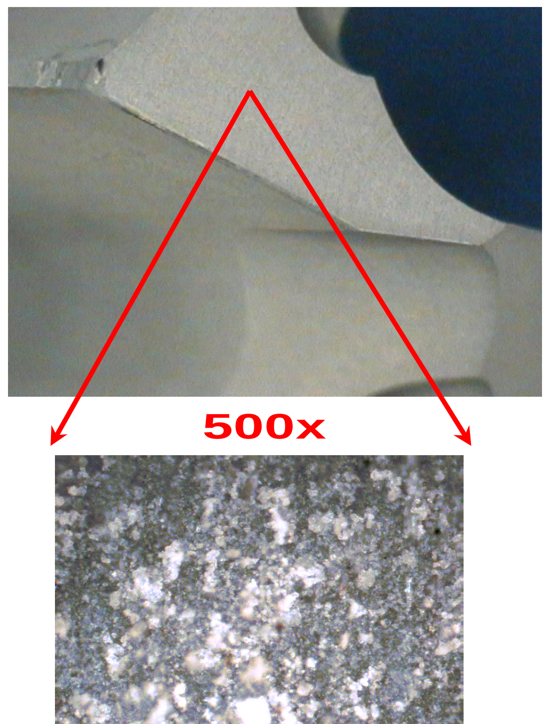


Stripping (Decoating) of Carbide Tools

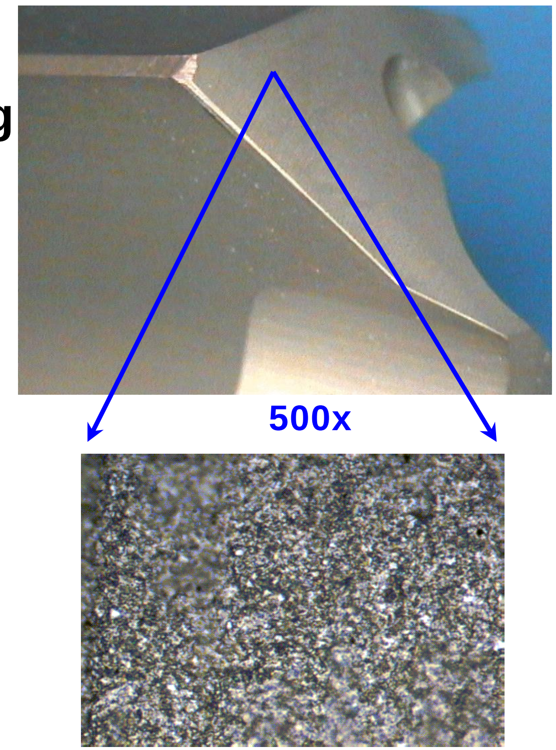
Worn tool after use



Cobalt letching
after electrolytic stripping

