NOVA SWISS

SURFACE TECHNOLOGY

Surface and coating techn

FOR LONG DURABILITY

In addition to economic and ecological factors, the increased service life of machines and parts is forcing industry to continuously improve and optimize surface properties. Thermal spraying processes enable highly durable and corrosion-resistant coatings to be applied as needed — and without changing the base material.


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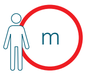
Thermal Spraying

MULTIFACETED AND RESULT-ORIENTED

Thermal spraying processes as classified in the **EN ISO 14917** standards offer a wide range of applications within modern surface technologies. Components made from a wide range of base materials can be coated with layers of high-melting-point metals or ceramics to protect them against wear and corrosion. Furthermore, thermally conductive or heat-insulating layers can be applied to highly thermally stressed components. Almost all coating materials that can be produced in powder or wire form can be processed in this way. During thermal spraying, the coating materials are fed into — and melted by — an energetic heat source (fuel gas oxygen flames from combustible gas, arcs or plasmas of noble gases such as argon, hydrogen, nitrogen, helium). The particles, which are either softened or fully molten, are accelerated in the direction of the workpiece and collide with it at high speed (40 – 600 m/s). Once the heat has been transferred to the base material, the particles solidify and form a coating that consists of multiple layers. The desired thickness is achieved by repeated passes with the burner.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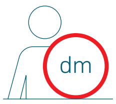
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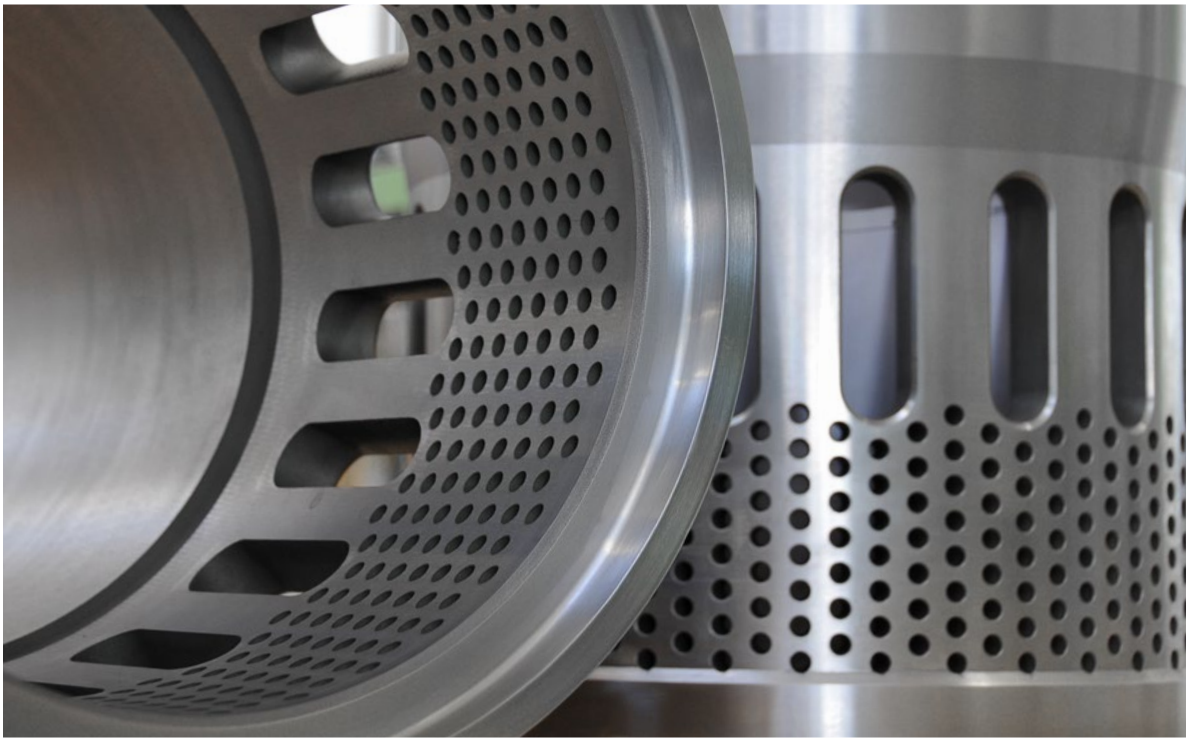
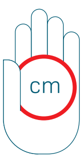
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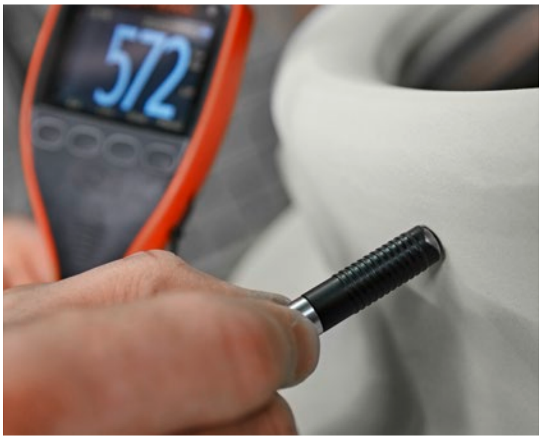
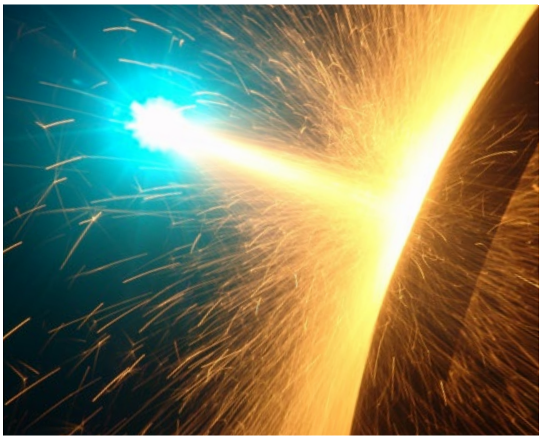
BASE MATERIALS

