Sliding rings and sliding pairings

Manufactered by laser hard coating

Köthener Sepzialdichtungen GmbH |
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The technology

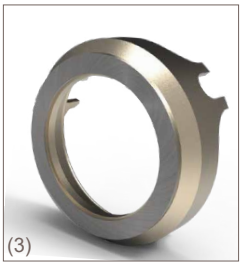
KSD GmbH manufactures slide rings according to the principle of laser hard coating. This innovative photonic coating process enables high-quality alloys to be used in a way that conserves resources. We have succeeded in developing this process to such an extent that it enables the realization of new materials directly in the laser beam. Our many years of experience allow us today to coat the slide ring or slide bearing blanks provided and to subject them to a subsequent high-quality finish. Delivery times within 48 hours are therefore not a problem for our laser hard coating alloys. For individual pieces or small quantities, we can also take over the complete production. Up to a max. Outside diameter of 380 mm, the entire manufacturing and testing process takes place in-house. Larger dimensions, special contours and wire-cut recesses in the sliding surfaces as well as inner coatings of slide bearings from 25 mm bore diameter can also be realized in our company. In addition to the hard metal pairings manufactured by us, we also supply mixed pairings. These include laser hard coating alloys in combination with

- coal und electrographite,
- silicon carbide (SiSiC and SiC)
- silicon infiltrated graphite (C-SiC).

Anwendungsbeispiele


(1)


(2)


(3)

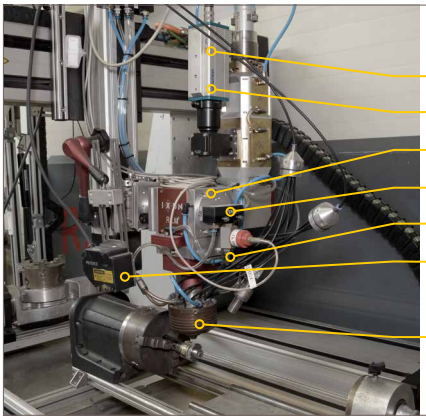

(4)

Fertigungszeiten:
(1) 1h*, (2) 1h*, (3) 1 Tag (Komplettfertigung),
(4) 1 Woche inkl. Drahterodieren

* bei Rohteil Beistellung

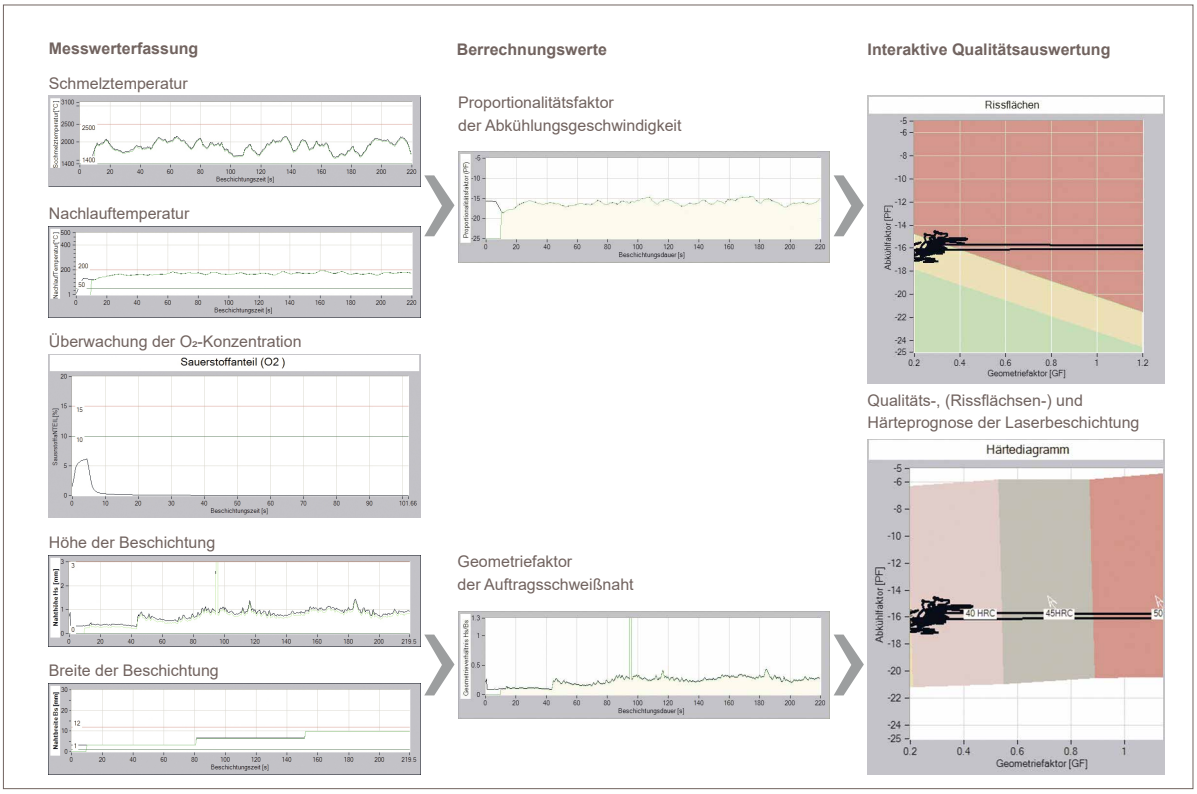
The R: LM² technology developed in-house enables us to create the optimal wear or corrosion protection alloy for your application on the computer and to implement it directly in the laser beam. With this technology, we are also able to precisely control the laser hard coating process and also implement interactive quality monitoring and quality forecasting. [3]