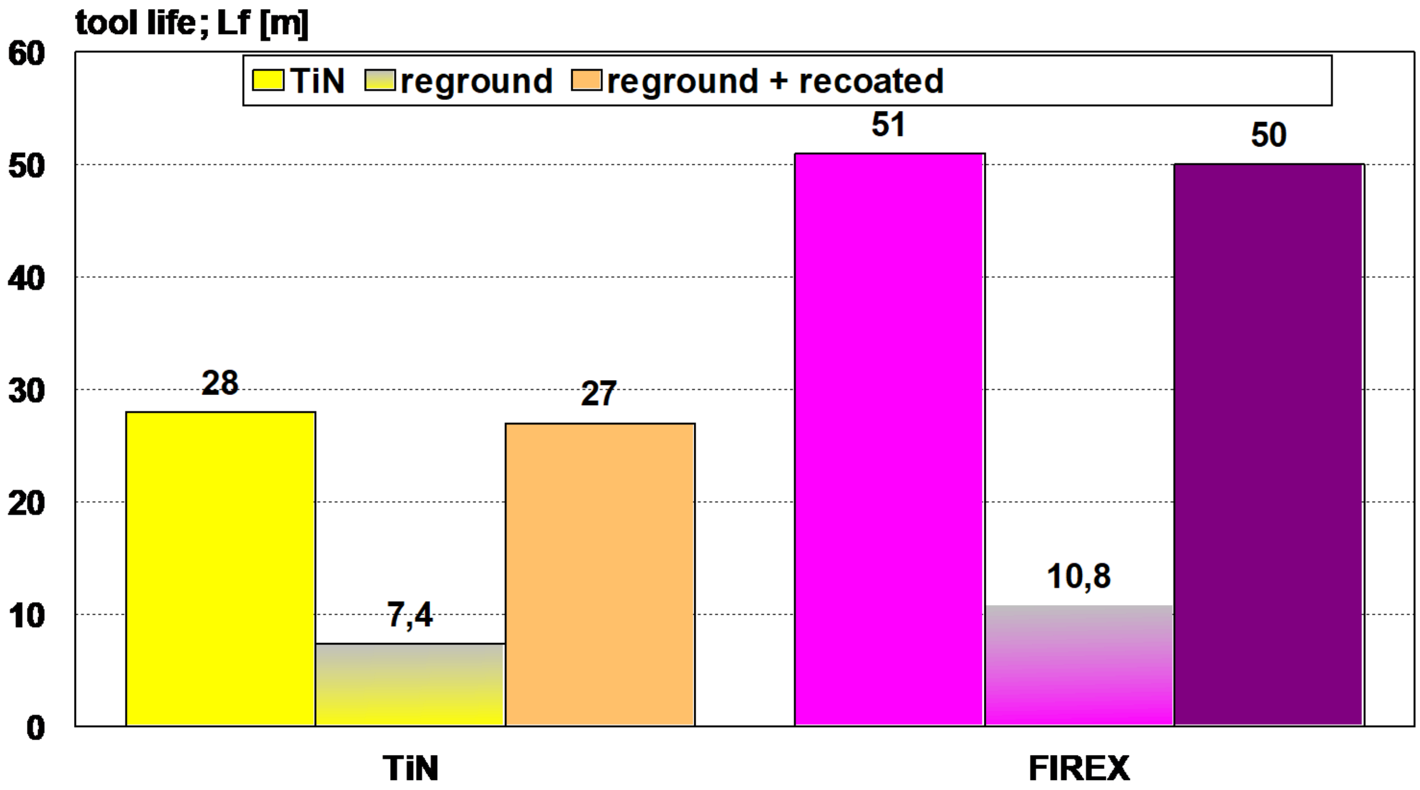


Surface after blasting
excellent ground for coating



Source: Aptodry, Brite-Euram-Project

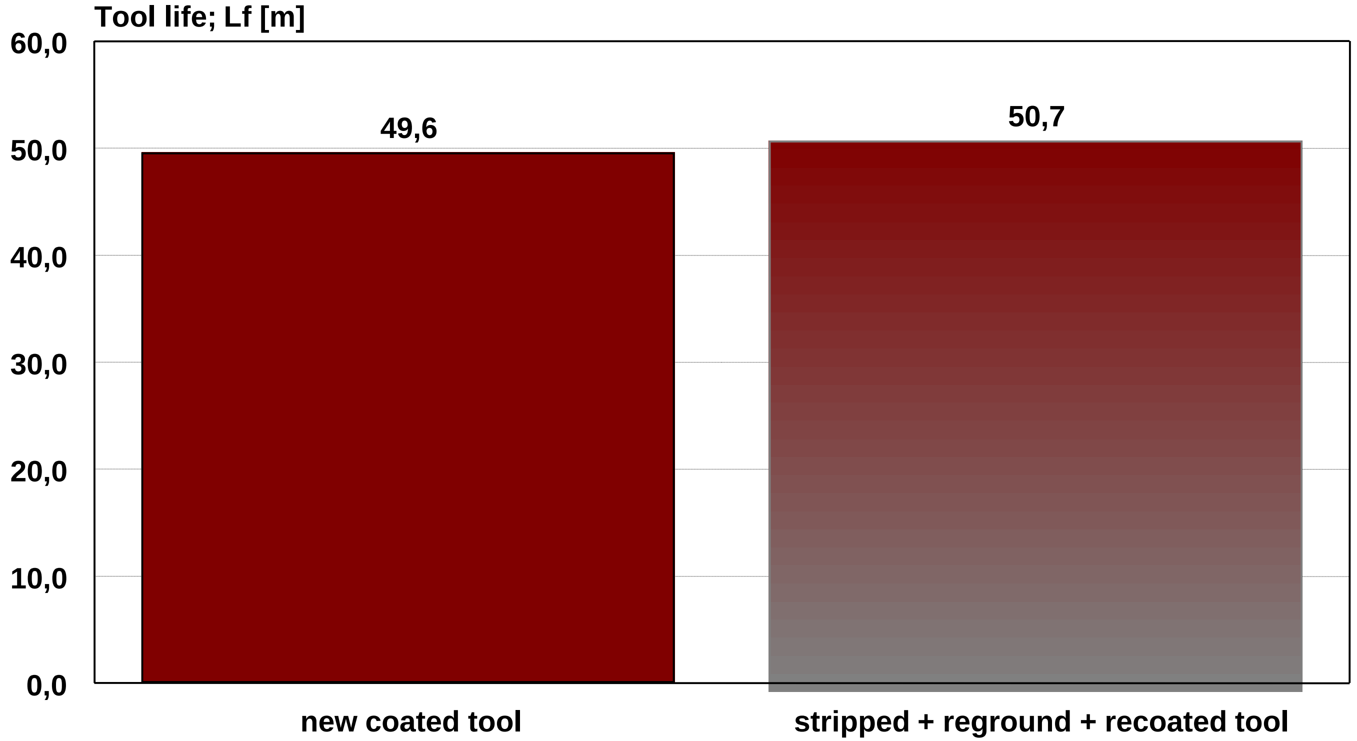
Tool Life Comparison for Solid Carbide Drills



