DURNI-COAT®

functional finishing of metals
via electroless nickel

DURNI-COAT®

your components are in safe hands with us

Aalberts surface technologies is the right market partner for you in electroless nickel plating with high precision and production reliability for almost all metals.

- DURNI-COAT® (DNC) – 50 years of experience
- Electroless nickel plating (DURNI-COAT®) complies with DIN EN ISO 4527
- More than 350 million DNC-coated components per year
- DNC offered at eight locations
- Experience from thousands of projects in all key industries
- A broad diversity of processes for individual component characteristics
- Highest precision – own electrolytes
- Europe's largest DNC plant for series and small components
- State-of-the-art process technology for aluminum components

Whether DNC-coated nuts in bulk or DURNI-COAT®-AL coated valve spools for the automotive industry: your components are processed at Aalberts surface technologies using modern systems technology – highly functional and economical at the same time.

what is DURNI-COAT®?

DURNI-COAT®, also known as DNC, is a surface treatment tuned to each material, process and application. The main purpose of the DNC surface treatment is to provide machine components in all sectors of industry with protection against wear and corrosion, while at the same time fulfilling other application demands.

how are DURNI-COAT® layers built-up?

The electroless deposition of DURNI-COAT® layers is based on a reduction into metallic nickel of the nickel ions present in the aqueous process solution. The chemical reacting agents and formulators of the electrons required in this process are the hypophosphite ions in the solution. These agents transform themselves, by oxidation in the course of the reaction, into orthophosphite and are also responsible for the phosphorus content of the deposited DURNI-COAT® layers.

advantages of DURNI-COAT® layers compared to electroplated layers

The surfaces of complex shaped components are treated true to their original contours. Sharp edges and impressions, accessible cavities and bores are coated uniformly.

The uniform DURNI-COAT® layer can be built up with close tolerances. Normal tolerances are ±10 % of the specified surface thickness, with a minimum of ±3 µm.

Valve spool, base material EN AW-6064 (AlMgSiBiPb), electroless nickel plated with the DURNI-COAT® process 571 (lead-free), heat-treated > 850 HV, before finish grinding.

The valve spool was cut longitudinally for the micrograph (right). The area shown is circled red in the photograph. An even DURNI-COAT® layer envelops the component. Even complex component geometries can be coated with precise contours using DURNI-COAT®.

DURNI-COAT®

what can DURNI-COAT® do?

DURNI-COAT® processed materials

The range of base materials suitable for treatment with DURNI-COAT® includes most of the metals destined for industrial use.

- all types of low-alloy ferritic steel
- cast iron-based materials
- stainless steel
- non-ferrous metals such as copper, brass and bronze
- aluminum alloys
- sintered metal materials

other materials depending on previously-supplied sample coatings

general coating characteristics

DURNI-COAT® finishes are highly suited to applications involving special uses.

- excellent corrosion resistance
- resistant to erosion and cavitation
- high wear resistance
- elongation at break up to 2 %
- uniform layer formation
- good dimensional stability
- outstanding hardness
- magnetic properties
- suitable for contact functions and soldering
- surface conductivity
- optimized anti-friction properties
- good chemical resistance

chemical composition and structure

DURNI-COAT® layers are nickel-phosphorus alloy layers. The composition of the electrolyte and the processing conditions are used to control the phosphorus content of the DURNI-COAT® layers. This content can be varied between 3 and 14 %.

Phosphorus concentration is an important factor for many functional properties and can be fine-tuned here to suit cases of special use. DURNI-COAT® layers with a higher phosphorus content are in the state *as plated* X-ray amorphous. Heat treatment brings about re-crystallisation with the formation of nickel phosphides. Electrical and magnetic characteristics, and other mechanical and chemical properties, can be altered in this way.

layer thickness recommendations

When DURNI-COAT® is applied to make surfaces suitable for soldering, a thickness of 2 to 5 µm is sufficient. When selecting a variant from the DURNI-COAT® range – and when deciding on the thickness of the finish – the following factors should be taken into account: corrosion conditions, type and quality of the base material and its surface, the tribo-system and the required service life of the component.