Laserarbeitskopf

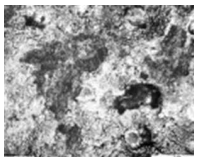
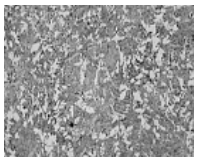
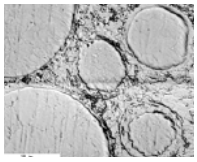
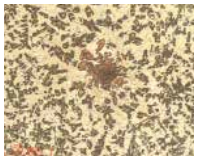
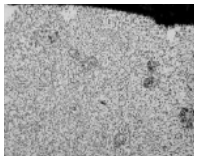
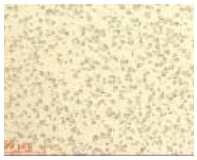
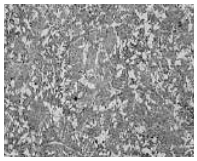
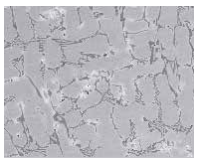


- Kollimation
- Pyrometer zur Schmelztemperaturerfassung
- Arbeitsoptik mit Strahlanpassung
- Injektorsystem zur Überwachung der O_2-Konzentration
- Pyrometer zur Nachlauftemperaturmessung
- Lasertriangulationsmeßsystem zur Erfassung der Beschichtungshöhe und -breite
- Aktive Schutzgashülse zur Optimierung der Schutzgasatmosphäre

Interaktive Qualitätsüberwachung und Prognose



Overview laser hard coating alloys

designating (hardness)	description	qualities	microsection
B40 (40-50 HRC) B60 (50-60 HRC)	Nickel-chromium-boron-silicon alloy (nickel-based superalloy)	Superalloy with excellent media / corrosion resistance. (Comparable to incon alloys) **Wear resistance:** good **Sliding behavior:** good	
M40 (40-50 HRC)	Metastable austenitic iron-based alloy	Metastable austenitic iron-based alloy (corrosion behavior similar to V2A) **Wear resistance:** good. **Sliding behavior:** good	
W4060 (58-63 HRC)	Tungsten carbide nickel base alloy	Super alloy with tungsten carbide. **Media / corrosion properties:** excellent. **wear resistence:** very good **sliding behaviour:** good to very good	
T4040 (58-63 HRC)	Tungsten carbide iron-based alloy (storage alloy[1])	Metastable austenitic iron-based alloy with tungsten carbide. **Media / corrosion properties**: good **wear resistance:** very good **sliding behavior:** very good	
R4040 (55-60 HRC)	Vanadumcarid-iron base alloy (excretion alloy[2])	Metastable austentic iron base alloy with tungsten carbide. **Media/ corrosion properties:** good **wear resistance:** very good **Sliding behavior:** very good	
U406010 (62-67 HRC)	Vanadiumcarbit-chrom base alloy (transformation alloy[3])	Ferritic austentic chrome base alloy with extremely high chrome-, nickel-, and vanadiumcarbid content **media-/corrosion resistance:** very good to excellent, due to small iron content (comparable to V4A) **bonding resistance:** 1 very good to excellent (comparable with SiC) **Sliding behavior:** very good	
A505010 (55-62 HRC)	Titancarbid with intermetallic Matrix (transformation alloy[3])	Iron ventricle titanium caride alloy with an intermetallic matrix of silicon and aluminiummatrix and/orTitan. Specially designed for base materials made of aluminium or titan alloys.	
Stellit 6M (43-45HRC)	Cobat base alloy modified	Cobalt base alloy modified with stanless steel. Specially designed for sliding bearings in magnetic pumps.	