Almost any base material can be coated, including metals, ceramics, plastics, fiber composites or natural materials such as stone, wood, etc. Thermal spraying offers a great flexibility in terms of the possible material combinations.



COATING THICKNESS

Achieving an optimal coating thickness – which may vary greatly depending on the application – is a prerequisite for good results. Depending on the material and process used, a coating thickness from a few tens of microns to several millimeters can be achieved. In the case of worn parts, for which the total thickness of the coating cannot be freely determined, the coating can be applied after a build-up layer.



COMPONENT TEMPERATURE

During the coating process, workpieces are usually heated to a maximum of 150 °C and their surface temperature is monitored. Changes in the base material are largely excluded, with the exception of self-flowing alloys, which are subsequently fused at temperatures exceeding 1'000 °C.

FINISHING

To achieve the required surface quality, efficient finishing of the sprayed layers is just as important as selecting optimum materials of the necessary quality. For this reason, Nova Werke uses state-of-the-art facilities for turning, grinding, lapping, honing and polishing.

QUALITY ASSURANCE

Far from taking a "spray-and-pray" approach, our thermal spraying processes are based on consistent quality awareness on four M-levels: Material, Machine, Men and Measurement/Inspection. For comprehensive quality control, Nova Werke uses state-of-the-art test equipment for three-dimensional tolerance monitoring as well as a dedicated metallography lab, in which roughness measurements with track profile recording are carried out in addition to microsection analysis, hardness measurements and adhesion strength tests. These QA measures are coordinated with the customer on the basis of the applicable standards when the order is placed.

THERMAL SPRAYING PROCESSES AT NOVA SWISS

The process to be used depends on the specific application.
Economic considerations always play an important role here.

AVAILABLE SPRAYING METHODS				
	Gas temperature [°C]	**Particle velocity [m/s]**	**Adhesive pull strength [MPa]**	**Porosity [Vol.-%]**
Arc spraying	4'000	100	10 – 15	10
Flame spraying	3'100	40	10	10 – 15
High-velocity flame spraying	3'100	800	> 70	1 – 2
Plasma spraying	15'000	200	> 50	2 – 5