Mat: 38MnV35 - forged steel - Rm=800 N/mm² - external coolant with emulsion 7%
Solid carbide drill - d=12.6mm - ap=13,5mm - vc=78 m/min - f=0.25 mm/U

Tool Life Comparison for Solid Carbide Drills

Original Coating ⇔ Stripped + Recoated

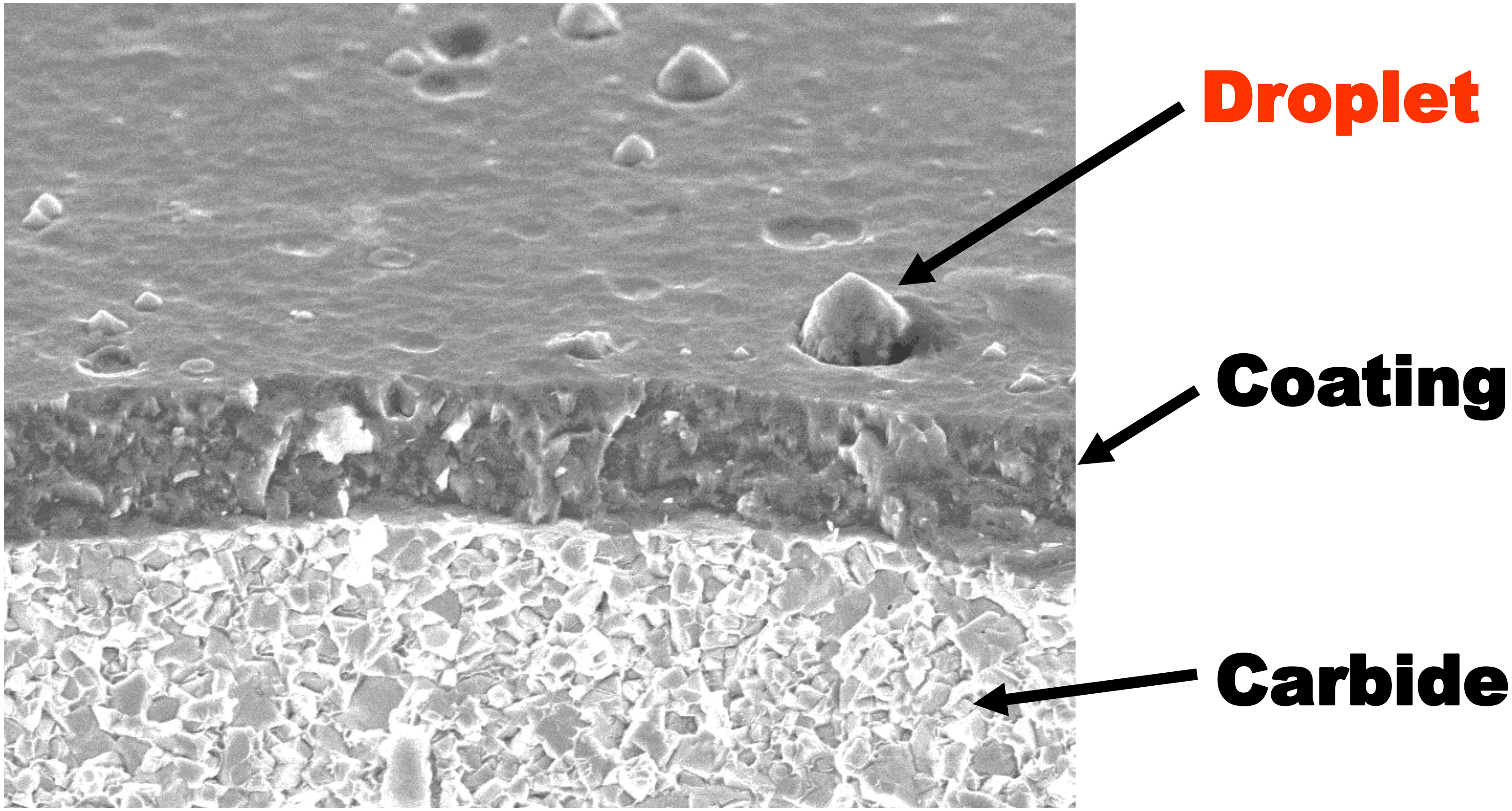


Mat.:42CrMo4V - IC=40 bar - emulsion: 7%

Source: Aptodry, Brite-Euram-Projekt

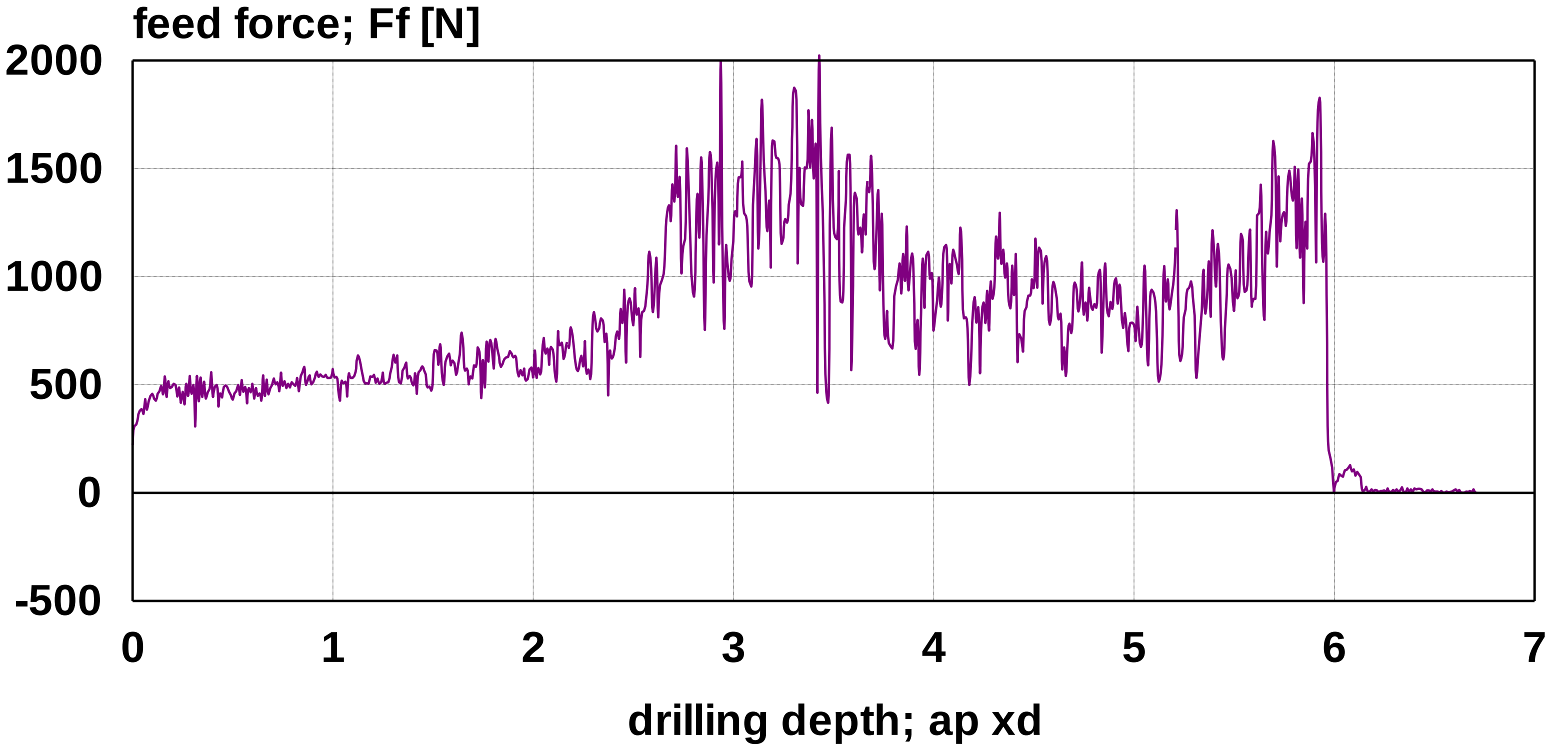
Tool: FIRE coated - d=5,5 mm - Vc=110 m/min - f=0,185 mm/rev - ap=22 mm