[1] In case of deposit alloys, tungsten carbide is thermally split and tungsten can be deposited into the alloy matrix, which clears it up.
[2] In case of excretion alloys, vanadium or titanium cabides are thermally split, which are then excretend again, but with significantly smaller conglomeration and a smaller grain size spectrum.
[3] Alliages are in-situ alloys, which reform directly in the laser beam.

As basic materials can all weldable materials, preferably stainless steels from 1.4301 (1.4308), as well as titanium and aliuminium alloys be used. The material 1.4305 is unusuable.

The overview of the laser hard coating alloys we carry out can also be a summary of the development in this area. In addition to the classics with their own hard phases, such as the nickel-based alloys B40, B60 and the cobalt-based alloy. Stellit 6M, there are also newer alloy systems with the behavior-proven type. These include the W4060 nickel base alloy system and the T4040 and R4040 iron base alloy.

All iron-based alloys from our company are based on the corrosion-resistant, metastable austenitic alloy M40, which uses boron instead of carbon for the hard phase formation. As a result, she has a significantly better media and corrosion resistance compared to our comparable iron-based alloys Competitor. Work on this innovative iron-based alloy with its own hard phase formation began in the mid-1980s to replace cobalt-based alloys. [2]

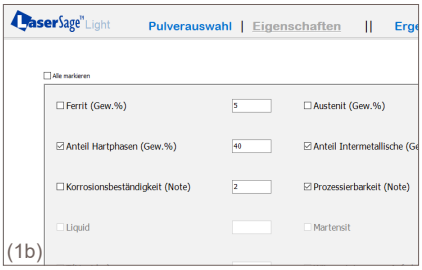
The alloy systems U406010 and A505010 represent a completely new approach to alloying. These systems, known as conversion alloys, only arise in the laser beam focus. These "in-situ alloys" are produced by the thermal splitting of hard materials, which serve as carbon suppliers for the new formation of thermodynamically more stable hard phases. This is why the development of this type of alloy should also be seen in close connection with the introduction of high-energy welding processes, such as laser welding.

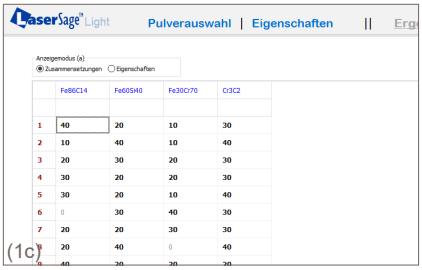
The alloy system U406010 is also representative of a computer-aided material calculation. Even if the theoretical foundations used are based on Gibb's laws, which are more than 150 years old, powerful material simulation programs and the necessary material databases have only been available to industry for a few years.

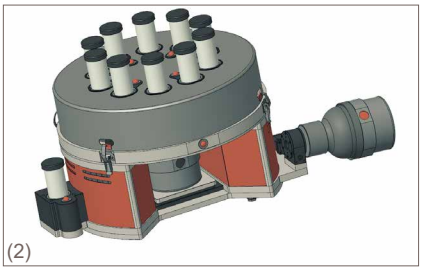
With the alloy U406010, cost-effective and resource-saving ferro-alloys are used for laser cladding for the first time. [4] LASERSAGE[1] was specially developed for material simulation with ferro master alloys. It uses an advanced approach to take into account the rapid cooling that is inherent in the laser cladding process.

The alloys produced in this way are characterized by extreme hardness and wear resistance. Despite their extremely high hardness, these conversion alloys can be welded free of cracks and pores. Their high media and corrosion resistance is another advantage. So z. B. the alloy U406010 from a very low iron content and a very high chromium content. It is therefore justified to call the U406010 a chrome-based alloy.

