KLÜBER LUBRICATION

your global specialist

Detailed information

Bonded coatings for all metal surfaces.

Contents

General information on bonded coatings

Composition

The composition of a bonded coating is similar to that of an industrial lacquer, however instead of pigments it contains lubricating substances.

The main constituents of a bonded coating are:

- **Solid lubricant**
  e. g. polytetrafluoroethylene (PTFE), molybdenum disulfide (MoS_2), graphite or a combination of solid lubricants
- **Binder**
  (organic or inorganic, made up of one or two components)
- **Solvent**
  (organic or water)

Further constituents are for example coloring agents or corrosion inhibitors etc.

Once applied and hardened, bonded coatings form a thin lubricating layer which reduces friction and wear. This layer is dry, adheres firmly to the surface and does not drip off. This rules out the possibility of contaminating the environment as in the case of oil or grease lubrication.

Performance

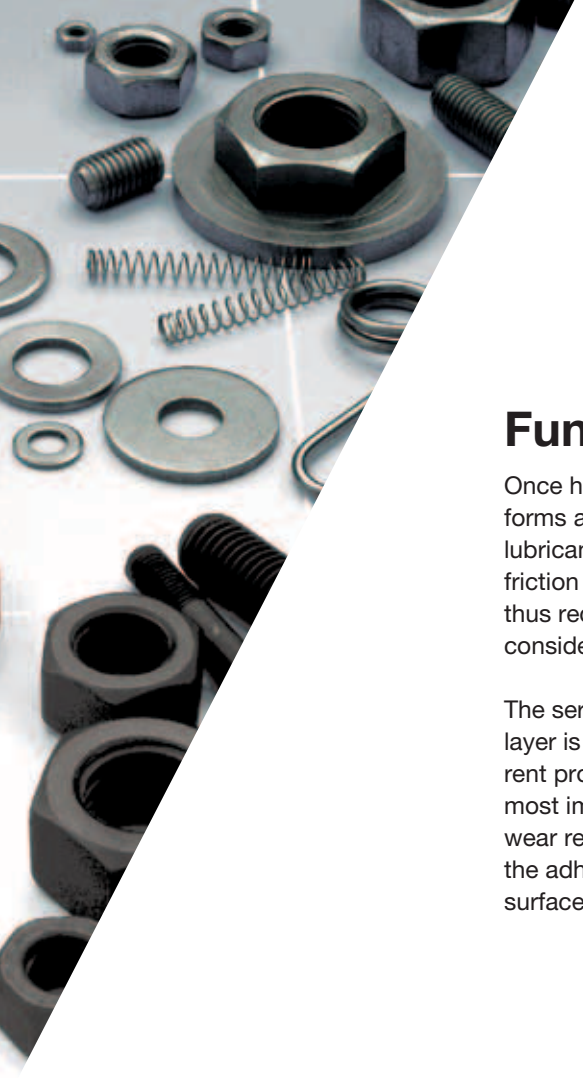
Bonded coatings

- ensure dry and clean lubrication
- improve running-in behavior, also in connection with oil or grease lubrication
- protect against wear and ensure constant motion at low speeds (no stick-slip)
- provide lifetime lubrication (no relubrication required), particularly at low sliding speeds and/or short sliding distances
- protect against corrosion
- offer efficient lubrication at low and high temperatures, when exposed to aggressive media, UV and X-rays or under vacuum conditions
- facilitate assembly and disassembly of close-tolerance components
- ensure defined tightening torques and preload forces in screw connections
- are suitable for coating a great number of materials
- make economical solutions possible owing to precise application methods

Application of bonded coatings

Bonded coatings are used in the aerospace industry, but also in many other sectors such as the automotive industry, in bearings or precision engineering applications. They often offer lifetime lubrication, e. g. in armatures, plain bearings or journals, safety belt components (locks, retractors), door locks, hinges, screws and bolts, valves, pistons, guide rails, seals, rolling bearings and many more.

For more details, please refer to pages 9 ff.