COATING MATERIALS

Material		Melting point [°C]	Vickers Hardness [HV 0.3]*	Typical Properties	Application Areas
Pure Metals	Aluminum Al	660	80	Soft	Corrosion protection for industrial and saltwater environments
	Copper Cu	1'080	120	Good thermal and electrical conductivity	Conductive layers, e.g. on non-conductors
	Molybdenum Mo	2'600	700	Good sliding and dry-running properties, hard, tough, good abrasion resistance, also suitable as corrosion protection. Extremely dense layers possible, good compressive strength	Sliding surfaces in general. Crankshafts, synchronizer and piston rings, pump parts, guides, diesel engine components, fit and press seats, prevention of fretting corrosion
	Zinc Zn	420	30	Low melting point, good corrosion protection	Corrosion protection such as aluminum (often also as an Al/Zn alloy), in particular for bridge and crane structures as well as containers, etc.
	Tungsten W	3'400	300	High-melting-point element	Electrical contacts, electrodes
Steel	Various alloys	1'325 – 1'536	160 – 600	Depending on the alloy: flexible to very hard, high fretting resistance, oxidation and acid-resistant	General repairs of heavily worn parts
	NiCr alloy	1'400	350	Corrosion-resistant, very good adhesion, temperature-resistant	Base and intermediate layers
	MCrAlY M = Ni, Co, Fe,	1'360 – 1'410	400 – 500	High melting point, corrosion-resistant	Base and adhesive layers
	Stellite	up to 1'400	up to 700	Corrosion-resistant, abrasion-resistant	General wear resistance, steam turbine components
	Tribaloy (cobalt or nickel-based)	up to 1'600	up to 650	Wear and corrosion-resistant. Good hot hardness	Resistant to fretting with good sliding properties
Self-flowing alloys	NiCrBSi, NiCoBSi, CoCrNiMoBSi, CoCrNiWBSi	1'000 – 1'100	up to 800	Hard, tough, dense, high abrasion resistance. Fusing possible. Good hot hardness	General wear protection, especially for valve plating. Also used as corrosion protection. Fused layers are absolutely impervious
Non-ferrous alloys	Aluminum bronze	1'060	210	Hard, tough, pressure-resistant, corrosion-resistant, good dry-running properties	Fretting protection with very good dry-running properties
	Nickel aluminum NiAl	1'400	230	Very dense with good adhesion and resistance to thermal shock and corrosion	Base or intermediate layers Bearing seats

