GTV Spray powder catalogue

Application fields

Overhaul / Repair

Wear protection

Corrosion protection

Bond Coats

Electrical isolation

Thermal isolation

Clearance control (Abradable coatings)

Powder morphology

Fused and crushed powder

Water or gas atomized powder

Agglomerated and sintered powder

Clad powder

GTV spray powders comply with DIN EN 1274

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Application fields

The technology of thermal spraying permits the manufacturing of adapted surfaces for each application by local deposition of coating materials with optimized properties. Due to the various possibilities to combine coating and substrate materials and due to the large variety of processes and achievable processing conditions, thermal spraying is of utmost significance among the coating processes. In various applications it offers perfect solutions regarding surface technological problems.

The majority of thermal spray applications can be found within the following outlined fields. In practice these fields often overlap. Therefore a multiplicity of proven coating materials exceed the property profile necessary within individual applications.

Overhaul / Repair

Technical components are not only subject to changes of shape by wear, but also show deviations due to manufacturing tolerances. Regardless whether cast, forged, sheet metal or machined parts are concerned the various thermal spray processes offer application-adapted possibilities for the restoration of faulty components.

The universal spectrum of spraying consumables offered by GTV enables the customer to select the material either depending on the load or with regard to the compatibility of the coating and substrate material.

Wear protection

The optimal choice of a coating material for wear protection of component surfaces depends on the tribological system (materials and surface state of the friction partners, relative movement, lubrication, load). The friction condition can be liquid, boundary or dry friction. Also, in accordance with the chemico-physical boundary conditions different wear mechanisms can occur: abrasion, adhesion, fatigue and / or tribo-chemical reaction.

Abrasion takes place through scratching of the component surface by a substantially harder counterbody or during the interaction with a fluid that contains abrasive particles. Hard, dense and fine-structured coatings have proved to be best suited for this type of tribological conditions. In case of interaction with a fluid that contains abrasive particles the size of hard phases in e.g. WC/Co(Cr) or Cr_3C_2/Ni20Cr coatings has to be adapted to the abrasive particles size in order to provide optimal wear protection function by avoiding local removal of the soft binder phase. Depending on the specific tribological load the spectrum of GTV spraying consumables offers adequate solutions with adapted hardness, hard phase size and distribution within a matrix material and resistance to impact load. In addition to the wear resistance of the coating material one has to consider the kind of applicable finishing and the achievable coating thickness required to ascertain an aspired life time.

Adhesion wear proceeds by formation and destruction of atomic bonds (micro or cold weldings) between the friction partners resulting in tear out of material from one components surface and transfer to the counterbody. Adhesion wear, also called "galling", can be avoided by the use of coatings with low adhesion properties (low surface energy) or adapted lubricating and / or sliding characteristics.

Fatigue wear occurs as consequence of cyclic mechanical or thermo-mechanical load. Accumulative plastic deformation within micro contact areas leads to excess of the materials strain capability and therefore to crack evolution. Crack propagation under ongoing cyclic load finally leads to material removal from the component surface. As crack evolution can originate from microstructure irregularities like pores, phase and grain boundaries that are generally present in thermal spray coatings, a coating designed to resist fatigue wear has to provide high fracture toughness in order to prevent excessive crack propagation. Homogeneous and dense coatings with compressive residual stress state show best suitability for this type of tribological conditions.

The *tribo-chemical reaction* is as a chemical reaction occurring during and due to the tribological load leading to material loss in form of reaction products on one or both friction partners. Tribo-chemical reactions are favored by friction induced rise of (local) temperature. Reaction products like e.g. metal oxides differ from the base material concerning hardness, strain capability, thermal expansion and thermal shock behavior. In the shape of fine particles these oxides can additionally affect the tribological conditions, e.g. by superposition of abrasive wear. Thermal spray coatings protecting component surfaces efficiently against wear due to tribo-chemical reactions need to be chosen under consideration of the environment and the counterbodys chemical composition.

In practice the described wear mechanisms often occur superimposed. E.g. sliding, rolling and oscillation wear can impart all of the described mechanisms simultaneously. Beyond that the prevailing application temperature can substantially influence the material behavior. Therefore spraying feedstock that permits production of coatings that fulfill the sum of partially contradicting demands according to the complex tribological conditions in an optimal way have to be chosen.

Corrosion protection

Adequate choice of feedstock for production of corrosion protective coatings requires consideration of the substrates chemical properties, the environment in use of the component as well as pressure and temperature in use of the component. Furthermore attention has to be paid whether the corrosion attack is pure based on chemical or electro-chemical reactions. In particular for electro-chemical corrosion attack the influence of potentially existing contact materials, e.g. due to partial coating of the components surface, needs to taken into account. Choice of a coating material that is more noble than the substrate material can even lead to accelerated corrosion, if there is a location, where the corrosive medium can penetrate the coating down to the substrate surface.

Corrosive attack on the substrate material by the surrounding medium via pure chemical corrosion processes can be prevented by application of chemically more resistant coatings. Also there is the possibility to produce cathodically protective coatings. In that case the less noble coatings corrode instead of the substrate material and thereby provide protective function. Typical examples are zinc and aluminum coatings on steel structures.

Electro-chemical corrosion takes place, if two materials showing substantially dissimilar corrosin potential are in contact by a conductive liquid film. Coatings suppressing the galvanic current flow are utilized to prevent this type of corrosion.

Bond coats

Bond coats are sprayed as intermediate layers with the aim to improve the adhesion of a functional coating to the substrate. Besides molybdenum that permits local formation of metallurgical bonds at impact of liquid spray particles on the substrate surface due to the materials high reactivity and high melting temperature the spectrum of so called self bonding coatings provides high adhesion strength. Therefore such coatings are an excellent base for thermally sprayed functional coatings. For production of self bonding coatings clad powders are used. The powder constituents undergo an exothermic reaction and therefore impinge on the substrate at significantly higher temperature than particles sprayed with homogeneous alloy particles with the same chemical composition. Diffusion processes lead to a local formation of metallurgical bonds. But self bonding coatings are not only used as bond coats. They are also available with different hardness levels and can be used as functional coatings, e.g. for combined wear and corrosion protection.

A further group of bond coats are ductile nickel or cobalt based alloys that prevent access of corrosive media to the substrate surface, if functional top coats cannot provide this function securely. Hot gas corrosion protective MCrAlY (M := Ni, Co) coatings are also designed in a way that they show an intermediate thermal expansion behavior between typical super alloy substrates and zirconia based thermal barrier top coats. Therefore thermally induced strain is minimized and thermal shock resistance of the compound greatly improved. Such coatings can provide excellent long-term oxidation resistance up to 1,050 °C.

Electrical isolation

In various applications special electrical characteristics of thermally sprayed coatings are utilized. Thus by the use of non conductive ceramic coatings with high dielectric strength the conduction of electric currents between technical components is prevented. In contrast other applications require the use of coatings with particularly high electrical conductivity, e.g. copper or aluminum).

Thermal isolation

Due to extreme thermal loads various components in modern technical systems have to be coated with so called thermal barrier coatings. Apart from decreased component core temperatures that result in increased life time the process efficiency can be increased at constant component core temperature, because either the operating temperature can be increased or the cooling capacity reduced.

Usually ceramics are applied as thermal barrier coating materials. Especially oxide ceramics mostly show low thermal conductivities. If the coatings are also subject to thermal cyclic loads the use of ceramics with a comparatively high coefficient of thermal expansion and thermal shock resistance is essential.

Clearance control (Abradable coatings)

Tolerances in the interaction of turning and static components have to be kept as small as possible to achieve optimum process efficiencies of e.g. power generation systems. Thus power losses can be substantially decreased by keeping close clearances, e.g. in gas turbines or screw compressors.