Our various alloy formulations are made using a mixing computer. This mixing computer works with modern transponder technology, which avoids possible mistakes when mixing the alloys. The mixing computer also carries out automatic batch numbering, which ensures 100% traceability of our products. The powder mixtures produced in this way are then injected into the laser beam on modern laser systems and under an optimal protective gas atmosphere.



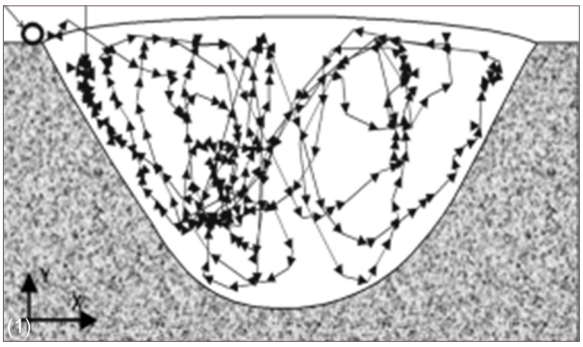


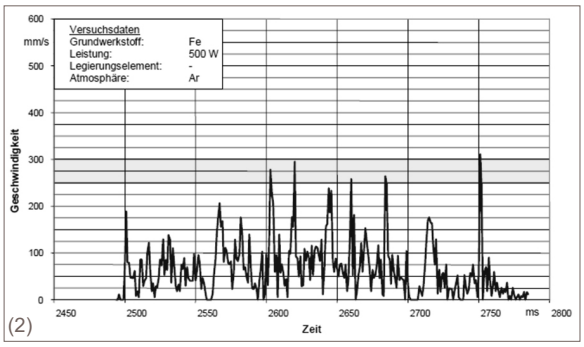


(1) **Lasersageoberflächen**
(1a) Auswahl der gewünschten Legierungspartner
(1b) Auswahl der gewünschten Eigenschaften
(1a) Mögliche Zusammensetzungen der Legierungen
(4) **Pulvermischcomputer**

[1] LASERSAGE wurde im Rahmen des geförderten AIF Projektes „Werkstoffe nach Maß“, durch die beteiligten Partner KSD GmbH, IRAtec GmbH, GTT GmbH und der Hochschule Osnabrück – Bereich Werkstoffinstitut, entwickelt.

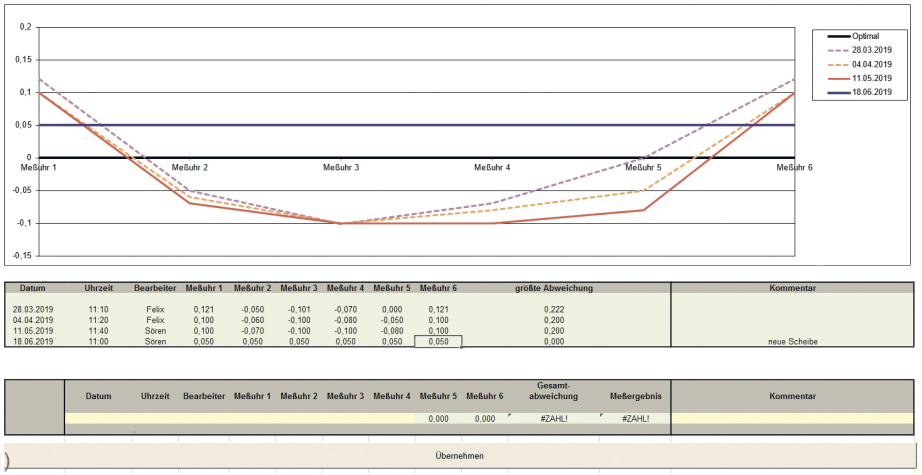
The powder mixtures are melted onto the mechanical seal blank at melting temperatures of 1500–2500 ° C. Despite the high melting temperature, the blank hardly heats up to over 100 ° C. The actual laser hard coating process takes between **3** and **6 minutes** depending on the size of the sliding ring a sliding surface width of up to **5 mm** and a coating thickness of at least 1.2 mm. With extreme dimensions, the process can take up to 20 minutes. During the laser process, we use the marangony flow within the melt, which was first made visible in [1] during a laser cladding process in order to optimally distribute the alloy components.