Function

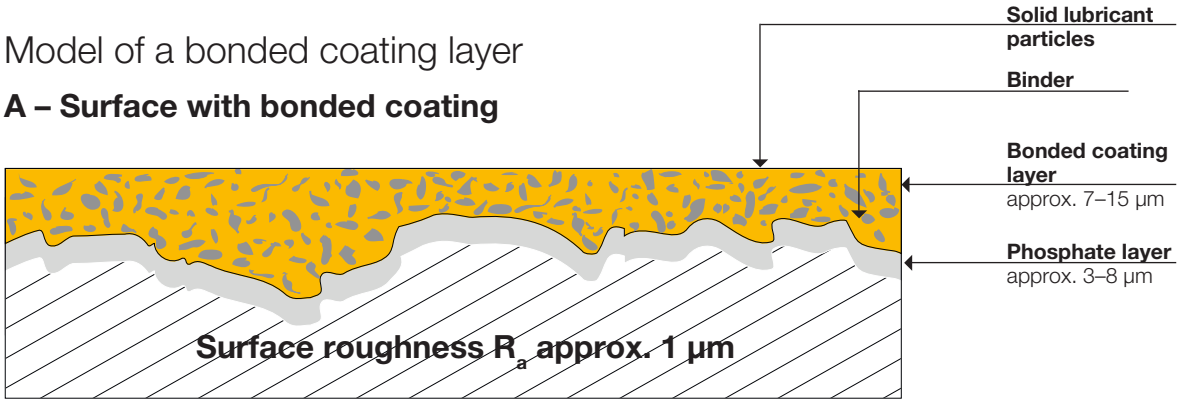
Once hardened, the bonded coating forms a thin, dry and firmly adhering lubricant layer, which separates the friction components in contact, thus reducing friction and wear considerably.

The service life of a bonded coating layer is limited and depends on different product characteristics, the most important being the binder's wear resistance and elasticity, and the adhesiveness to the component surface.

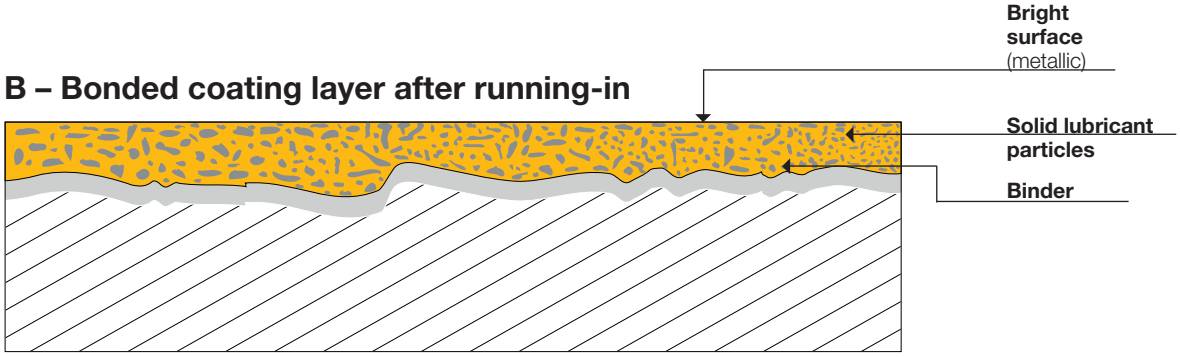
Frictional stresses gradually wear off the bonded coating layer, which is why this type of lubrication is also referred to as "transfer lubrication" or "wear-related lubrication". The process is comparable to writing with a lead pencil: the pencil will only work as long as there is lead.

Model of a bonded coating layer

A – Surface with bonded coating



B – Bonded coating layer after running-in



Design details

The components to be coated should be designed following certain criteria:

No sharp edges

This applies both to the friction body to be coated and the opposing body. Sharp-edged opposing bodies scratch the coating. Coated parts with sharp edges tend to corrode around the edges and have a shorter life because the coating is thinner in these areas.

Tolerances

The acceptable tolerances have to be determined in accordance with the layer thickness. Standard layers are between 7 and 15 µm.

Component

According to our experience, only one friction body is usually coated for cost reasons, i. e. the friction body with the larger frictional surface.

Surface roughness

The minimum surface roughness of the component to be coated should be $R_a \cong 1–2$ µm. The surface can be roughened for example by mechanical or chemical processes. The ideal depth of roughness of the uncoated opposing body is between $R_a = 0.2$ and 0.4 µm and should not exceed 0.8 µm.

Load-carrying capacity

Our experience has shown that polytetrafluoroethylene (PTFE) or graphite should be the preferred solid lubricants if the friction points are subject to low loads, e. g. mean surface pressure $p = 1$ N/mm^2 or lower.