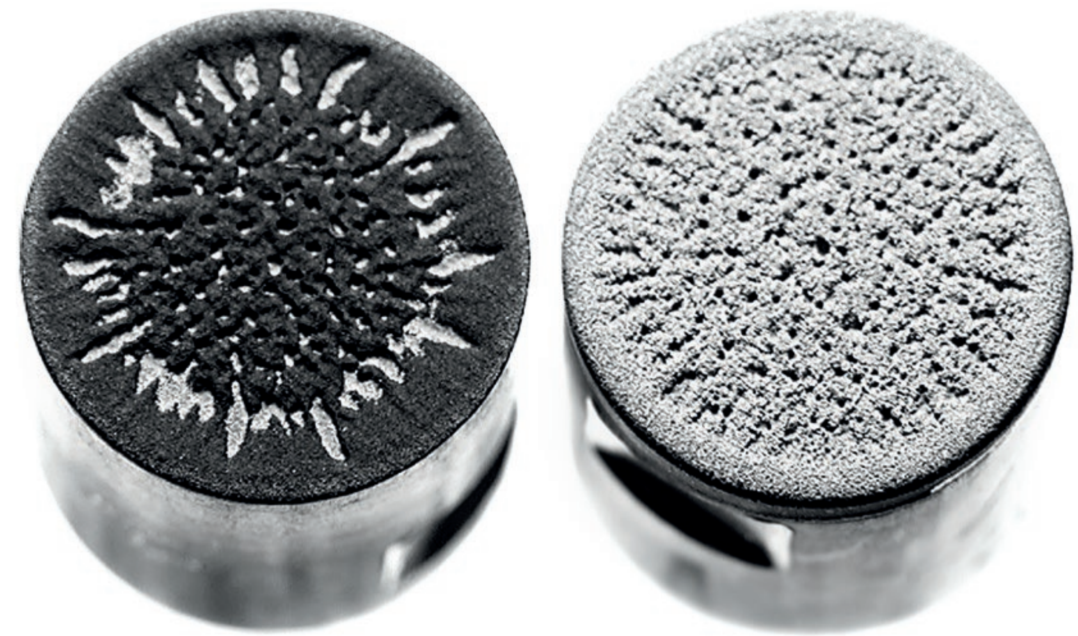
COATING MATERIALS					
Material		**Melting point [°C]**	**Vickers Hardness [HV 0.3]***	**Typical Properties**	**Application Areas**
Ceramics	Aluminum oxide pure Al_2O_3	2'050	up to 1'000	Very hard, abrasion-resistant, but relatively brittle, good electrical insulator	Textile machine components, electrical and thermal insulation, highly wear-resistant, e.g. for mixer blades
	Aluminum oxide + titanium dioxide Al_2O_3-TiO_2	1'900	850	The titanium dioxide content improves the density, sliding properties and polishability, and also reduces the brittleness, however lower hardness values are achieved	Mechanical seals, shaft protection sleeves, textile machine parts, hydraulic parts, pressure rollers
	Chromoxid Cr_2O_3	2'435	1'200	Excellent corrosion resistance, hard, highly abrasion-resistant, very dense, smooth layers	Pump parts, plungers, shaft protection sleeves, seal seats, textile machine parts
	Zirconium dioxide ZrO_2 – Y_2O_3 stab. – MgO stab. – CaO stab.	up to 2'680	up to 800	Thermal insulation layer, poorly wettable with molten metal, electrically conductive at high temperatures	Casting machine components, molds, high-temperature nozzles, combustion chambers, high-temperature heating elements (> 2'000 °C)
Cermets	Composite materials made from ceramics and metals or metal alloys			These materials are usually a combination of two or more widely differing components.	Special applications and also suitable as intermediate layers
	Tungsten carbide + cobalt WC-Co	(up to 1'500)*	1'450	Hard, high fretting resistance, corrosion, erosion and thermal shock-resistant. Very dense layers, very good adhesion	General wear protection against abrasion and erosion
	Tungsten carbide + cobalt-chromium WC-CoCr	(up to 1'500)*	1'400	For properties, see WC-Co coatings	Corrosion-resistant in aqueous solutions
	Tungsten carbide + nickel WC-Ni	(up to 1'500)*	1'100	Like tungsten carbide, highly wear-resistant in corrosive media and at high temperatures	Chemical plant components, linings, hydraulic valves, machines and tool parts of all kinds. Ideal wear protection for aluminum components
Pseudo alloys	Nickel graphite	(up to 1'450)*	44	Self-lubricating thanks to free graphite	Plain bearings Also suitable for dry running (depending on the application)
	Ceramic metal Ceramic plastic Metal plastic	–	–	No longer a homogeneous alloy, but often combines the properties of the two partner materials	Hard, abrasion protection (see "Cermets"), hard, non-wetting (foodstuffs / printing technology), e.g. Al-Si polyester (run-in coating)

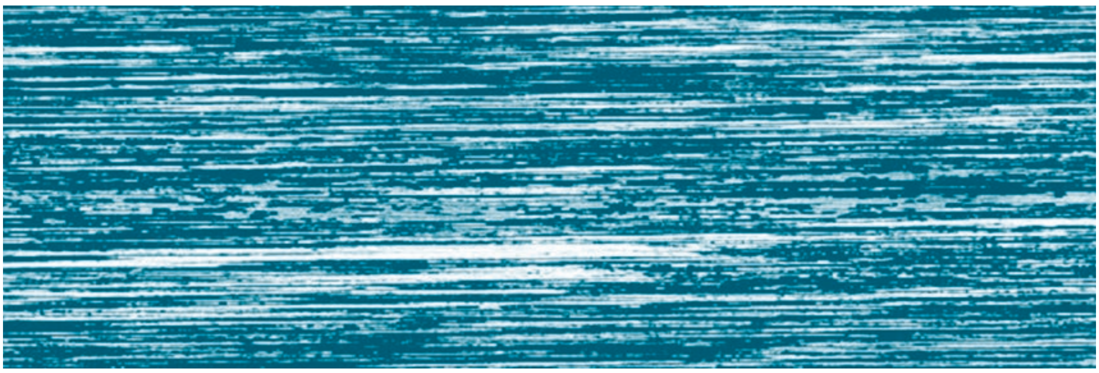
[ ]* The Vickers hardness values [HV 0.3] are guideline values for thermal spray coatings.
( )* Instead of the melting point, the sintering temperature for the composite materials is given here.