Droplets of ARC-Coating



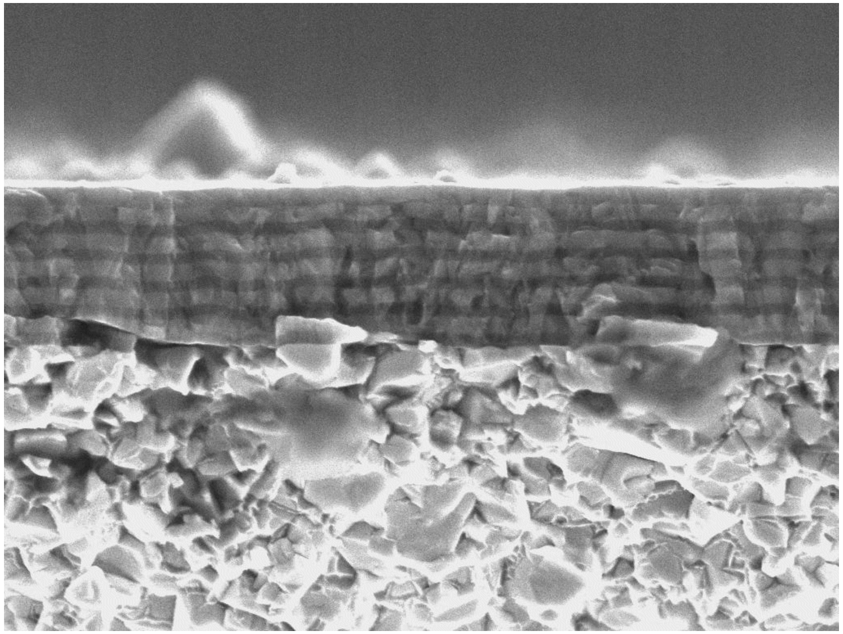
Feed Force at Drilling Deeper Holes

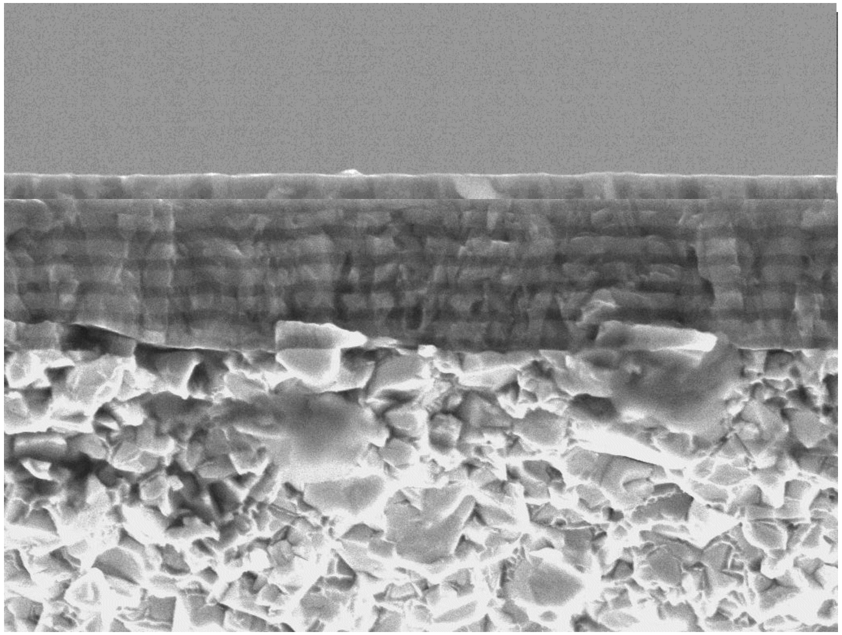
Multilayer ARC-TiAlN of Competition



Mat.: GGG40 - Tool.: HSS-DIN 338 - d=6mm - ap=6xd - vc=30m/min - f=0.18mm/rev