Especially with bonded coatings containing MoS_2, surface pressures up to the yielding point of constructional steel are possible.

Burn-in temperature

When selecting the material it has to be taken into consideration that many bonded coatings harden at temperatures between 160 and 250 °C. This applies in particular to highly wear-resistant bonded coatings. The components involved are subject to the same temperatures and therefore have to be sufficiently resistant. The hardening time is between 15 and 60 minutes depending on the temperature. Air-drying or hygrosetting bonded coatings should be used on materials which are not resistant to increased temperatures.

Corrosion protection

Corrosion protection can be increased by applying an additional phosphate substrate layer.

Thermal stability

The upper and lower temperature of a bonded coating depend on the binder and the solid lubricant.

The thermal stability of a bonded coating depends on its chemical composition (binder, solid lubricants).

Pretreatment and application

The surfaces to be coated always have to be free of oil, grease, water, corrosion, scale etc.

Prior to applying a bonded coating, the component surfaces (substrate) have to be thoroughly degreased.

The cleanliness of the surface to be coated is the most important pre-requisite for good adhesion and hence also for the function of the bonded coating.

Furthermore, sufficient surface roughness is required for the bonded coating to become firmly rooted on the component surface.

Degreasing and cleaning can be done in an ultrasonics bath using alcaline, aqueous agents, or with solvents which do not leave any residues after evaporation, such as ethlyacetate, acetone or volatile white spirits.

Roughening of metal materials is either done by means of purely mechanical processes, such as sand blasting, or by chemical processes, such as phosphatizing which also provides additional corrosion protection.

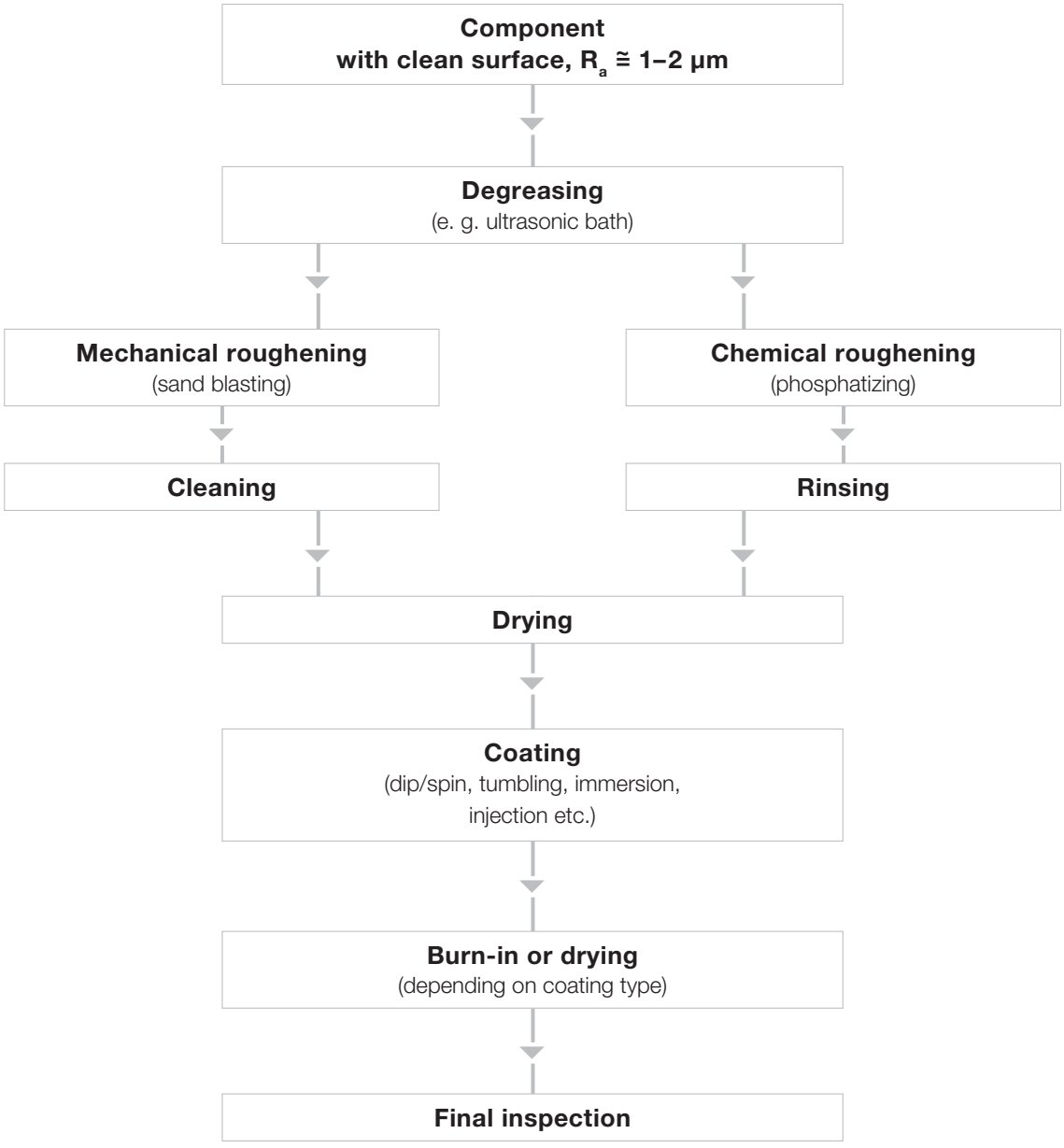
After degreasing and roughening, the components should not be touched with bare hands.