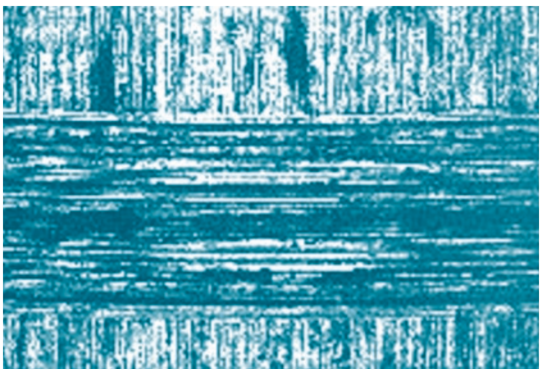
Tribology

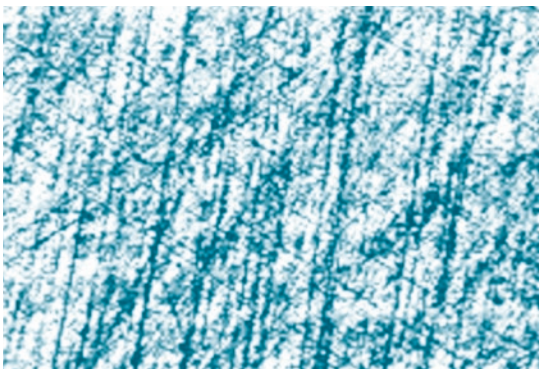
WEAR AND FRICTION MEASUREMENT AT NOVA SWISS

At Nova laboratory we can conduct several tribological systems to investigate coatings and surface engineered materials subjected to friction and wear for their application in harsh environments, e.g. elevated temperature, high humidity, high loading stress and high speed. Our dedication to the highest levels of customer service and excellence helps us to solve complex wear and friction problems related to coating solutions. Independent of what our customer requires; extending product's life time, reducing downtime, or optimizing the material performance and reliability, our tribology set-ups can be used according to several standardized procedures (mainly: **ASTM** "American Society for Testing and Materials", **DIN** "Deutsches Institut für Normung", and **ISO** "International Organization for Standardization), or we tailor our testing programs to meet our customers' individual needs, whether they regularly test just a few samples or need us to analyze thousands of samples to screen and/or simulate a particular application.



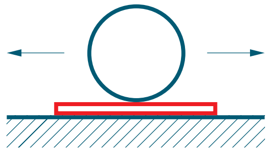






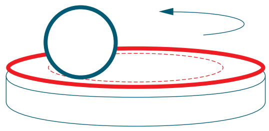
WEAR TESTING FACILITIES

The Tribology laboratory is well equipped to cover a wide range of tribological systems to simulate industrial friction and wear problems at different scales. Here are some of our tribometers and testing set-ups:



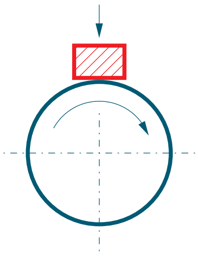
1. High frequency oscillating tribometer «SRV» (DIN 51834)

Standard test method for measuring the friction and wear properties of lubricating oils using the SRV test machine



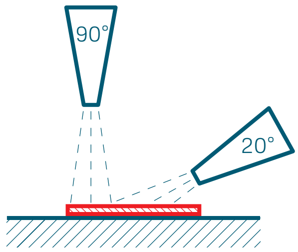
2. Pin-On-Disk (POD) or Ball on Disk tribometer (ASTM G 99)

Standard test method for wear testing with a pin-on-disk apparatus



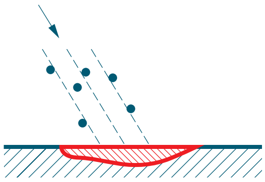
3. Block-on-Ring under atmospheric conditions and elevated temperatures (ASTM G 77)

Standard test method for ranking the resistance of materials to sliding wear using block-on-ring wear test