The following DIN EN ISO 4527 standard layer thicknesses can be used as a reference with respect to wear and corrosion loads:

- mild loads
  - 5 to 10 µm (wear load)
  - 2 to 10 µm (corrosion load)
- moderate loads
  - 10 to 25 µm
- severe loads
  - 25 to 50 µm
- very severe loads
  - > 50 µm

Aalbert surface technologies' Weiterstadt site is home to Europe's largest electroless nickel plant for serial and small parts. Even the most complex component geometries receive a uniform coating thickness.

DURNI-COAT®

fields of use

DURNI-COAT® surface finishing is an industrial coating for different components in many sectors of industry:

- aircraft manufacture
- chemical industry
- communications technology
- defence technology
- domestic appliances
- electronics/electrical engineering
- energy and reactor technology
- hydraulic and pneumatic industry
- measurement and control technology
- mechanical engineering in general
- mining
- office and data technology
- pharmaceutical and medical device manufacturing
- printing machinery construction
- railway technology
- the automotive sector
- textile machinery construction
- valves and fittings

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1/ Aluminum weights for vibrating dumbbells, electroless nickel plated with the DURNI-COAT® process: abrasion-resistant, dirt repellent and resistant to fingerprints.

2/ Spindles for screwdriving systems with DNC-coated aluminum components.

3/ DNC-coated turbocharger compressor wheel.

4/ Pump for the pumping of aggressive water. The lead-free DURNI-COAT® 471 electroless nickel valve housing can be seen in the front left.

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1/ Patented vibration dumbbells with high quality finish (Source: BodyVib.).

2/ Multi-spindle assembly system in operation (Source: Weber).

3/ DURNI-COAT® 520-AL electroless nickel plated robot bearing flange.

4/ Cutaway model of a turbocharger.

5/ DNC 571 (DNC lead-free) electroless nickel plated case-hardened steel motorcycle axle shaft.

DURNI-COAT®

Air filters for compressors plated
with Electroless Nickel DURNI-COAT®

process variants

DNC 450 und DNC 471* (lead-free) especially ductile and corrosion resistant

DURNI-COAT®	DNC 450	DNC 471 (lead-free)
Applications	components used in sewage disposal technology, drive units, filter housings, guide bushes, hydraulic systems for mines, printing press cylinders, reactor construction, structural parts subject to vibration, valves	components with high corrosion and chemical loads, metal fittings (stainless steel appearance)
Layer characteristics	• phosphorus content: 10–14 % • elongation at break: 1.0–1.5 % foils, dome method) • abrasion: ≤35 mg, Taber-Abraser test with CS 10 wheel after 1,000 revolutions • hardness: approx. 570 $HV_{0.05}$ • more than 300 hours resistance according to DIN EN ISO 9227[1)] (acetic acid salt-spray test) • Kesternich test, resistance according to DIN 50 018[1)] : > 3 cycles SFW 2.0	• phosphorus alloy content: 10–14 % (incl. alloying elements) • elongation at break: 1.5–2.0 % (foils, dome method) • abrasion: ≤35 mg, Taber-Abraser test with CS 10 wheel after 1,000 revolutions • hardness: approx. 570 $HV_{0.05}$ • more than 500 hours resistance according to DIN EN ISO 9227[2)] (acetic acid salt-spray test) • Kesternich test, resistance according to DIN 50 018[2)]): >7 cycles SFW 2.0 • lead-free, high solderability, ultra-bright

DNC 520 and DNC 571* (lead-free) especially corrosion and wear resistant

DURNI-COAT®	DNC 520	DNC 571 (lead-free)
Applications	pump housings and stopcocks for use with natural gas and crude oil and processing equipment, nozzless, compressors, screw threads, the automotive industry, transmission systems, electrical engineering, electronics	
Layer characteristics	• phosphorus content: 9–13 % • elongation at break: 0.5–1.0 % (foils, dome method) • abrasion: ≤35 mg, Taber-Abraser test with CS 10 wheel after 1,000 revolutions • hardness: approx. 570 $HV_{0.05}$, after heat treatment up to 1,000 $HV_{0.05}$ • more than 200 hours resistance according to DIN EN ISO 9227[1)] (acetic acid salt-spray test) • Kesternich test, resistance according to DIN 50 018[1)]: >3 cycles SFW 0.2 bright	• phosphorus alloy content: 9–13 % (incl. alloying elements) • elongation at break: 0.5–1.0 % (foils, dome method) • abrasion: ≤35 mg, Taber-Abraser test with CS 10 wheel after 1,000 revolutions • hardness: approx. 570 $HV_{0.05}$, after heat treatment up to 1,000 $HV_{0.05}$ • more than 200 hours resistance according to DIN EN ISO 9227[1)] (acetic acid salt-spray test) • Kesternich test, resistance according to DIN 50 018*: >3 cycles SFW 0.2 • lead-free, ultra bright