(1) **Bewegungsvektoren im Schmelzbad** [1]
Laserleistung: 500 W; Schutzgas: Ar, Markierungspartikel: WC
(2) **Geschwindigkeit der WC Partikel** [1]
Die mittlere Geschwindigkeit liegt bei ca. 170 mm/s

After the coating process, each slide ring is trowalized to remove tarnish and any welding spatter that could come off. Then the grinding and lapping of the slide rings is carried out according to strictly defined work programs. In order to meet the high requirements for flatness, surface quality and dimensional accuracy for our sliding rings at all times, the system technology must be constantly checked. For example, an analysis program was developed with which the flatness of the face plate of a lapping machine can be mapped in order to determine the optimal position of the dressing rings.



Datum	Uhrzeit	Bearbeiter	Meßuhr 1	Meßuhr 2	Meßuhr 3	Meßuhr 4	Meßuhr 5	Meßuhr 6	größte Abweichung	Kommentar
28.03.2019	11:10	Felix	0,121	-0,050	-0,101	-0,070	0,000	0,121	0,222	
04.04.2019	11:20	Felix	0,100	-0,060	-0,100	-0,080	-0,050	0,100	0,200	
11.05.2019	11:40	Sören	0,100	-0,070	-0,100	-0,100	-0,080	0,100	0,200	
18.06.2019	11:00	Sören	0,050	0,050	0,050	0,050	0,050	0,050	0,000	neue Scheibe

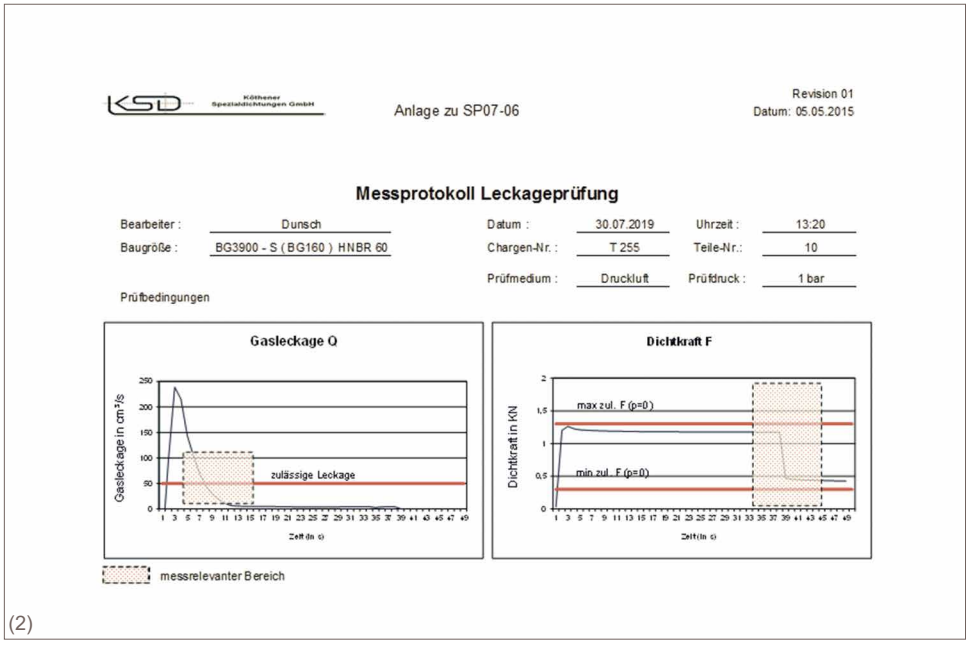
	Datum	Uhrzeit	Bearbeiter	Meßuhr 1	Meßuhr 2	Meßuhr 3	Meßuhr 4	Meßuhr 5	Meßuhr 6	Gesamt-abweichung	Meßergebnis	Kommentar
								0,000	0,000	#ZAHL!	#ZAHL!	

Übernehmen

(1)

(1) **Analyseprogramm zur Abbildung der Ebenheit der Planscheibe**

Unless otherwise requested by our customers, a 100% visual inspection and a 10% functional test of the mechanical ring pairs are carried out.