By combination of „abradable“ coatings, often applied upon static components, with wear resistant coatings applied to turning components, the resistant material successively grates into the abradable. Thereby a minimum clearance between the components is attained.

Powder morphology

Due to the diversity of processes and spraying materials the technology of thermal spraying offers adapted solutions for a wide range of application fields. GTV offers the full spectrum of feedstock powder with different morphology, size fractions and chemical composition. Thereby the user is enabled to exploit the full potential of the thermal spray technology.

Spraying powder are available in very different size fractions and with different morphologies. Both properties take significant influence e.g. on the flowing characteristics, the melting behavior and potential micro-structural transformations during the spraying process or subsequently performed heat treatments.

The consequence of bad powder flow characteristics are fluctuations in powder feeding and thereby induced inhomogeneities in the produced coatings microstructure. Therefore, even for use of fine powder size fractions minimum flow characteristics need to be maintained.

The melting behavior has to be evaluated with regard to the desired heat transfer into the powder particles. The degree of melt formation in single particles determines e.g. the intensity of chemical reactions like oxidation or reactions of different powder constituents as well as phase transformations during spraying.

The powder particles morphology is a result of the powder production route and the applied processing. The majority of common spray powders is produced via four different routes.

Fused or sintered and crushed powders

Such powders are produced by crushing of a cast or sintered block and subsequent milling to achieve a desired particle size regime.

This procedure is mainly used for brittle materials like oxide-ceramics or carbides. The particles are characterized by a comparatively high density and a moderate melting behavior.

To manufacture multi-component powders with individual constituents side by side the raw materials are mixed and afterwards bonded by means of sintering. Finally the sintered block is crushed and milled.

Crushed powder particles show a rough, fissured surface and irregular shape (**figure 1**) which leads to rather poor flow characteristics.

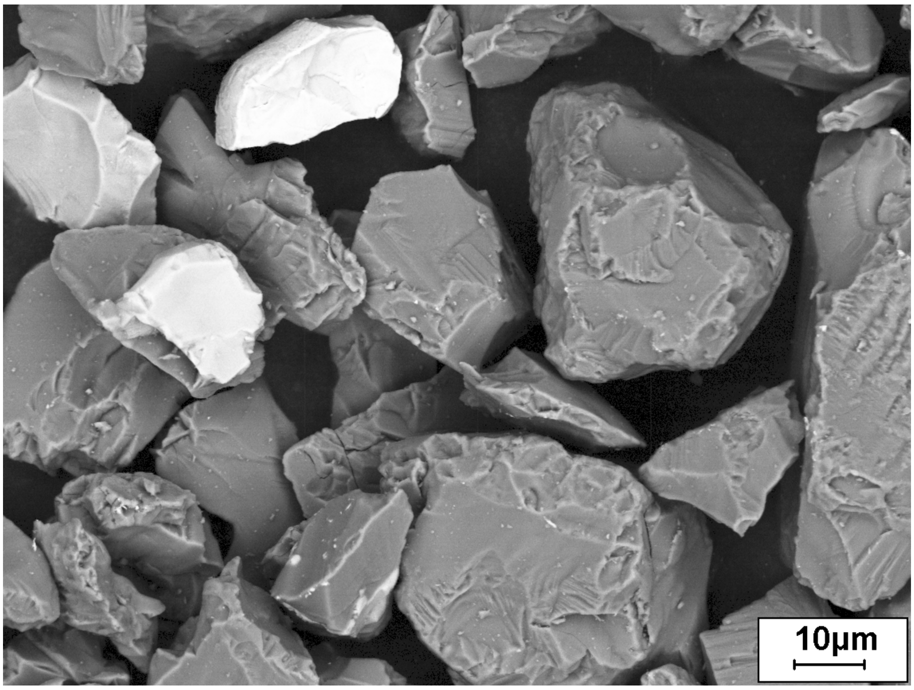


Figure 1: Scanning electron micrograph of a fused and crushed Al_2O_3/TiO_2 97/3 powder

Water or gas atomized powders

Production of atomized powders proceeds by atomization of molten material with use of adapted atomization gases either into water pool or into a vessel with adapted gas atmosphere. By choice of the atomizing gas and the atmosphere the material composition can be influenced, e.g. with concern to the powders oxygen content. Thus, the hardness of a molybdenum coatings can be controlled not only by the spraying conditions, but also by the oxygen content of the powder feedstock. On the other hand the oxygen content in MCrAlY powders is kept at minimum values in order to permit spraying of coatings that will show optimized oxidation resistance.

Particles of water or gas atomized powders show a relatively low surface roughness. Water atomized particles show a more irregular geometry (**figure 2**), while gas atomized particles are nearly perfectly spherical (**figure 3**). The spherical shape greatly supports the flowing behavior. Due to the minimal surface / volume ratio of the sphere shape the heat flux into the particles and therefore the melting behavior is impeded.