*) Phosphorus content of layers (30 µm); ascertained in defined measuring ranges; steel as base material; stationary; measurements according to DIN 4527. 1) measured on 40 µm layer thickness, surface roughness $R_Z \leq 1$ µm, base material St. 52, 2) measured on 50 µm layer thickness, surface roughness $R_Z \leq 1$ µm, base material St. 52

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1/ DNC-AL-coated housing for absolute encoder (Material: EN AW-2007 (AlCu4PbMgMn)): Perfect corrosion protection of dynamic speed control for generators (wind turbines).

2/ Control valves coated with DURNI-COAT®-AL, which are used, for example, in mechatronic systems for passenger car transmission controls. The DNC-AL coating exactly traces the surface contour and effectively protects the component against wear, cavitation and erosion.

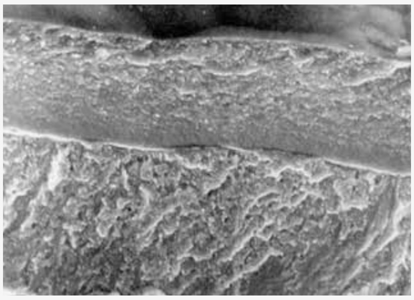
process variants

DNC 771* (lead-free) especially wear resistant

DURNI-COAT®	DNC 771 (lead-free)
Applications	mining equipment and components, metal fittings and hydraulic flaps, high-spec non-ferrous alloys, vehicle components
Layer characteristics	• phosphorus alloy content: 3–6 % (incl. alloying elements) • abrasion: <20 mg by Taber-Abraser test with CS-10 wheel after 1,000 revolutions and 14 mg after heat treatment • hardness: approx. 680 $HV_{0.05}$, after heat treatment up to approx. 1,000 $HV_{0.05}$ • residual compressive stress • ultra bright

DUPLEX-DNC for the most demanding specifications

DURNI-COAT®	DUPLEX-DNC
Layer characteristics	DUPLEX-DNC, for example a double coating combining the advantages of a hard, wear-resistant DNC 771-finish with the ductile, corrosion-resistant properties of a DNC layer which has a higher phosphorus content. For maximum mechanical, corrosive and chemical loads under extreme pressure fluctuations.



Edge view of a nickel-phosphorus duplex layer subjected to a forced fracture (SEM photograph: magnification 1 : 2,000)

DNC-AL** for aluminum and aluminum alloys

DURNI-COAT®	DNC-AL
Applications	structural parts for textile machines, printing presses, packaging machines, control system technology, electronics, electrical engineering, vehicle components
Layer characteristics	Typical DNC characteristics, depending on processing variant (450, 471, 520, 571 or 771), i.e. especially ductile and corrosion resistant, or high corrosion and wear resistance.

*) Phosphorus content of layers (30 µm); ascertained in defined measuring ranges; steel as base material; stationary; measurements according to DIN 4527.
**) Nickel-phosphorus coats deposited on aluminum substrates exhibit diverging phosphorus alloy contents within the first 10 µm of the coating thickness

DURNI-COAT®

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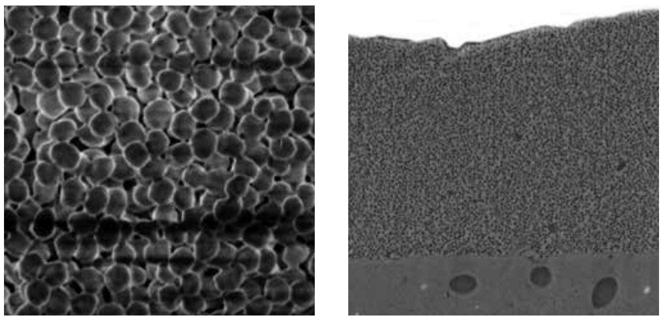


1/ Drive technology components coated with PTFE-DURNI-DISP.