Comparison of the Coating Surface

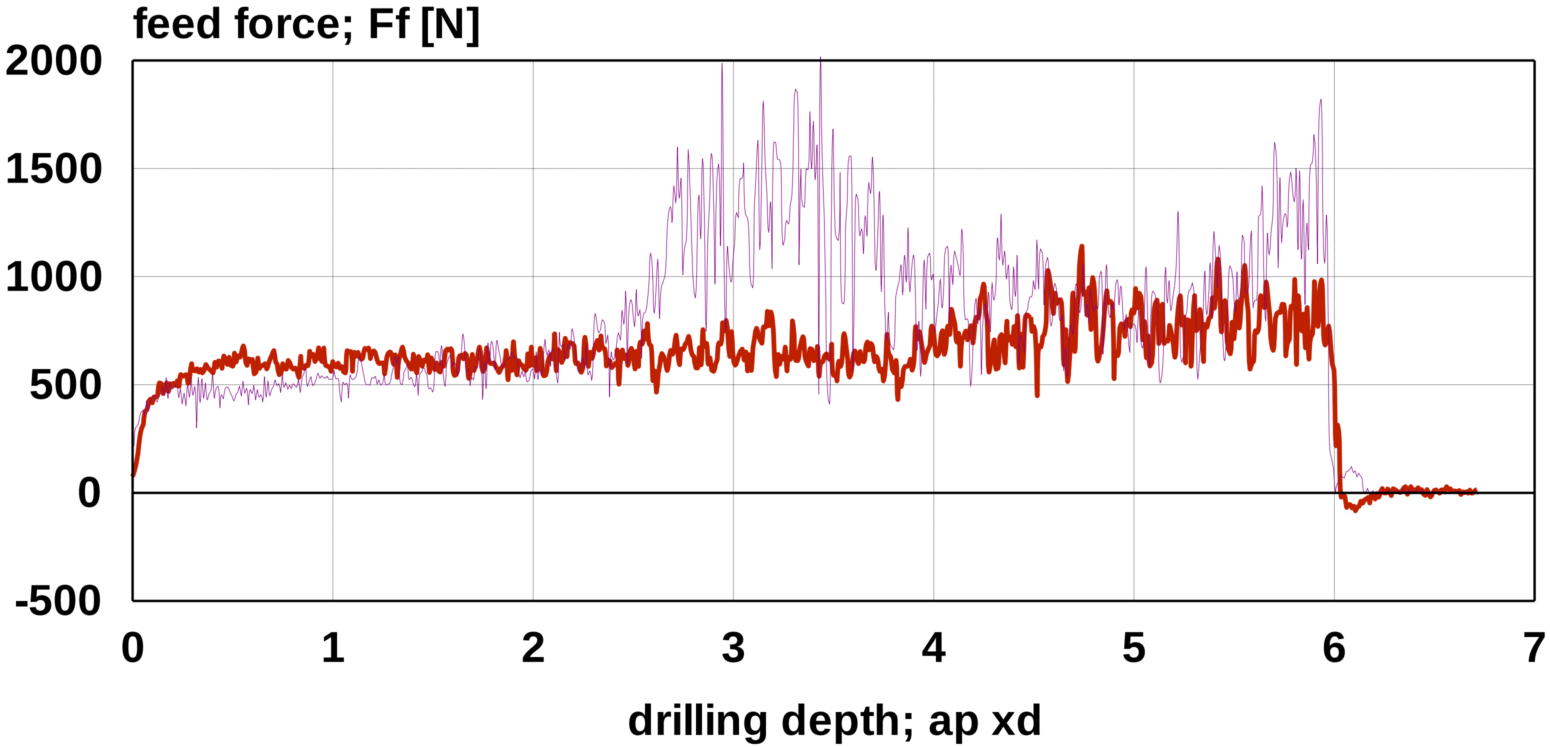




Without wipping **With wipping**

Feed Force at Drilling Deeper Holes

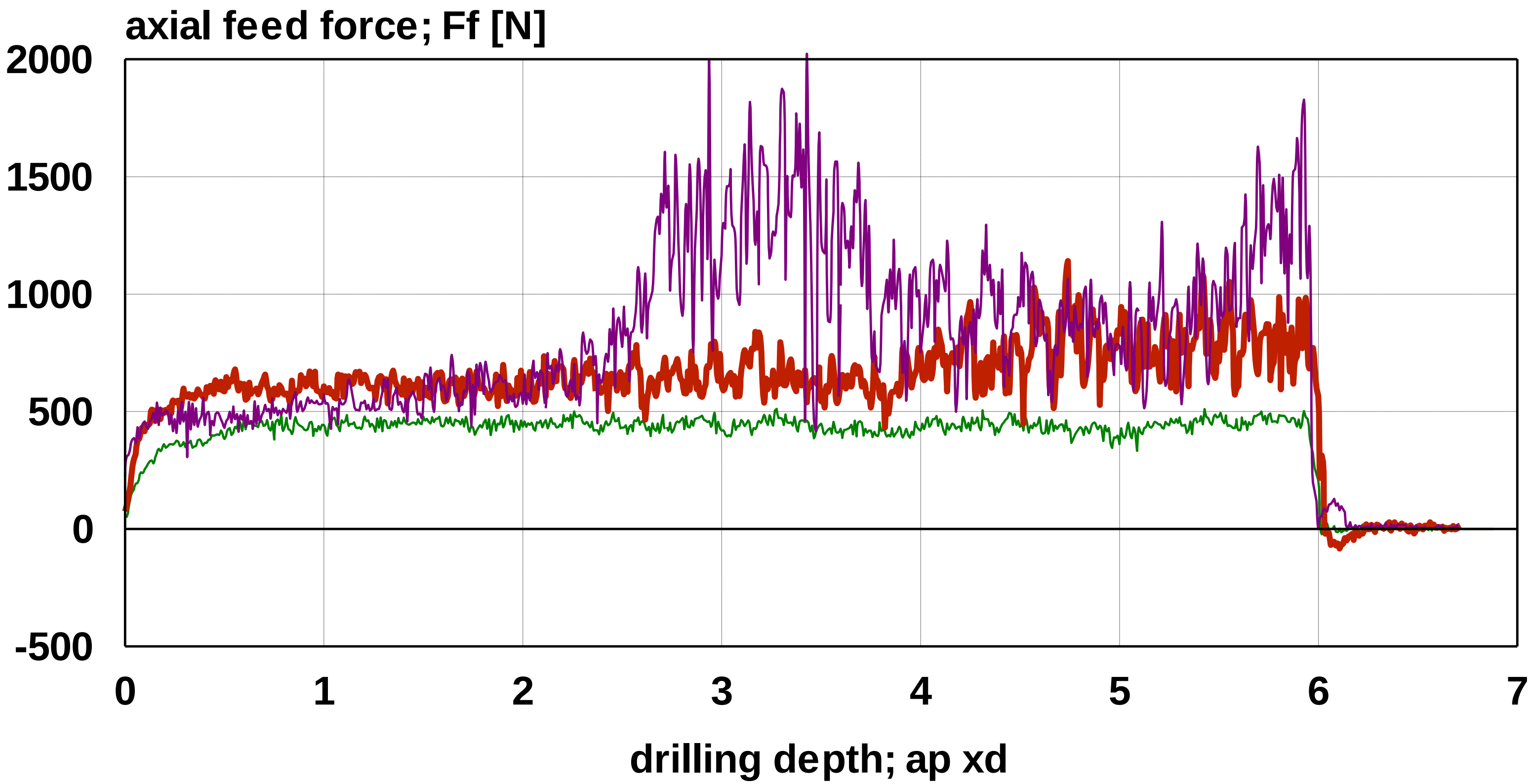
Multilayer ARC-TiAlN of Competition ⇔ FIREX



Mat.: GGG40 - Tool.: HSS-DIN 338 - d=6mm - ap=6xd - vc=30m/min - f=0.18mm/rev

Feed Force at Drilling Deeper Holes

Multilayer ARC-TiAlN of Competition ⇔ FIREX ⇔ FIREX+MOVIC



Mat.: GGG40 - Tool.: HSS-DIN 338 - d=6mm - ap=6xd - vc=30m/min - f=0.18mm/rev