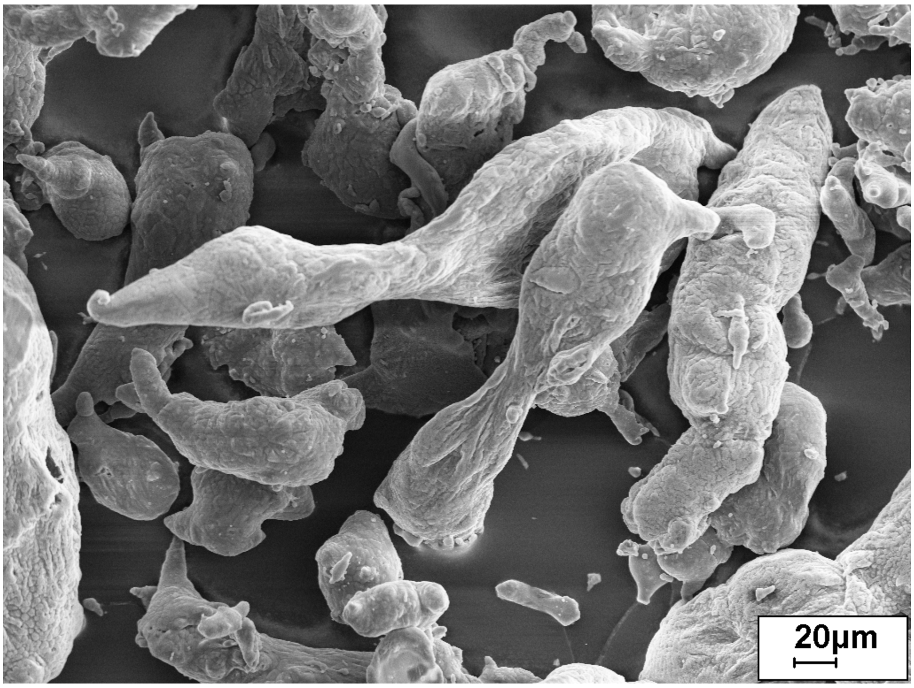


Figure 2: Scanning electron micrograph of a *water atomized* aluminum powder

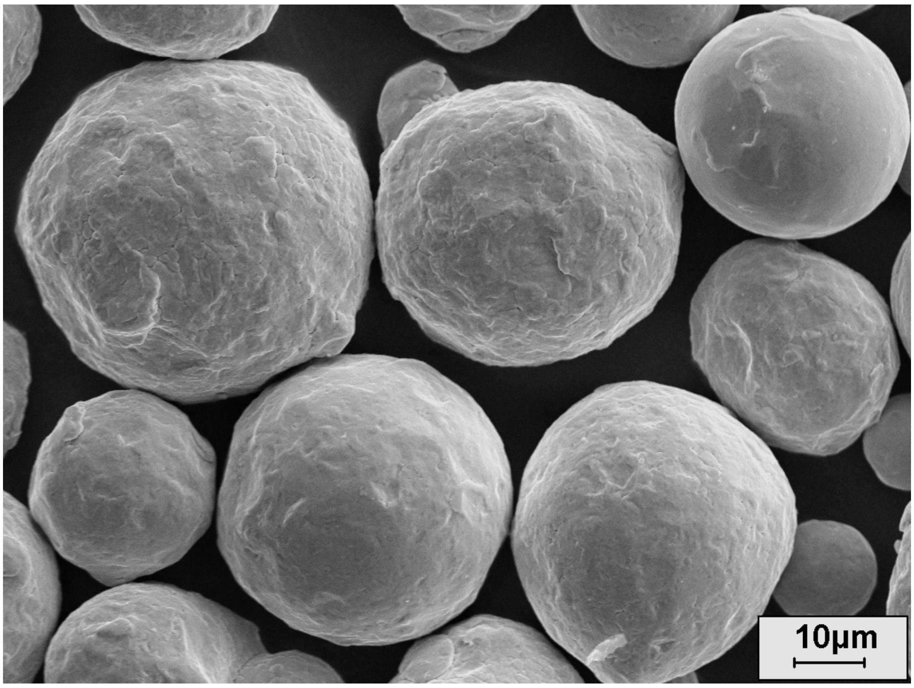


Figure 3: Scanning electron micrograph of a *gas atomized* Ni20Cr powder

Agglomerated and sintered powders

Due to a large surface / volume ratio agglomerated and sintered powders show excellent melting behavior. Their flowing characteristics are relatively good due to nearly spherical shape of most particles (**figure 4**).

Powders are produced by atomizing a suspension containing one or more material constituents as well as an organic binder into a large vessel that is kept at constant elevated temperature. Thereby spherical agglomerates are formed. The process is well established for manufacturing of cermet powders, but oxide powders are also produced. In order to avoid particle break up due to high shearing forces acting in the spray jet, in particular in the high velocity flames of HVOF guns, the agglomerates are densified in either a thermal plasma jet or in a sintering furnace. In addition, during the densification process the organic binder that would affect thermal spray coatings mechanical properties is eliminated.

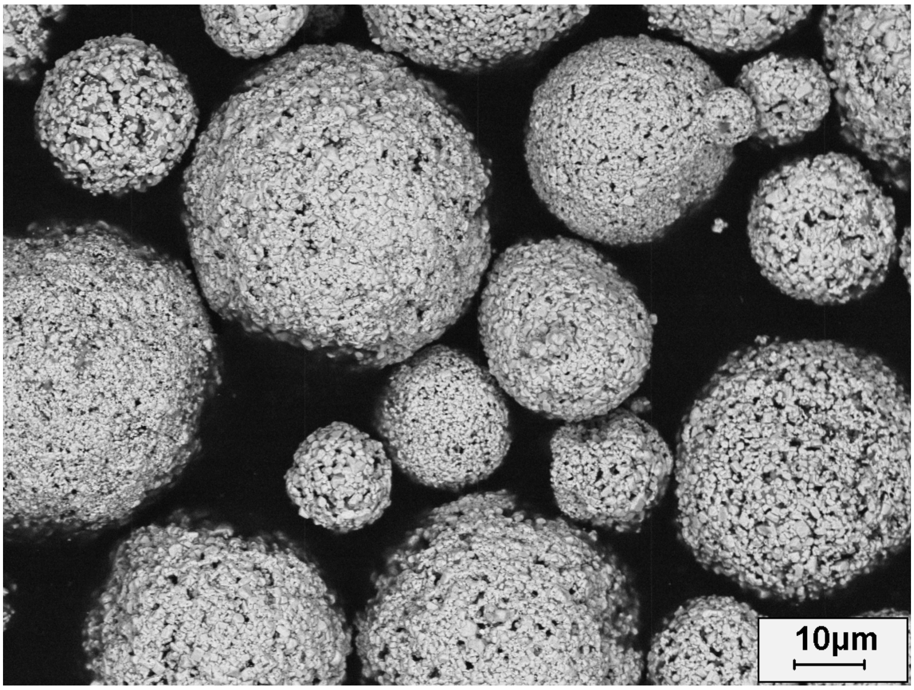


Figure 4: Scanning electron micrograph of an *agglomerated and sintered* WC/Co 88/12 powder

Clad powders

To protect specific material constituents of compound powders against direct contact with the heat source of a thermal spray process or to take influence on chemical reactions of the powder constituents several powders clad.

CVD and sol gel processes are used as well as electrolytic coating processes. Furthermore adapted milling processes permit a so called mechanical cladding. Finally relatively coarse core particles are clad by fine powder particles of another constituent by use of an organic binder (**figure 5**). Like in the case of agglomerated and sintered powder the composite strength can be improved by annealing. Thereby it is important not to initiate chemical reactions that are desired to occur only in the spraying process.

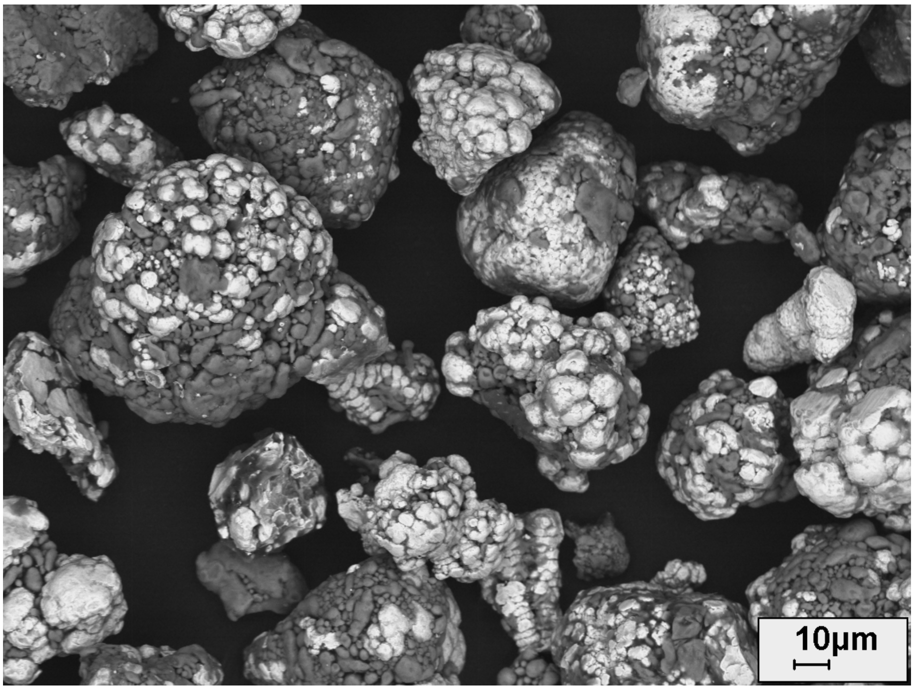


Figure 5: Scanning electron micrograph of an aluminum *clad* nickel powder (Ni5Al)

Content

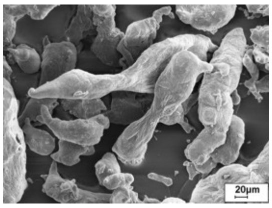
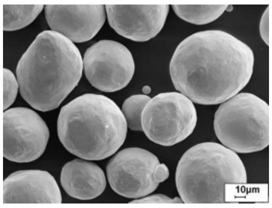
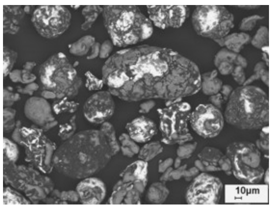
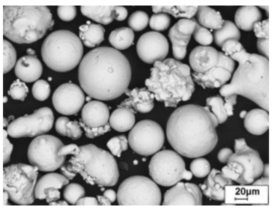
Metals and metallic alloys