2/ This injection moulding tool is made of St 2767 and used in the manufacture of polyamide 6-housings for hot-air welding machines, coated with 15 µm PTFE-DURNI-DISP.

3/ Left picture:
SEM photograph of PTFE-lubricant particles.

Right picture:
SEM photograph of a PTFE-DURNI-DISP layer (bottom: base material, top: PTFE-DURNI-DISP layer with incorporated PTFE lubricant particles).

process variants

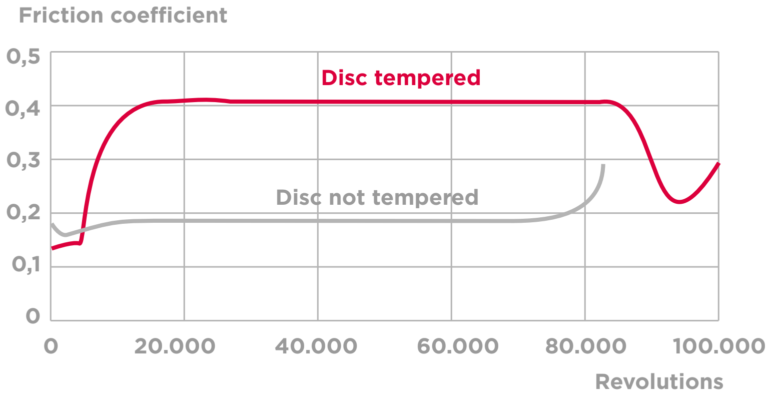
DURNI-COAT® + PTFE ⟶ PTFE-DURNI-DISP

especially wear resistant with anti-friction properties

Electroless nickel-plating with dispersed PTFE

PTFE-DURNI-DISP surface finish consists of an electroless (chemically) deposited nickel-phosphorus alloy layer applied according to the DURNI-COAT® process in which PTFE dry lubricant is uniformly and homogeneously dispersed. The dispersion layer combines the properties of the DURNI-COAT® layer with those of the PTFE. The corrosion resistance and hardness of pure DURNI-COAT® layers are barely affected by the dispersed dry lubricant, and the tribological characteristics are actually considerably improved.