Költhener Spezialdichtungen GmbH

Anlage zu SP07-06

Revision 01
Datum: 05.05.2015

Messprotokoll Leckageprüfung

Bearbeiter :	Dunsch	Datum :	30.07.2019	Uhrzeit :	13:20
Baugröße :	BG3900 - S (BG160) HNBR 60	Chargen-Nr. :	T 255	Teile-Nr.:	10
		Prüfmedium :	Druckluft	Prüfdruck :	1 bar

Prüfbedingungen

(2)

(2) **Prüfprotokoll der Funktionsprüfung**

The hardness of the slide rings is checked with every change of material batch and with every change of slide ring size. In the case of sliding rings, which cannot be subjected to a functional test due to their dimensions, a 100% flatness test of the sliding surface and a plane parallelism test between the sliding surface and the back surface are carried out. In total, we ensure the consistently high quality of our products.

Laser hard coating pairings and intermetallic pairings

Mating type	Eigenschaften und bevorzugte Anwendungsbereiche
W4060 / W4060	**Media and corrosion resistance:** excellent (CIP resistant) **wear resistance:** very good **sliding behavior:** very good **Preferred applications:** food and chemical industry
B60 / W4060	Like pairing W4060 / W4060, but with a difference in hardness of approx. 10 HRC between rotating and stationary slide ring in order to implement the mother-father principle. (The mother-father principle is a proven one tribological approach, in which the softer slide ring can always adapt to the harder, even if damaged)
T4040 / T4040	**Media and corrosion resistance:** good to very good. **Wear resistance:** very good **Sliding behavior:** very good **Preferred applications:** food and sugar industry, as well as in sewage and wastewater technology
M40 / T4040	Like pairing T4040 / T4040, but with a difference in hardness of approx. 10 HRC between rotating and stationary slide ring, around the mother-father To implement the principle. (Mother-father principle see also pairing B60 / W4060)
R4040 / R4040	**Media and corrosion resistance:** good **Wear resistance:** good **Sliding behavior:** good to very good **Preferred applications:** agricultural engineering, construction industry, waste disposal technology
M40 / R4040	Like pairing R4040 / R4040, but with a difference in hardness of approx. 10 HRC between rotating and stationary slide ring to implement the mother-father principle. (Mother-father principle, see also pairing B60 / W4060)
U406010 / U406010	Conversion alloy that is formed directly in the laser beam **Media and corrosion resistance:** very good to excellent **Wear resistance:** excellent **Sliding behavior:** very good **Preferred applications:** food and chemical industry and in connection with extremely strongly abrasive products
A505010 / A505010	Iron-free conversion alloy, which is formed as an intermetallic alloy directly in the laser beam. **Media and corrosion resistance:** excellent in combination with titanium base materials **Wear resistance:** good to very good **Sliding behavior:** good Preferred applications: chemical industry

Rough operating conditions are the preferred areas of application for laser hard coating pairings.

Laser hard coating pairs are insensitive to:
• thermal shock,
• oscillations and vibrations,
• shocks and impacts,
• foreign bodies in the product (eg metal parts such as screws or nuts)

In addition, laser hard coating pairings are now preferably used again in the food and cosmetics industry, since fragments of ceramic or carbon sliding rings cannot be detected in the event of damage.

The use of pure laser hard coating pairings or pure intermetallic pairings should be avoided if:
• There is a risk of dry running and no suitable lubrication depot spaces are available in the GRD.
• Media are conveyed that tend to evaporate and thus cause cavitation between the slide rings. (e.g. hot water pumps)

Laser-based mixed pairings with coal or electrographite

Mating type	Properties and preferred areas of application
M40 / coal (resin bound)	**Media and corrosion resistance:** good to satisfactory **wear resistance:** due to the synthetic resin impregnation, it is only suitable for dry running for a short time and the maximum temperature limit should not exceed 100 ° C to 120 ° C. **Sliding behavior:** excellent **Preferred applications:** for hot water pumps or as a secondary seal in double-acting GRD.
B40 / coal (antimony-bound)	Like M40 / carbon pairing (antimony-bound), but with excellent media and corrosion resistance. **Preferred applications:** Pumps for heat transfer oils, self-priming pumps with a dry run for a limited time and above all pumps and units with high speed.
B60 / electrographite	This combination is a premium combination of **media and corrosion resistance:** excellent **wear resistance:** the temperature limit is over 400 ° C and the high thermal conductivity of electrographite of approx. 85 W / m * K make this combination safe to run dry. **Preferred applications:** this mixed pairing can be used as an ATEX pairing.