Cermets (Metal-ceramic composites)

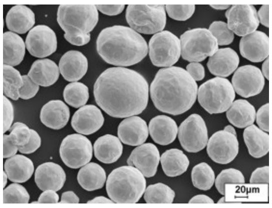
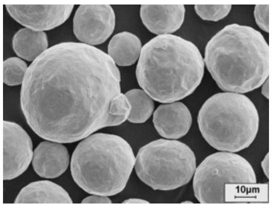
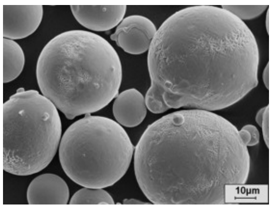
Oxide ceramics

Polymers

Metals and metallic alloys

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on aluminum					
Al, water atomized 	**Al 99.0%**	**30.54.1**	**+20 µm -45 µm**	**APS**	• **Repair of aluminum and magnesium alloys** • **Corrosion protection for pH 5 - 8,3, even at elevated temperature**
		30.54.2	**+45 µm -90 µm**	**PFS**	
Materials based on copper					
Cu, water atomized 	**Cu 99.0%**	**30.55.2**	**+45 µm -90 µm**	**PFS**	• **Repair of copper and copper alloys** • **High electrical conductivity** • **High thermal conductivity**
Cu/Al, clad powder 	**Al 10%** **Cu rest** (Metco 445)	**20.45.2**	**+45 µm -90 µm**	**PFS**	• **Bearing material featuring excellent gliding and dry-running operation properties** • **„Self bonding“ due to chem. reaction of components** • **Applicable up to about 230 °C**
CuAlFe, gas atomized 	**Al 10%** **Fe 1%** **Cu rest**	**30.51.2**	**+45 µm -90 µm**	**PFS**	• **Repair of copper and copper alloys** • **Bearing material featuring excellent gliding and dry-running operation properties** • **Applicable up to about 230 °C**

Specified powder represent a selection only.
We ask for your detailed enquiry.

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on iron					
Chromium steel, gas atomized	Cr 13.5% C 0.45% Fe rest	80.91.8	+15 µm -45 µm	HVOF APS	• Machinable steel for repair and build-up • Hardness: 34 HRC
Chromium steel, gas atomized	Cr 16% Ni 2% C 0.2% Fe rest	30.42.2	+45 µm -90 µm	PFS APS	• Machinable steel for repair and build-up • Hardness: 35 HRC
Aluminum-Molybdenum-Steel, clad powder	Al 10% Mo 1% C 0.2% Fe rest	20.48.2	+45 µm -90 µm	PFS APS	• Low shrinkage machinable steel for repair and build-up • „Self bonding“ due to chem. reaction of components • Hardness: 45 HRC • Applicable up to about 370 °C
Chromium-Nickel-Steel, gas atomized (AISI 316L)  	Cr 17% Ni 12.5% Mo 2.5% Si 0.7% Mn 1.5% C 0.02% Fe rest	30.46.2	+45 µm -90 µm	PFS APS	• Machinable austenitic steel for repair and build-up • High corrosion resistance in various media • Applicable up to about 540 °C
		80.46.1	+20 µm -45 µm	HVOF	
Iron based hard alloy, gas atomized 	Cr 27% Ni 11% Mo 4% Si 1.5% C 2.0% Fe rest	81.43.8S	+15 µm -53 µm	HVOF	• Corrosion protective coatings with excellent corrosion resistance in various media • Coating hardness 700 HV0,3

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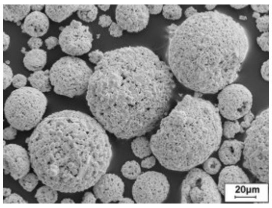
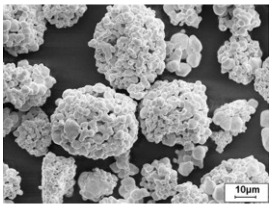
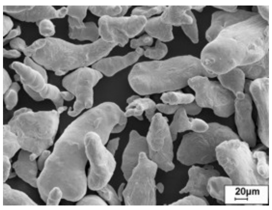
	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on molybdenum					
Mo, agglomerated and sintered  	Mo 99.0% O 0.1%	30.63.2	+45 µm -90 µm	PFS APS	• High adhesion strength due to high particle temperature and strong chemical reactivity • High resistance against all kinds of wear stress with excellent sliding properties • Coating hardness depending on oxidation 300 - 600 HV0,3 • Applicable up to about 320 °C (for excessive temperature oxidation)
		80.63.1	+20 µm -53 µm	HVOF	
		80.63.1S	+15 µm -45 µm	HVOF	
Mo / NiCrBSi, powder blend	Ni 18% Cr 4.5% B 0.8% Si 2% Fe 1% Mo rest	30.05.2	+45 µm -90 µm	PFS	• High resistance against all kinds of wear stress • Hardness: 55 HRC • Applicable up to about 320 °C (for excessive temperature oxidation)
		80.05.1	+20 µm -45 µm	APS HVOF	

Materials based on zinc					
Zn, water atomized 	Zn 99.0%	30.10.2	+45 µm -90 µm	PFS	• Corrosion protection for pH 7 - 12.5, at maximum temperature of 60 °C

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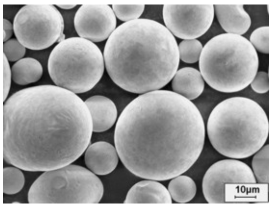
	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on cobalt					
CoCrW, gas atomized 	**Cr 30%** **W 12%** **C 2.5%** **Co rest** (Stellite® 1)	**10.01.6**	**+45 µm** **-125 µm**	**PFS** **APS**	• **High resistance against all kinds of wear stress** • **Good sliding properties** • **High impact resistance** • **High hot gas corrosion and oxidation resistance** • **Excellent corrosion resistance in various media** • **Hardness: HRC 54** • **Applicable up to about 730 °C**
		85.01.1	**+20 µm** **-45 µm**	**HVOF**	
CoCrW, gas atomized	**Cr 28%** **W 4%** **C 1.1%** **Co rest** (Stellite® 6)	**15.06.6**	**+45 µm** **-125 µm**	**PFS** **APS**	• **High resistance against all kinds of wear stress** • **Good sliding properties** • **High impact resistance** • **High hot gas corrosion and oxidation resistance** • **Excellent corrosion resistance in various media** • **Hardness: HRC 42** • **Applicable up to about 730 °C**
		85.06.1	**+20 µm** **-45 µm**	**HVOF**	
CoCrW, gas atomized	**Cr 28%** **W 8%** **C 1.5%** **Co rest** (Stellite® 12)	**15.12.6**	**+45 µm** **-125 µm**	**PFS** **APS**	• **High resistance against all kinds of wear stress** • **Good sliding properties** • **High impact resistance** • **High hot gas corrosion and oxidation resistance** • **Excellent corrosion resistance in various media** • **Hardness: HRC 48** • **Applicable up to about 730 °C**
		85.12.1	**+20 µm** **-45 µm**	**HVOF**	
CoNiCrAlY, gas atomized	**Ni 32%** **Cr 21%** **Al 8%** **Y 0.5%** **Co rest**	**60.95.1**	**+20 µm** **-45 µm**	**HVOF** **VPS**	• **Repair of super alloys with comparable composition** • **Excellent hot gas corrosion and oxidation resistance** • **Excellent corrosion resistance in various media** • **Applicable up to about 1050 °C**