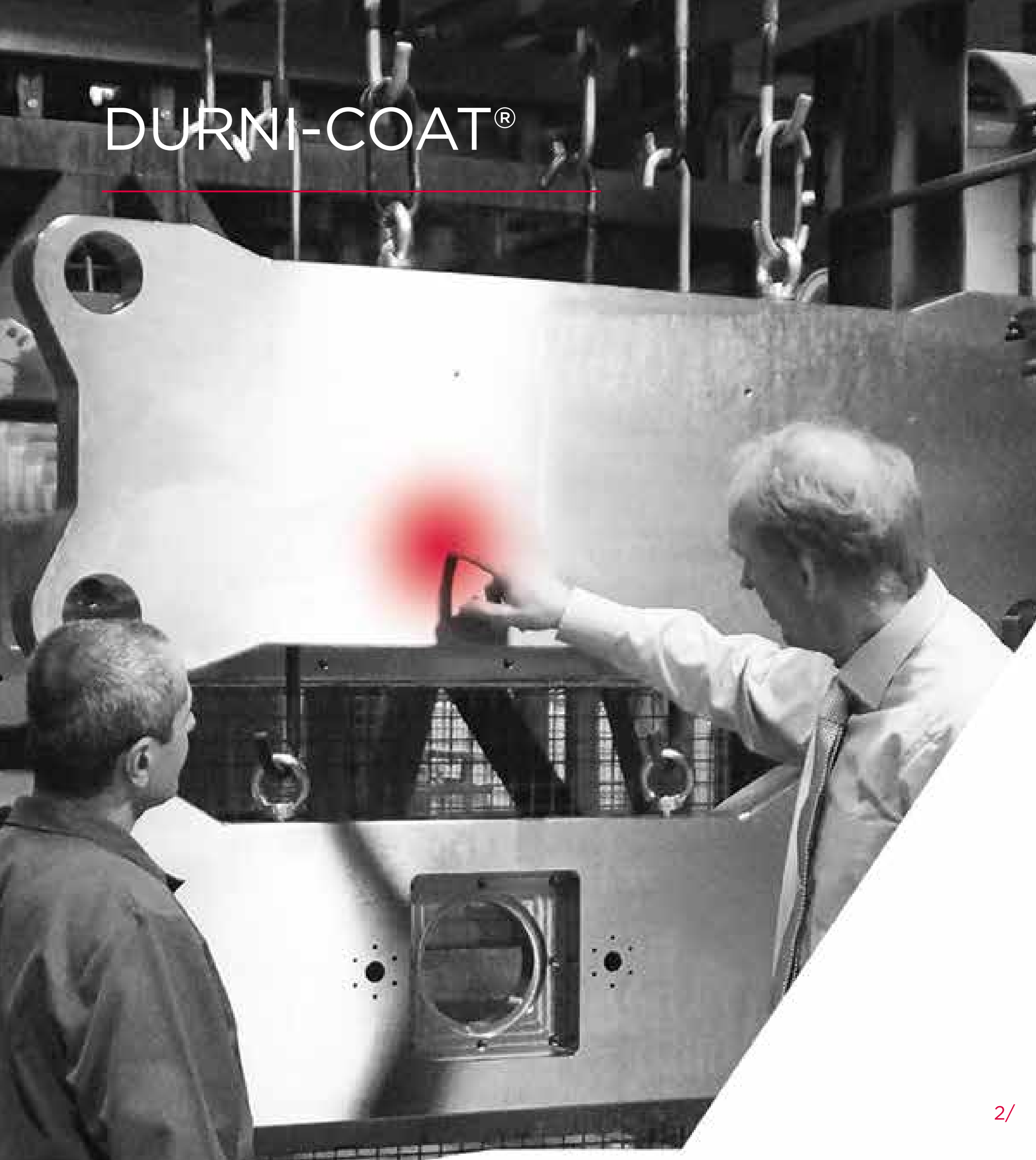
Heat treatment (tempering) of PTFE-DURNI-DISP leads to changes in the layer properties. The mixed hardness can be increased by heat treatment. However it also leads to an impairment in anti-friction characteristics, as the chart shows. For each application it has to be weighed up whether the hardness or the anti-friction characteristics is paramount. For example, with the injection moulds shown here the anti-adhesion effect is the priority, so the PTFE-DURNI-DISP layer is tempered for a relatively short time (15 to 20 min at about 350 °C). Here again, the anti-friction characteristics are reduced.



Slide test with pin-disc-tribometer: F_N = 5 N, v = 6 m/min, pin (ball): 100Cr6, discs coated with 15 µm PTFE-DURNI-DISP, conditions of heat treatment: 2h, 350°C

DURNI-COAT®	PTFE-DURNI-DISP
Applications	bakery equipment, bearing and mould making, bearing seats, control levers,conveyor systems, door lock fittings, electrical switching components, fan wheels, filter gauzes, gaskets, gearbox components, plastic moulding components, printing machines, rollers, shafts, structural pneumatic and hydraulic components, textile machine parts, tyre moulds, valves
	DURNI-COAT® – electroless nickel-plating
Layer characteristics and advantages	• excellent hardness • excellent abrasion resistance • high corrosion resistance
	PTFE – fluoroplastic
Characteristics and advantages	• tensile stress: 20–40 N/mm² • resistance to heat: short-term up to 300 °C, long-term up to 250 °C • friction coefficient: depending on load surface, roughness and sliding speed 0.05–0.20 • good abrasion resistance • excellent dry-lubricant characteristics • high corrosion resistance • excellent abrasion resistance • good self-cleaning properties
	PTFE-DURNI-DISP – electroless nickel-plating with dispersed PTFE
Layer characteristics and advantages	• coefficient of friction: depending on tribosystem, 0.1–0.2 • PTFE dispersion rate: approx. 20–30 Vol. % • hardness: approx. 230 $HV_{0.01}$ (mixed hardness) • typical layer thickness: 7–15 µm • excellent adhesive wear resistance • outstanding dry-running performance • high temperature resistance • outstanding anti-friction and anti-adhesive properties • high corrosion resistance (with intermediate layer)

DURNI-COAT®



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1/ Silicon carbide, a very solid natural material, is crushed and incorporated.