Laser-based mixed pairings with coal or electrographite are the classic example of a proven tribological approach in which the carbon or electrographite sliding ring adapts to the harder metallic sliding ring. The wear is deliberately placed on the softer slide ring so that it can re-align and grind against the counterpart even in the event of local damage ("mother-father principle"). Although carbon sliding rings can be classified as soft based on the purely measurable hardness, they require a minimum wear resistance from the counterpart, which is not achieved by untreated metallic materials.

The reasons for this phenomenon can be explained as follows:

• Coal has a scale-like structure that is responsible for its excellent sliding properties. However, diamond-like structures can form on the edge zones of these scales, which are responsible for wear on the counterpart.

• The low hardness of the coal can lead to foreign particles becoming embedded in the surface and thus contributing to wear on the counterpart partner.

Laser-based mixed pairs of coal or electrographite are preferably used in applications that are at risk from dry running and cavitation. Due to the excellent sliding properties of the coal or electrographite, there is only little friction in the pairing and therefore only a small amount of heat. This effect is further supported by the use of electrographite with its high thermal conductivity.

The use of laser-based mixed pairs of coal or electrograpite should be avoided if:

• The conveyed product is highly abrasive.

• The unit only in the mixed friction area is operated and the product contains solids.

The mixed friction area can be represented by the summer field number **So**. It is present when the viscosity of the product is high but the speed is low. This applies to positive displacement pumps, like rotary lobe; Eccentric screw and gear pumps too.

Laser-based mixed pairs with silicon carbide (SiSiC or SSiC)

Mating type	Properties and preferred areas of application
R4040 / SiSiC	Inexpensive mixed pairing with an iron-based alloy with Vanadium carbide and a reaction-bound, infiltrated silicon carbide. Standard mixed pairing with a very wide range of uses. **Media and corrosion properties:** good **Wear properties:** good to very good, the combination is based on a hardness difference of approx. 8-10 HRC compared to the SiSiC seal ring. **Sliding behavior:** good to very good
W4060 / SiSiC	Mixed pairing between a nickel-based alloy and tungsten carbide and a reaction-bound, infiltrated silicon carbide. **Media and corrosion properties:** very good **Wear properties:** very good **Sliding behavior:** very good to excellent, also due to the large grain size of the tungsten carbide, preferred chemical applications and food industry (CIP-resistant)
W4060 / SiC	Premium mixed pairing between a nickel-based alloy with Tungsten carbide and a sintered silicon carbide. **Media and corrosion properties:** excellent **Wear and sliding behavior:** comparable to W4060 / SiSiC **Preferred applications:** chemical and food industry (CIP resistant)
U406010 / SiSiC	Premium mixed pairing between a conversion alloy with Vanadium carbide and a reaction-bound, infiltratedSilicon carbide with very good **media and corrosion resistance.** **Wear and sliding behavior:** excellent due to the extremely high hardness of both materials and the high thermal conductivity of SiSiC. **Preferred applications:** highly abrasive media that have to be sealed under mixed friction conditions.
A505010 / SiC	This absolutely iron-free mixed pairing guarantees the highest **media and corrosion resistance** in connection with titanium base materials. The high proportion of titanium carbides in the light metal alloy and the high hardness of the ceramic pairing material ensure very good to excellent **wear and sliding behavior.**

Laser-based mixed pairs with reaction-bound, infiltrated silicon carbide (SiSiC) or sintered silicon carbide (SiC) are particularly suitable for use in water-abrasive media due to the good thermal conductivity of the silicon carbide of 80–130 W/m*K. Due to the excellent heat dissipation, cavitation problems can be avoided. The high hardness of both pairing partners ensures the excellent wear and sliding properties without giving up the tried and tested basic tribological principle of using pairings with different materials wherever possible.

The use of laser-based mixed pairs of silicon carbide should be avoided if:

• There is an acute risk of dry running and no suitable lubrication depot spaces are available in the GRD.
• If there is a risk of thermal shock.
• With extreme oscillations and vibrations.
• With extreme impact and impact loads.

If foreign objects can appear in the product (e.g. metal parts such as screws or nuts), the ceramic mating partner should be designed as a stationary slide ring.