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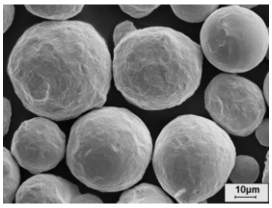
	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on nickel I					
Ni, water atomized	Ni 99.0%	80.56.1	+20 µm -45 µm	APS HVOF	• Machinable material for repair and build-up of nickel and nickel based alloys • Good corrosion resistance in various media
NiCr, gas atomized  	Cr 20% Ni rest	80.20.1	+20 µm -53 µm	APS HVOF	• Excellent bond coat for ceramic top coats • Machinable material for repair and build-up • High hot gas corrosion and oxidation resistance • Excellent corrosion resistance in various media • Applicable up to about 1000 °C
		80.20.0	+10 µm -30 µm	APS HVOF	
		20.43.2	+45 µm -90 µm	PFS	
Ni/Cr, clad powder	Cr 6% Ni rest	60.43.6	+45 µm -125 µm	APS	• Excellent bond coat for ceramic top coats • Machinable material for repair and build-up • High hot gas corrosion and oxidation as well as general corrosion resistance • Applicable up to about 1000 °C
NiCrAl, gas atomized	Cr 18% Al 6% Ni rest	80.01.1	+20 µm -53 µm	APS HVOF	• Excellent bond coat for ceramic top coats • Machinable material for repair and build-up • High hot gas corrosion and oxidation as well as general corrosion resistance • Applicable up to about 1000 °C
		30.01.2	+45 µm -90 µm	PFS	
NiCrFe, gas atomized	Cr 16% Fe 9% Si 0.5% Ni rest	30.04.2	+45 µm -90 µm	PFS	• Excellent bond coat for ceramic top coats • Machinable material for repair and build-up • High hot gas corrosion and oxidation as well as general corrosion resistance • Applicable up to about 870 °C

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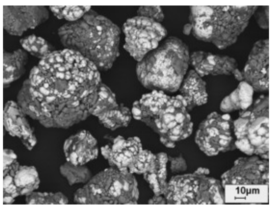
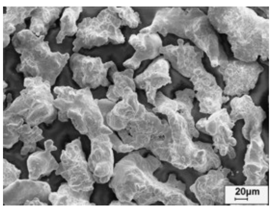
	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on nickel II					
NiCrMoAl, clad powder (Metco 442)	**Cr 8.5%** **Al 7%** **Mo 5%** **Si 2%** **B 2%** **Fe 2 %** **TiO_2 3 %** **Ni rest**	**20.42.2**	**+45 µm -90 µm**	**PFS**	• **Material for repair and build-up with limited machinability** • **High wear resistance** • **Good corrosion resistance in various media** • **„Self bonding“ due to chem. reaction of components** • **Hardness: HRC 35** • **Applicable up to about 750 °C**
NiCrMoAlFe, clad powder (Metco 444)	**Cr 9%** **Al 7%** **Mo 5.5%** **Fe 5%** **Ni rest**	**20.44.2**	**+45 µm -90 µm**	**PFS**	• **Machinable material for repair and build-up** • **High wear resistance** • **Good corrosion resistance in various media** • **„Self bonding“ due to chem. reaction of components** • **Applicable up to about 870 °C**
Ni/Al, clad powder 	**Al 5%** **Ni rest**	**20.50.2**	**+45 µm -90 µm**	**PFS**	• **Machinable material for repair and build-up** • **Excellent bond coat for ceramic top coats with high ductility and impact resistance** • **Good corrosion resistance in various media** • **„Self bonding“ due to chem. reaction of components** • **Applicable up to about 800 °C**
NiAl, water atomized 	**Al 5%** **Ni rest**	**21.50.2**	**+45 µm -90 µm**	**PFS APS**	• **Machinable material for repair and build-up** • **Excellent bond coat for ceramic top coats with high ductility and impact resistance** • **Good corrosion resistance in various media** • **Applicable up to about 800 °C**
NiAl, water atomized	**Al 31%** **Ni rest**	**21.69.1**	**+20 µm -45 µm**	**APS**	• **Good corrosion resistance in various media** • **Good hot gas corrosion resistance** • **Applicable up to about 800 °C**

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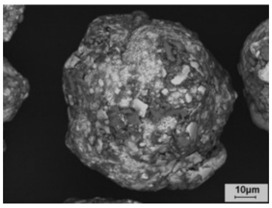
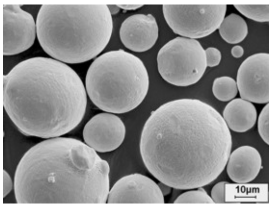
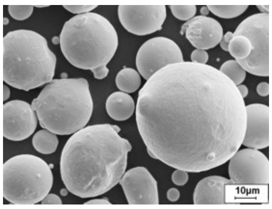
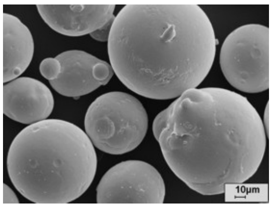
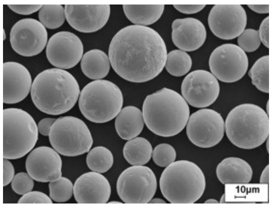
	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on nickel III					
NiAlMo, clad powder  	**Al 5.5%** **Mo 5%** **Ni rest** (Metco 447)	**20.47.2**	**+45 µm** **-90 µm**	**PFS** **APS**	• **Machinable material for repair and build-up** • **High wear resistance** • **High ductility and impact resistance** • **Good corrosion resistance in various media** • **„Self bonding“ due to chem. reaction of components**
NiCrAlY, gas atomized	**Cr 22%** **Al 10%** **Y 1%** **Ni rest**	**60.46.8**	**+15 µm** **-38 µm**	**HVOF** **VPS**	• **Repair of super alloys with comparable composition** • **Excellent hot gas corrosion resistance** • **Excellent corrosion resistance in various media** • **Applicable up to about 1050 °C**
NiCrMoNb, gas atomized  	**Cr 21%** **Mo 9%** **Nb 3.5%** **Ni rest** (Inconel® 625)	**80.25.1**	**+20 µm** **-53 µm**	**APS** **HVOF**	• **Machinable material for repair and build-up of super alloys with comparable composition** • **High wear resistance** • **Good hot gas corrosion resistance** • **Excellent corrosion resistance in various media** • **Applicable up to about 800 °C**
NiCrMoW, gas atomized  	**Cr 16%** **Mo 16%** **W 4%** **Fe 5.5%** **Ni rest** (Hastalloy® C / C-276)	**80.93.1**	**+20 µm** **-53 µm**	**APS** **HVOF**	• **Machinable material for repair and build-up of super alloys with comparable composition** • **High wear resistance** • **Good hot gas corrosion resistance** • **Excellent corrosion resistance in various media** • **Applicable up to about 800 °C**

Specified powder represent a selection only.
We ask for your detailed enquiry.

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on nickel (Self fluxing alloys) I					
NiBSi, gas atomized	**B 1.3%** **Si 2.3%** **Fe 1%** **Ni rest** HRC 22	**10.10.5**	**+30 µm** **-105 µm**	**PFS** **APS**	• **High wear resistance** • **Good corrosion resistance in various media** • **Good machinability** • **After fusion coatings are gas tight and metallurgically bonded to substrates due to diffusion** • **Hardness: HRC 22-25** • **Applicable up to about 820 °C**
		10.10.6	**+45 µm** **-125 µm**	**PFS** **APS**	
NiCrBSi, gas atomized	**Cr 7%** **B 1.25** **Si 3.4%** **Fe 3%** **C 0.15%** **Ni rest** HRC 30	**10.11.5**	**+30 µm** **-105 µm**	**PFS** **APS**	• **High wear resistance** • **Good corrosion resistance in various media** • **Good machinability** • **After fusion coatings are gas tight and metallurgically bonded to substrates due to diffusion** • **Hardness: HRC 33-35** • **Applicable up to about 820 °C**
NiCrBSi, gas atomized	**Cr 7.5%** **B 1.7%** **Si 3.5%** **Fe 2.5%** **C 0.25%** **Ni rest** HRC 40	**10.12.6**	**+45 µm** **-125 µm**	**PFS** **APS**	• **High wear resistance** • **Good corrosion resistance in various media** • **Good machinability** • **After fusion coatings are gas tight and metallurgically bonded to substrates due to diffusion** • **Hardness: HRC 30-35** • **Applicable up to about 820 °C**
NiCrBSi, gas atomized	**Cr 14%** **B 2.5%** **Si 3.7%** **Fe 4%** **C 0.5%** **Ni rest** HRC 50	**10.14.6**	**+45 µm** **-125 µm**	**PFS** **APS**	• **High wear resistance** • **Good corrosion resistance in various media** • **Good machinability** • **After fusion coatings are gas tight and metallurgically bonded to substrates due to diffusion** • **Low susceptibiloity to cracking** • **Hardness: HRC 48-50** • **Applicable up to about 820 °C**

Specified powder represent a selection only.
We ask for your detailed enquiry.