Depending on the part's geometry and the coating selected to meet tribological requirements, the bonded coating is applied by immersion, injection, tumbling or dip-spinning or other techniques commonly used for paint application.

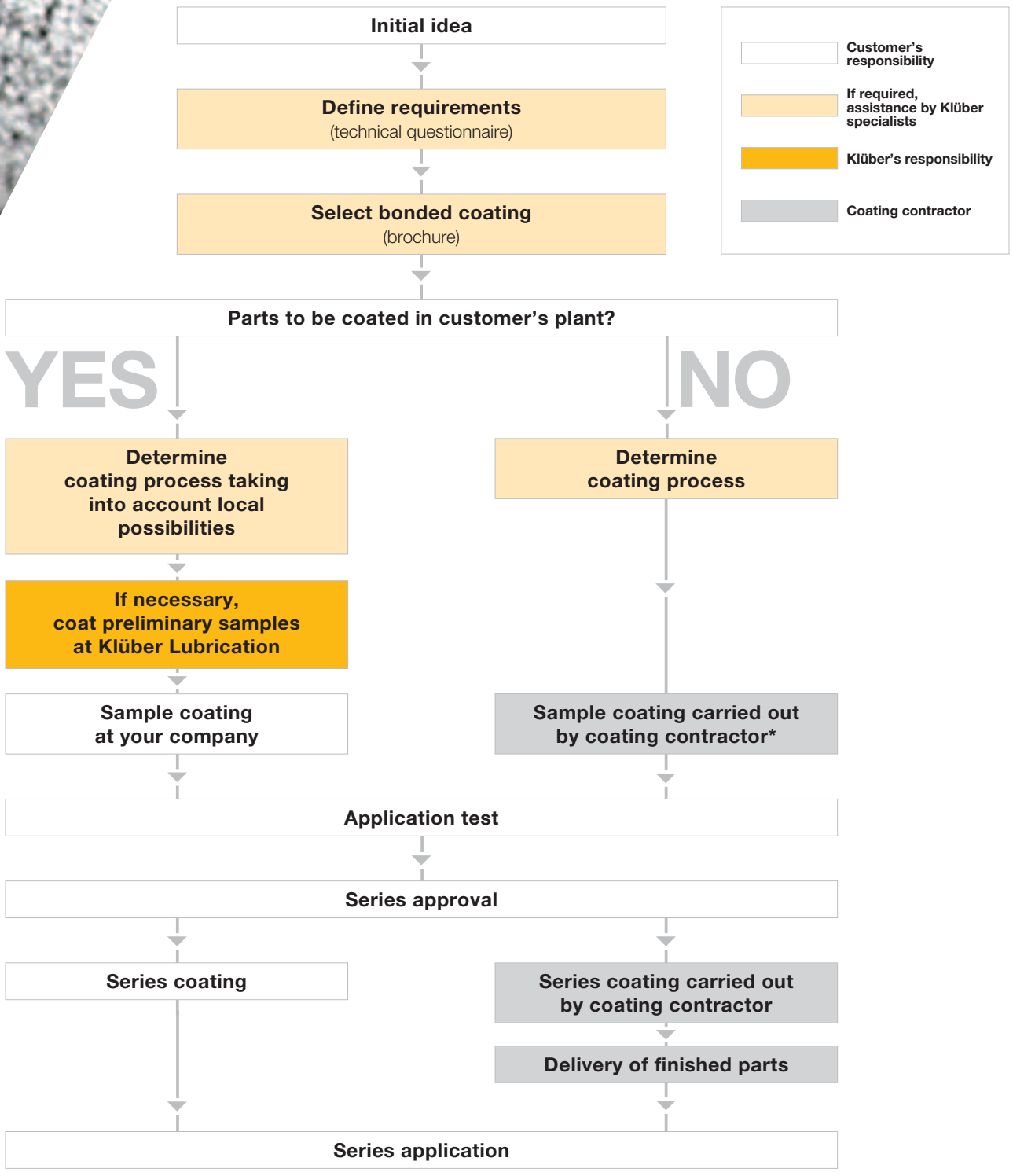
Thermosetting bonded coatings require a burning-process at temperatures between 160 and 250 °C.