2/ SEM photograph: Edge view of a SIC-DURNI-DISP layer (magnification 1:3,000).

3/ Valve for core shooting machine (for the foundry sector). The base material G-AlSi7Mg was treated with 30 µm following the SIC-DURNI-DISP process and subsequently tempered to 1,000 $HV_{0.05}$. This produces a high wear resistance against highly abrasive core sand.

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process variants

DURNI-COAT® + SiC → SIC-DURNI-DISP

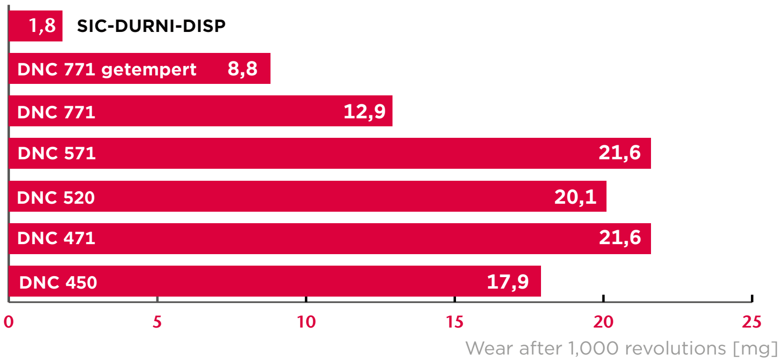
SIC-DURNI-DISP especially wear resistant

Electroless nickel-plating with dispersed SiC

The SIC-DURNI-DISP finish consists of an electroless (chemically) deposited nickel-phosphorus alloy layer applied according to the DURNI-COAT® process in which hard silicon carbide is uniformly and homogeneously dispersed. This dispersion layer combines the properties of the DURNI-COAT® layer with those of the hard material. The corrosion resistance of pure DURNI-COAT® layers is barely affected by the dispersed hard materials. The hardness of the compound and the abrasion resistance properties of the finish are actually considerably improved.

SIC-DURNI-DISP has the best abrasion resistance of all DURNI-COAT® layer variants. This layer contains lead. If you are looking for a lead-free electroless nickel layer having a good abrasion resistance, then we recommend the variant DNC 771, in the tempered version where necessary. When your products need a higher corrosion protection, variants DNC 571 or even DNC 471 are worth considering. However, you have to compromise in terms of abrasion resistance here, as the table shows.

Abrasion values, measured using the Taber wear-test
load 10 N, base material CK 45, friction roller type CS 10



DURNI-COAT®	SIC-DURNI-DISP	
Applications	brake discs, cylinder running surfaces, feeding funnels, pistons, rollers, structural pneumatic and hydraulic parts, track rollers, valve plates	
	DURNI-COAT® – electroless nickel-plating	
Layer characteristics and advantages	• excellent hardness • excellent abrasion resistance • high corrosion resistance	
	SiC – the hard material	
Characteristics and advantages	• Mohs hardness: approx. 9.5 • Vickers hardness: approx. 2,500 $HV_{0.05}$ • melting point: approx. 2,480 °C • density: 3.2/cm^3 • average grain size: approx. 0.6 µm to 1.5 µm	• extreme hardness • good chemical resistance • excellent wear resistance
	SIC-DURNI-DISP – electroless nickel-plating with dispersed SiC	
Layer characteristics and advantages (on base of the process variant DNC 520)	• abrasion: 5–8 mg with CS 17 abrasive wheel after 10,000 revolutions • hardness: approx. 700 $HV_{0.05}$ (mixed hardness) • dispersion rate: 30–35 Vol.%	• extreme hardness • extreme abrasion resistance

Aalberts surface technologies' Weiterstadt site is home to Europe's largest electroless nickel plant for serial and small parts. Even the most complex component geometries receive a uniform coating thickness.

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