Materials based on nickel (Self fluxing alloys) II

	chemical composition	GTV number	particle size	spraying process	properties / application fields
NiCrBSi, water atomized	Cr 14% B 3.3% Si 4.5% Fe 4.5% C 0.75% Ni rest HRC 60	10.15.6	+45 µm -125 µm	PFS APS	• High wear resistance • Good corrosion resistance in various media • High impact resistance • After fusion coatings are gas tight and metallurgically bonded to substrates due to diffusion • Hardness: HRC 60-62 • Applicable up to about 820 °C
NiCrBSi, gas atomized   		10.15.6G	+45 µm -125 µm	PFS APS	
		80.15.1	+20 µm -53 µm	HVOF	
NiCrBSiCuMo, gas atomized	Cr 16% B 3.5% Si 4.5% Fe 3.5% Cu 3% Mo 3% C 0.5% Ni rest HRC 58	10.16.6	+45 µm -125 µm	PFS APS	• High wear resistance • Good corrosion resistance in various media • High impact resistance, maximum edge stability • After fusion coatings are gas tight and metallurgically bonded to substrates due to diffusion • Hardness: HRC 58 • Applicable up to about 820 °C
NiCrBSiFeMoCo, gas atomized	no declaration HRC 52	10.18.6	+45 µm -125 µm	PFS APS	• High wear resistance • Good corrosion resistance in various media • High impact resistance • After fusion coatings are gas tight and metallurgically bonded to substrates due to diffusion • Hardness: HRC 52 • Applicable up to about 760 °C

Specified powder represent a selection only.
We ask for your detailed enquiry.

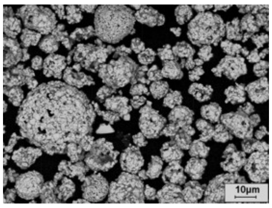
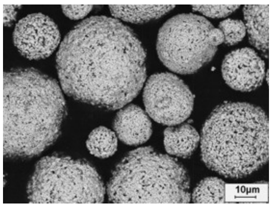
Cermets (Metal-Ceramic Composites)

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Self fluxing alloys with carbide reinforcement					
NiCrBSi, WC/Co 88/12, powder blend	80.15.1 20% 80.71.1 80%	80.32.1	+20 µm -45 µm	HVOF APS	• High wear resistance • Good corrosion resistance in various media • High impact resistance • Applicable up to about 540 °C
	10.15.6 20% 10.71.2 80%	10.32.6	+45 µm -125 µm	PFS APS	
NiCrBSi, WC/Ni 88/12, powder blend	80.15.1 50% 80.77.1 50%	80.34.1	+20 µm -45 µm	HVOF APS	• High wear resistance • Good corrosion resistance in various media • High impact resistance • More ductile than 80.32.1 / 10.32.6 • Applicable up to about 540 °C
	10.15.6 50% 10.77.2 50%	10.34.5	+30 µm -105 µm	PFS APS	
		10.34.6	+45 µm -125 µm	PFS APS	
NiCrBSi, WC/Ni 88/12, powder blend	10.15.6 65% 10.77.2 35%	10.36.6	+45 µm -125 µm	PFS APS	• High wear resistance • Good corrosion resistance in various media • High impact resistance • More ductile than 10.34.6 • Applicable up to about 540 °C
NiCrBSi, WC/Ni 88/12, powder blend	10.15.6 35% 10.77.2 65%	10.37.6	+45 µm -125 µm	PFS APS	• High wear resistance • Good corrosion resistance in various media • High impact resistance • Applicable up to about 540 °C
NiCrBSi, Cr_3C_2/Ni 25/75, powder blend	10.15.6 25% 10.81.2 75%	10.81.2	+45 µm -125 µm	PFS APS	• High wear resistance • Good corrosion resistance in various media • High impact resistance • Applicable up to about 820 °C

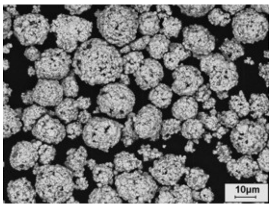
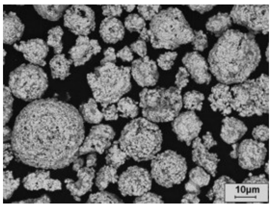
Specified powder represent a selection only.
We ask for your detailed enquiry.

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Nickel based alloys with oxide reinforcement					
NiAl, ZrO_2/Y_2O_3 92/8, powder blend	**20.50.2 35%** **40.23.4 65%**	**40.12.4**	**+15 µm** **-90 µm**	**APS**	• **High wear resistance** • **Good corrosion resistance in various media** • **Bond strength, impact and thermal shock resistance better than for pure ceramic coatings** • **Applicable up to about 800 °C**
NiAl, ZrO_2/Y_2O_3 92/8, powder blend	**20.50.2 65%** **40.23.4 35%**	**40.13.4**	**+15 µm** **-90 µm**	**APS**	• **High wear resistance** • **Good corrosion resistance in various media** • **Bond strength, impact and thermal shock resistance better than for pure ceramic coatings** • **Applicable up to about 800 °C**
NiAl, ZrO_2/MgO 80/20, powder blend	**20.50.2 35%** **40.21.4 65%**	**40.14.4**	**+15 µm** **-90 µm**	**APS**	• **High wear resistance** • **Good corrosion resistance in various media** • **Bond strength, impact and thermal shock resistance better than for pure ceramic coatings** • **Applicable up to about 800 °C**

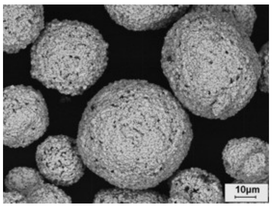
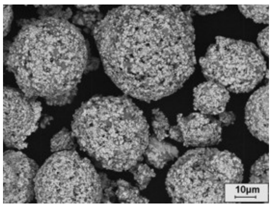
Specified powder represent a selection only.
We ask for your detailed enquiry.

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on tungsten carbide I					
WC/Co 88/12, agglomerated and sintered 	**Co 12% C 4% W rest**	**80.71.0W20**	**+5 µm -20 µm**	**HVOF**	• **Excellent wear resistance** • **Suitable for replacement of electroplated hard chromium in non-corrosive media** • **Coating hardness 800-1400 HV0,3** • **Applicable up to about 540 °C**
		80.71.0	**+5 µm -25 µm**	**HVOF**	
		**80.71.1**	**+20 µm -45 µm**	**HVOF APS**	
		80.71.1W	**+20 µm -53 µm**	**HVOF APS**	
		80.71.3W	**+5 µm -45 µm**	**HVOF APS**	
		80.71.8S	**+10 µm -40 µm**	**HVOF APS**	
		10.71.2	**+45 µm -90 µm**	**APS PFS**	
		10.71.60W	**+90 µm -125 µm**	**APS PFS**	
WC/Co 88/12, PTFE, powder blend	**65.00.1 6% 80.71.1W 94%**	**65.71.1-6P**	**+15 µm -53 µm**	**HVOF APS**	• **Excellent wear resistance** • **Anti-sticking properties due to lower surface energy compared to 80.71 und 10.71** • **Applicable up to about 260 °C**

Specified powder represent a selection only.
We ask for your detailed enquiry.