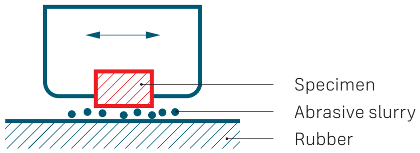
4. Solid particle erosion test (ASTM G 76), (high temperature optional)

Standard test method for conducting erosion tests by solid particle impingement using gas jets



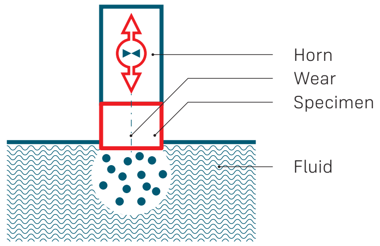
5. High pressure liquid (with / without solid particle) impingement erosion test (ASTM G 73 and 76)

A combination of the standard test method for liquid impingement erosion and the standard test method for conducting erosion tests by solid particle impingement



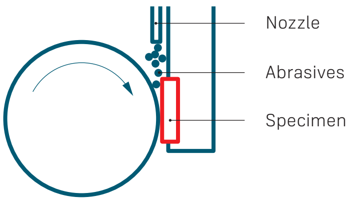
6. Slurry abrasion test / Miller test (ASTM G 75)

Standard test method for determination of slurry abrasivity (miller number) and slurry abrasion response of materials (SAR number)



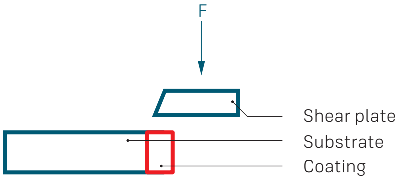
7. Cavitation erosion vibratory tribometer (ASTM G 32)

Standard test method for cavitation erosion using vibratory apparatus



8. Dry sand Rubber / Wheel abrasion test (ASTM G 65)

Standard test method for measuring abrasion using the dry sand / rubber wheel apparatus

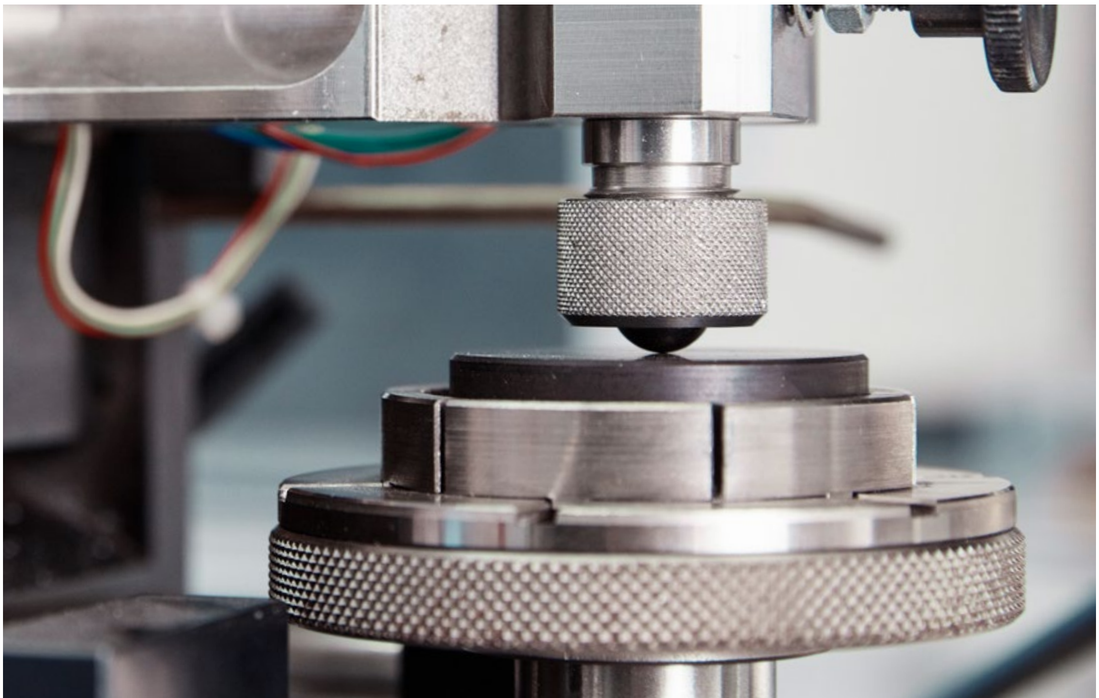


9. Determination of shear load resistance of thermally sprayed coatings (EN 15340)

Standard test method to characterize the adhesion and cohesion of thermally sprayed coatings