Air-drying bonded coatings have to be dried at room temperature before being subjected to loads. For the drying and baking times please refer to the corresponding product information leaflet.

Application of bonded coatings



From the requirements profile to series application



** The names of potential coating contractors are available on request.*

Selection examples

Coating of component/machine element

Axles
Bolts
Sealing rings
Sliding guides
– sliding discs
– sliding tubes
Guiding axles
Guiding bolts
Guiding tubes
Springs
– spiral springs
– flat spiral springs
– disc springs
Chain pins
Clamps
Armatures
Camshafts
Pistons
Hinges
– furniture hinges/pins
– hinge bolts
– cylinder bolts
Lock parts
Seat belt parts
Pins
Valves
– valve armatures
Hub-shaft connections
Shafts

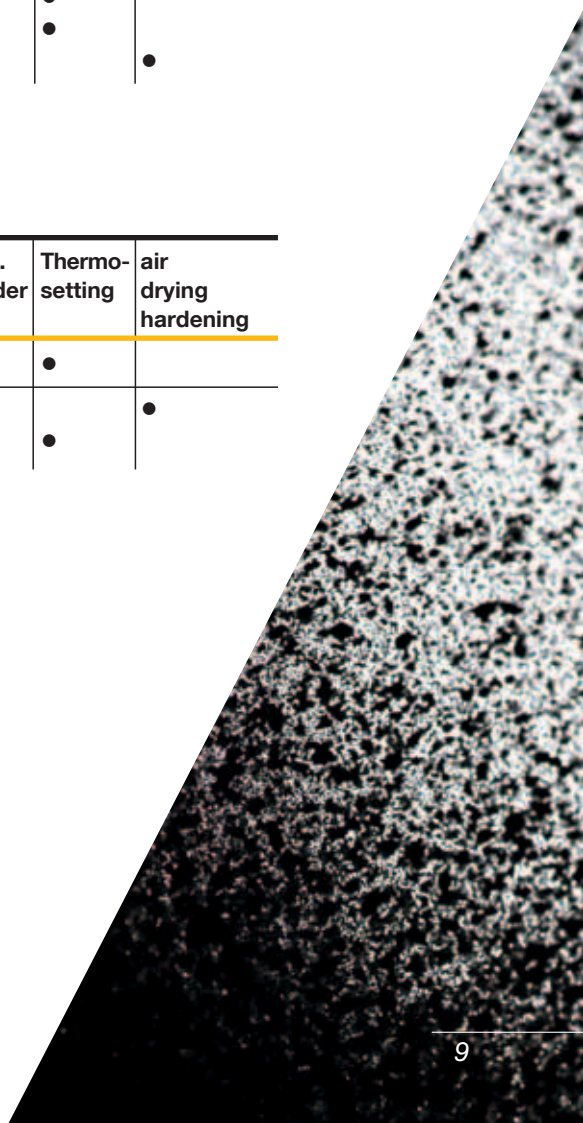
Single-part application (injection)

Standard value Surface pressure	Service temperature, °C[1)]	Klüber Product	Water base	Org. binder	Thermo-setting	air drying/ hardening
p < 10 N/mm²	–40 to 80	**Klübertop TP 15-810**	●			●
	–40 to 180	**Klübertop TP 03-111**		●	●	
p > 10 N/mm²	–40 to 230	**Klübertop TP 39 N A/B**		●	●	
	–40 to 300	**Klübertop TG 05 N**		●	●	
	–180 to 450	**UNIMOLY C 220**		●		●