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on tungsten carbide II					
WC/Co 83/17, agglomerated and sintered 	**Co 17% C 5.2% W rest**	**80.73.0W20**	**+5 µm -20 µm**	**HVOF**	• **Excellent wear resistance** • **For adequate processing conditions higher ductility and lower hardness than 80.71** • **Coating hardness 800-1400 HV0,3** • **Applicable up to about 540 °C**
		80.73.1	**+20 µm -45 µm**	**HVOF APS**	
		80.73.1W	**+20 µm -53 µm**	**HVOF APS**	
WC/CoCr 86/10-4, agglomerated and sintered 	**Co 10% Cr 4% C 5.3% W rest**	**80.76.0W20**	**+5 µm -20 µm**	**HVOF**	• **Excellent wear resistance** • **Improved corrosion resistance compared to 80.71 and 80.73** • **Application in various media for pH > 4 possible** • **Superior to electroplated hard chromium in most properties** • **Coating hardness 800-1450 HV0,3** • **Applicable up to about 540 °C**
		80.76.0W	**+5 µm -25 µm**	**HVOF**	
		80.76.1	**+20 µm -45 µm**	**HVOF APS**	
		80.76.8W	**+10 µm -38 µm**	**HVOF APS**	

Specified powder represent a selection only.
We ask for your detailed enquiry.

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on tungsten carbide III					
WC/Ni 88/12, agglomerated and sintered 	**Ni 12%** **C 4.2%** **W rest**	**80.77.1**	**+20 µm** **-45 µm**	**HVOF** **APS**	• **Excellent wear resistance** • **Improved corrosion resistance compared to 80.71 in many media** • **Application in various media for pH > 5 possible** • **Coating hardness 1000-1200 HV0,3** • **Applicable up to about 540 °C**
		80.77.1W	**+20 µm** **-53 µm**	**HVOF** **APS**	
		10.77.2	**+45 µm** **-90 µm**	**APS** **PFS**	
WC/Cr$_3$C$_2$/Ni 73/20/7, agglomerated and sintered 	**Ni 7%** **Cr 21%** **C 5.7%** **W rest**	**80.75.1**	**+20 µm** **-45 µm**	**HVOF** **APS**	• **Excellent wear resistance** • **Improved corrosion resistance compared to 80.71 in many media** • **Application in various media for pH > 4 possible** • **Coating hardness 1000-1200 HV0,3** • **Applicable up to about 540 °C**
		80.75.1X	**+15 µm** **-45 µm**	**HVOF** **APS**	

Specified powder represent a selection only.
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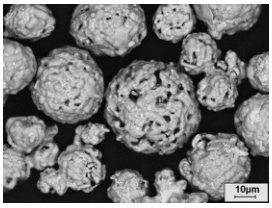
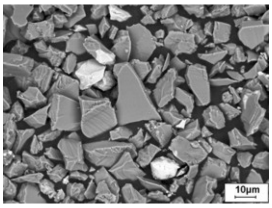
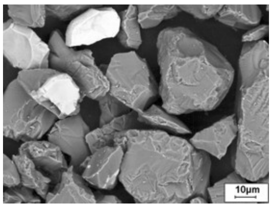
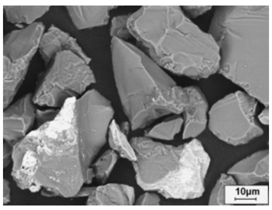
	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on chromium carbide					
Cr_3C_2/Ni20Cr 75/25, agglomerated and sintered 	Ni 20% C 10% Cr rest	80.81.1	+20 µm -45 µm	HVOF APS	• Excellent combined wear and corrosion resistance in various media • Coating hardness 800-1300 HV0,3 • Applicable up to about 980 °C
		80.81.1W	+20 µm -53 µm	HVOF APS	
		80.81.3W	+5 µm -45 µm	HVOF APS	
		80.81.8W	+10 µm -38 µm	HVOF APS	
		10.81.2	+45 µm -90 µm	APS PFS	
Cr_3C_2/Ni20Cr 75/25, PTFE, powder blend	PTFE 10% 80.81.1 90%	65.81.1-10P	+20 µm -45 µm	HVOF APS	• Excellent wear resistance • Anti-sticking properties due to lower surface energy compared to 80.81 und 10.81 • Applicable up to about 260 °C
Materials based on graphite					
Ni/graphite 85/15, clad powder	graphite 15% Ni rest	60.08.5	+30 µm -105 µm	APS	• Excellent abradable coating • Good sliding properties • Long term applicability for temperatures up to about 480°C

Specified powder represent a selection only.
We ask for your detailed enquiry.

Oxide ceramics

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on alumina I					
Al_2O_3, fused and crushed	Al_2O_3 99,0%	40.05.0	+5 µm -25 µm	$HVOF_{Gas}$ APS	• High wear resistance except for fatigue load conditions • Coating hardness 600-1200 HV0,3 • Applicable up to about 1500 °C • Excellent dielectric strength, especially at elevated temperature • Electr. resistance: 10^{15} Wcm • High chemical resistance except for bases
		40.05.1	+15 µm -45 µm	APS	
Al_2O_3/TiO_2 97/3, fused and crushed 	TiO_2 3% Al_2O_3 Rest	40.01.0	+5 µm -25 µm	$HVOF_{Gas}$ APS	• High chemical resistance except for bases • High wear resistance except for fatigue load conditions • Higher ductility than 40.05 • Lower roughness than for 40.05 possible after grinding • Coating hardness 600-1100 HV0,3 • Applicable up to about 1100 °C
		40.01.1	+20 µm -45 µm	APS	
		40.01.4	+15 µm -60 µm	APS	
		40.01.8	+10 µm -40 µm	APS	

Specified powder represent a selection only.
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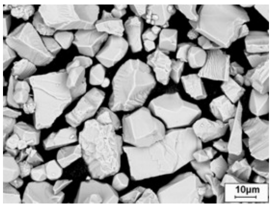
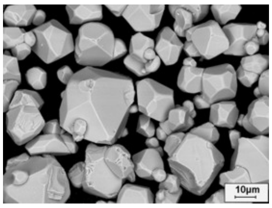
	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on alumina II					
Al_2O_3/TiO_2 87/13, fused and crushed	TiO_2 13% Al_2O_3 rest	40.30.0	+5 µm -25 µm	HVOF$_{Gas}$ APS	• High chemical resistance except for bases • High wear resistance except for fatigue load conditions • Higher ductility than 40.01 • Lower roughness than for 40.01 possible after grinding (R_a = 0,2 µm) • Coating hardness 500-1000 HV0,3 • Applicable up to about 550 °C • Low wettability
		40.30.1	+20 µm -45 µm	APS	
		40.30.4	+15 µm -60 µm	APS	
Al_2O_3/TiO_2 60/40, fused and crushed	TiO_2 40% Al_2O_3 rest	40.31.0	+5 µm -25 µm	HVOF$_{Gas}$ APS	• Lower chemical resistance than 40.30 • High wear resistance except for fatigue load conditions • Higher ductility than 40.30 • Lower roughness than for 40.30 possible after grinding • Coating hardness 400-1000 HV0,3 • Applicable up to about 550 °C • Low wettability
		40.31.1	+20 µm -45 µm	APS	
		40.31.4	+15 µm -60 µm	APS	
Al_2O_3/TiO_2 50/50, fused and crushed	TiO_2 50% Al_2O_3 rest	40.33.0	+5 µm -25 µm	HVOF$_{Gas}$ APS	• Lower chemical resistance than 40.31 • High wear resistance except for fatigue load conditions • Higher ductility than 40.31 • Lower roughness than for 40.31 possible after grinding • Coating hardness 400-900 HV0,3 • Applicable up to about 550 °C • Low wettability
		40.33.1	+20 µm -45 µm	APS	
		40.33.4	+15 µm -60 µm	APS	

Specified powder represent a selection only.
We ask for your detailed enquiry.