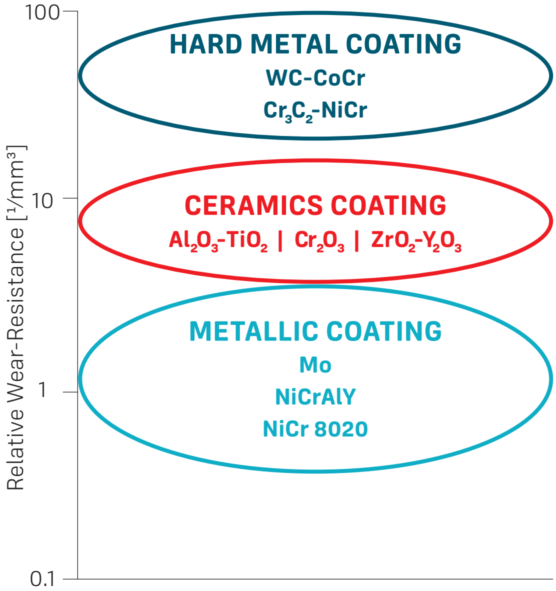
For detailed information, please refer to:

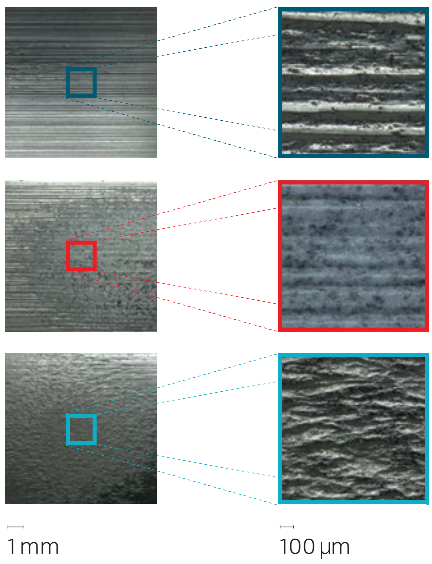
novaswiss.com/tribology

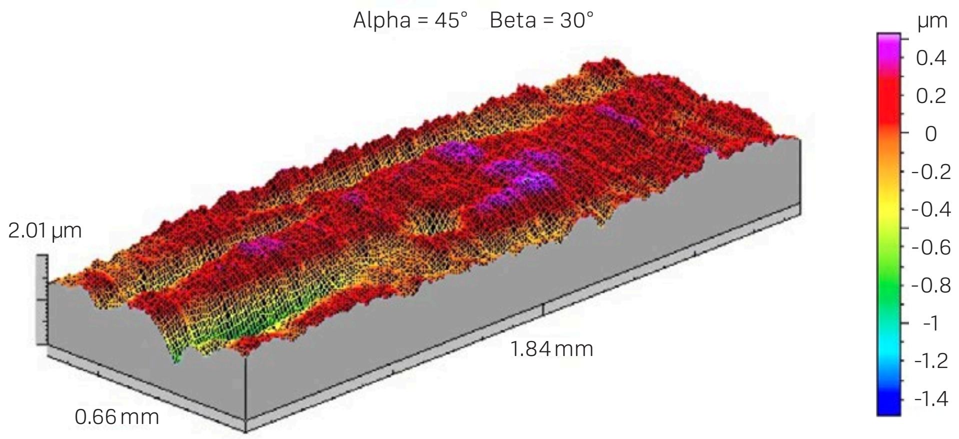


EVALUATION OF THE WEAR BEHAVIOR OF THERMAL SPRAYED COATINGS

In order to characterize the wear performance of thermal sprayed coatings, few samples are investigated and compared in abrasion, erosion and cavitation in our tribology laboratory according to international standard testing methods. As an example of the wear performance evaluation of several coatings, the ASTM G 75 (so-called Miller test) has been used. Up to four coated samples were simultaneously subjected to an oscillating sliding in slurry against a rubber lap. The wear evaluation was performed by measuring the cumulative mass loss several time intervals. The figure below shows the metallic, ceramic and hard metal coating, as well as the resulting values of relative wear resistance. The topography of a worn surface is shown as an example for the ceramic coating.