Laser-based mixed pairs with silicon-infiltrated graphite (C-SiC)

Mating type	Properties and preferred areas of application
W4060 / CSiC	Premium mixed pairing between a nickel-based alloy with tungsten carbide and the silicon-infiltrated graphite C-SiC. **Media and corrosion resistance:** very good to excellent **wear properties:** good to very good **sliding behavior:** excellent due to excellent emergency running suitability **Preferred applications:** The areas of application of this premium pairing are very diverse, in particular they are used for ATEX requirements, self-priming pumps with risk of dry running and in units with insufficient lubrication
U406010 / CSiC	Premium mixed pairing between a conversion alloy with vanadium carbide and the silicon-infiltrated graphite C-SiC. **Media and corrosion resistance:** good to very good **wear properties:** very good to excellent **sliding behavior:** excellent due to its excellent emergency running suitability **Preferred applications:** their preferred area of application is highly abrasive media which must be sealed under mixed friction conditions with the risk of dry running occurring at the same time.
A505010 / CSiC	This absolutely iron-free mixed pairing guarantees maximum resistance to **media and corrosion in connection** with the base material titanium. The high proportion of titanium carbides in the light metal alloy and the high hardness of the graphite-ceramic pairing material ensure excellent **wear and sliding behavior** even when there is insufficient lubrication.

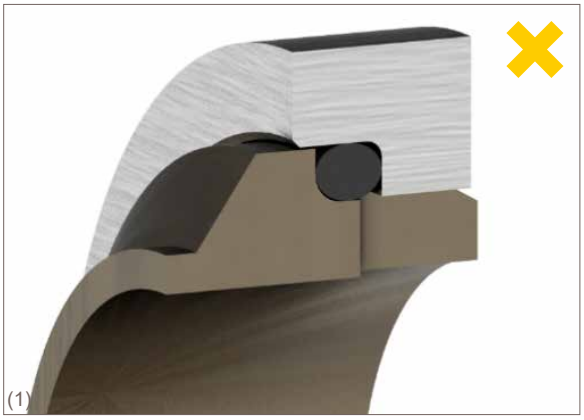
Laser-based mixed pairs with silicon-infiltrated graphite (CSiC) are characterized by excellent emergency running properties combined with high wear resistance. The combination of emergency running properties and excellent heat dissipation prevents cavitation problems. The high hardness of both pairing partners ensures the excellent wear and sliding properties without the basic tribological principle, pairings if possible to use different materials.

Dry running tests with the W4060 / C-SiC pairing showed that the temperature did not rise above 85 °C up to a peripheral speed of 10 m/s. These mixed pairs are therefore particularly recommended for ATEX applications. Restrictions on the use of these laser-based mixed pairings have not hitherto been known.

In the event of extreme impact and impact loads as well as foreign bodies in the product (e.g. metal parts such as screws or nuts), the graphite-ceramic should be used Mating partners can be designed as a stationary slide ring.

To support the excellent thermal conductivity of the C-SiC, we recommend that the stationary C-SiC sliding ring be designed as a block ring. (see example application ATEX)

Application example ATEX application:



(1) **Wärmeisolierten Einbau durch fehlende Kontaktflächen bei DIN-Gegenringen vermeiden**
(2) **Wärmeleitenden Einbau durch Blockringe mit großen Kontaktflächen vorsehen**

Laser-based mixed pairings for plain bearings

Mating type	Properties and preferred areas of application
Stellit 6M / SiSiC	This combination of a cobalt-based alloy and a reaction-bound, infiltrated silicon carbide SiSiC has excellent media and corrosion resistance as well as excellent sliding properties. Your preferred area of application is product-contacting plain bearings in magnetically coupled pumps
Stellit 6M / C-SiC	This combination of a cobalt-based alloy and a reaction-bound, infiltrated silicon carbide SiSiC has excellent media and corrosion resistance as well as excellent sliding properties. Your preferred area of application is product-contacting plain bearings in magnetically coupled pumps.

The laser-based mixed pairings were also convincing for highly loaded plain bearings, such as those used in the product room of magnetic pumps. Using such a mixed pair increased the service life of a magnetically coupled Allweiler pump from 30 to 40 production days to over 36 months. The enormous service life extension was achieved by replacing the breakable SiSiC all-ceramic pairing with the laser-based mixed pairing Stellit 6M / SiSiC and its flow-optimized adjustments, as shown in the following application examples.

Application example ATEX application:

(1) **KSD-zweigeteilte Buchse aus 1.4301 mit Stellit 6M Beschichtung inklusive, Srömungsnuten**
(2) **Original Buchse aus bruchanfälliger Keramik**

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