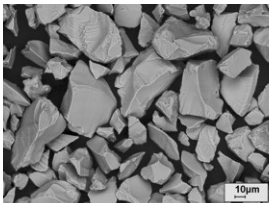
	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on alumina III					
Al_2O_3/ZrO_2 75/25, fused and crushed	ZrO_2 25% Al_2O_3 rest	40.28.1	+20 µm -45 µm	APS	• High wear resistance except for fatigue load conditions • Applicable up to about 1300 °C
Al_2O_3/MgO 72/28, fused and crushed	MgO 28% Al_2O_3 rest	40.29.1	+20 µm -45 µm	APS	• High wear resistance except for fatigue load conditions • Applicable up to about 900 °C
Al_2O_3/TiO_2/PTFE, powder blend	PTFE 10% TiO_2 11.7% Al_2O_3 rest	65.30.1-10P	+20 µm -45 µm	$HVOF_{Gas}$ APS	• High wear resistance except for fatigue load conditions • Lower surface energy compared to pure ceramic coatings, therefore anti-sticking property • Applicable up to about 260 °C

Specified powder represent a selection only.
We ask for your detailed enquiry.

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on chromia I					
Cr_2O_3, fused and crushed 	Cr_2O_3 97%	40.06.0	+5 µm -25 µm	$HVOF_{Gas}$ APS	• High chemical resistance for all pH values • High wear resistance except for fatigue load conditions • Low roughness possible after grinding (R_a = 0,1 µm) • Electr. resistance: 10^7 Wcm • Coating hardness 1500 HV0,3 • Applicable up to about 500 °C
		40.06.1	+20 µm -45 µm	APS	
		40.06.4	+15 µm -60 µm	APS	
Cr_2O_3, fused and crushed 	Cr_2O_3 99.6%	41.06.0	+5 µm -25 µm	$HVOF_{Gas}$ APS	• High chemical resistance for all pH values • High wear resistance except for fatigue load conditions • Low roughness possible after grinding (R_a = 0,1 µm) • Electr. resistance: 10^7 Wcm • Coating hardness 1500 HV0,3 • Applicable up to about 500 °C • Higher purity than 40.06; metal free, therefore laser engraving possible
		41.06.1	+20 µm -45 µm	APS	
		41.06.8	+15 µm -38 µm	APS	

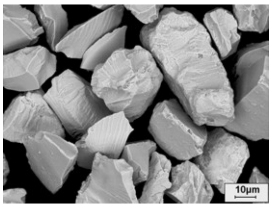
Specified powder represent a selection only.
We ask for your detailed enquiry.

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on chromia II					
Cr_2O_3/TiO_2 60/40, fused and crushed	TiO_2 40% Cr_2O_3 rest	40.60.1	+20 µm -45 µm	APS	• High wear resistance except for fatigue load conditions • Improved ductility compared to pure Cr_2O_3 coatings • Coating hardness 600 HV0,3 • Applicable up to about 500 °C • Low roughness possible after grinding
$Cr_2O_3/SiO_2/TiO_2$ 92/5/3, fused and crushed	SiO_2 5% TiO_2 3% Cr_2O_3 rest	40.36.0	+5 µm -25 µm	$HVOF_{Gas}$ APS	• High chemical resistance for all pH values • High wear resistance except for fatigue load conditions • More impact resistant than pure Cr_2O_3 coatings • Coating hardness 900-1300 HV0,3 • Applicable up to about 500 °C
		40.36.1	+20 µm -45 µm	APS	

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on titania					
TiO_2, fused and crushed 	TiO_2 97%	40.02.1	+20 µm -45 µm	APS	• Good wear resistabce (however, lower compared to alumina or chromia based coatings) except for fatigue load conditions • Improved ductility compared to Cr_2O_3 coatings • Coating hardness 650 HV0,3 • Applicable up to about 500 °C • antistatic

Specified powder represent a selection only.
We ask for your detailed enquiry.

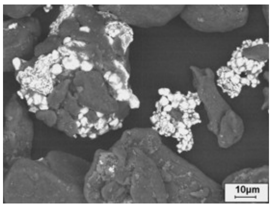
Materials based on zirconia I

	chemical composition	GTV number	particle size	spraying process	properties / application fields
ZrO_2/Y_2O_3 92/8, fused and crushed 	Y_2O_3 8% ZrO_2 rest	40.23.1	+20 µm -45 µm	APS	• Optimum coating material for heat insulation due to low thermal conductivity and excellent thermal shock resistance • Low thermal expansion mismatch to super alloys (11 10^{-6}·K^{-1}) • Coating hardness 500 HV0,3 • In combination with MCrAlY bond coats on super alloys long term applicability for surface temperatures up 1250 °C • Electr. Resistance: 10^{11} Wcm • Suitable for clearance control
		40.23.4	+15 µm -60 µm	APS	
ZrO_2/Y_2O_3 92/8, agglomerated and sintered	Y_2O_3 8% ZrO_2 rest	40.23.5N	+45 µm -100 µm	APS	
ZrO_2/Y_2O_3 87/13, fused and crushed	Y_2O_3 13% ZrO_2 rest	40.24.1	+20 µm -45 µm	APS	• Low thermal conductivity • High thermal shock resistance, but inferior to 40.23 • Therm. expansion: 11 10^{-6}·K^{-1} • Coatings hardness 500 HV0,3 • Applicable up to about 1150 °C • Suitable for clearance control
ZrO_2/MgO 80/20, fused and crushed	MgO 20% ZrO_2 rest	40.21.1	+20 µm -45 µm	APS	• Low thermal conductivity • High thermal shock resistance, but inferior to 40.23 • Coatings hardness 300-800 HV0,3 • Applicable up to about 900 °C • Suitable for clearance control
ZrO_2/CaO 95/5, fused and crushed	CaO 5% ZrO_2 rest	40.20.1	+20 µm -45 µm	APS	• Low thermal conductivity • High thermal shock resistance, but inferior to 40.23 • Coatings hardness 300-600 HV0,3 • Applicable up to about 900 °C • Suitable for clearance control

Specified powder represent a selection only.
We ask for your detailed enquiry.

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on zirconia II					
ZrO_2/CaO 70/30, fused and crushed	CaO 30% ZrO_2 rest	40.26.1	+20 µm -45 µm	APS	• Low thermal conductivity • High thermal shock resistance, but inferior to 40.23 • Coatings hardness 400 HV0,3 • Applicable up to about 900 °C • Suitable for clearance control

Polymers

	chemical composition	GTV number	particle size	spraying process	properties / application fields
Materials based on PTFE					
PTFE, clad by Mo 	Mo PTFE rest	65.00.1	+20 µm -45 µm	HVOF APS	• Powder for blends offering anti-sticking property coatings • Applicable up to about 260 °C
PTFE, clad by Ni	Ni PTFE rest	65.00.1	+20 µm -45 µm	HVOF APS	• Powder for blends offering anti-sticking property coatings • Applicable up to about 260 °C
PTFE, clad by Al_2O_3/TiO_2 97/3	Al_2O_3/TiO_2 97/3 PTFE rest	65.00.1	+20 µm -45 µm	HVOF APS	• Powder for blends offering anti-sticking property coatings • Applicable up to about 260 °C

Specified powder represent a selection only.
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