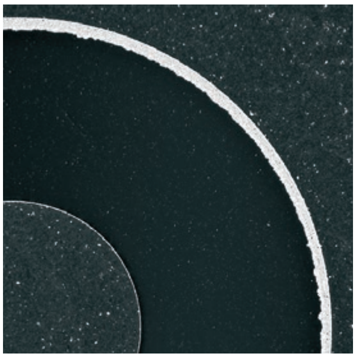




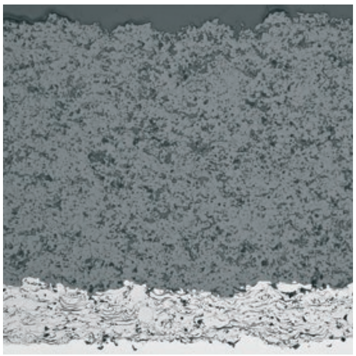
Metallography lab

FOR THE INVESTIGATION OF THE MICROSTRUCTURE

In our own modern metallography laboratory, the coating quality can be directly assessed on the cross sections. The coating porosities can, for example, have a strong effect depending on the material selection and spraying method and have to be adjusted to the application. With the several coating systems used by Nova Werke AG, coating porosities of less than 1 vol-% up to approx. 40 vol-% can be achieved. Fused layers consisting of self -fluxing alloys, on the other hand, are absolutely dense. It is also possible to seal sprayed coatings by filling the residual pores and capillaries with a corrosion-proof medium.



Cross section on a shaft



Thermal barrier and bond coat

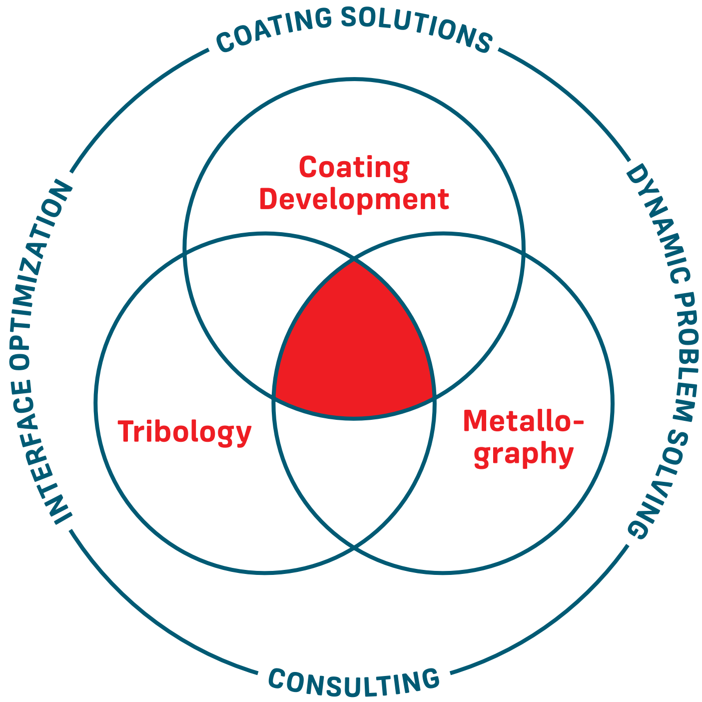
Image analysis to determine the porosity of a thermal barrier coating

Consulting Service

COATING DEVELOPMENT, METALLOGRAPHY AND TRIBOLOGY

One of our highest values lies in our ability not only to provide three consistent pillars of CMT (coating development, metallography and tribology), but also to offer consulting services and know-how in:

- Determination of the mechanical and physical properties of materials.
- Investigation of the failure and wear mechanisms in order to propose suitable materials.
- Consulting and R&D services in the fields of "coating, metallography and tribology".
- Scaling of the tribosystems from the application to the lab and vice versa. In addition, we can perform wear and friction analysis of materials under "real-world" operating conditions, e.g. at elevated temperatures, high relative speeds and high local surface pressures.



WHAT MAKES YOU SUPER
IS NOVA

ENGINE
COMPONENTS

HIGH PRESSURE
TECHNOLOGY

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