Bulk application (mass process)

Standard value Surface pressure	Service temperature, °C[1)]	Klüber Product	Water base	Org. binder	Thermo-setting	air drying hardening
p < 10 N/mm²	–40 to 180	**Klübertop TP 03-111**		●	●	
p > 10 N/mm²	–180 to 450	**UNIMOLY C 220**		●		●
	–40 to 220	**Klübertop TM 06-111**		●	●	

1) Service temperatures are guide values which depend on the lubricant's composition, the intended use and the application method. Lubricants change their consistency, apparent dynamic viscosity or viscosity depending on the mechano-dynamical loads, time, pressure and temperature. These changes in product characteristics may affect the function of a component.



Special applications

Component/Application	Klüber bonded coating	Advantage
Threaded spindles –40 to 230 °C	**FLUOROPAN 340 NP A/B**	Lifetime lubrication
Plain bearings –40 to 120 °C	**Klübertop TG 05 N**	Improves runnning-in, wear protection
Belt tensioners –40 to 120 °C	**Klübertop TP 02-131**	Wear protection, lower friction coefficient
Chain pins –10 to 260 °C	**UNIMOLY C 220**	Improves running-in
Pistons for **air conditioning compressors**	**Klübertop TP 39 N A/B**	Wear protection, noise reduction
Piston skirt –40 to 200 °C	**Klübertop TG 05 N**	Wear protection
Armatures	**FLUOROPAN 340 NP A/B**	Lifetime lubrication for steel parts
Metalforming	**UNIMOLY CP** **Klübertop TG 04-1121**	Improved processing
Hinge bolts Household appliances 5 to 100 °C	**Klübertop TP 03-111**	Lifetime lubrication
Hinge bolts Furniture hinges –10 to 80 °C	**UNIMOLY C 220**	Lifetime lubrication
Lock parts –40 to 120 °C	**Klübertop TM 06-111**	Lifetime lubrication for medium to high surface pressures
Seat belt mechanisms –40 to 100 °C	**Klübertop TP 03-111** **Klübertop TM 06-111**	Lifetime lubrication for parts subject to low loads Lifetime lubrication for parts subject to high loads
Rolling bearings	**UNIMOLY C 220**	Lifetime lubrication Improves running-in
Gear rims –40 to 120 °C	**UNIMOLY C 220**	Improves running-in
Cylinder head screws –40 to 260 °C	**UNIMOLY C 220**	Lower friction coefficient, constant preload force of screw

Assembly of components

	Service temperature, °C[1)]	Klüber bonded coating	Water base	Bin-der	Thermo-setting	air drying/ hardening
Press-in and press-on assembly						
Bolts						
Pins						
Rivets						
Bushings	–180 to 450	**UNIMOLY C 220**		●		●
Sleeves						
Rolling bearings						
Wheels						
Flanges						
Power-locking and positive connections						
Screw-bolt connections						
Wedge-type connections						
Feather key connections						
Woodruff key connections	–180 to 450	**UNIMOLY C 220**		●		●
		(Klüberplus SK 12-205)	●			
Splined shaft connections						
Involute spline connections						
Serrated hub connections						
Screw connections						
Screws	–180 to 450	**UNIMOLY C 220**		●		●
Threaded bolts	–40 to 180	**Klübertop TP 03-111**		●	●	
Threaded rods	–40 to 300	**Klübertop TG 05 N**		●	●	
Threaded nuts						

1) Service temperatures are guide values which depend on the lubricant's composition, the intended use and the application method. Lubricants change their consistency, apparent dynamic viscosity or viscosity depending on the mechano-dynamical loads, time, pressure and temperature. These changes in product characteristics may affect the function of a component.

Product survey

		FLUOROPAN 340 NP A/B	Klübertop TP 02-131	Klübertop TP 03-111	Klübertop TP 15-810	Klübertop TP 39 N A/B	Klübertop TG 05 N	Klübertop TM 06-111	UNIMOLY C 220
Service temperature range °C[1)]		**–40 to +230**	**–40 to +180**	**–40 to +180**	**–40 to +80***	**–40 to +230**	**–40 to +300**	**–40 to +220**	**–180 to +450**
Standard values of max. surface pressure [N/mm²]		**p>10**	**p<10**	**p<10**	**p<10**	**p>10**	**p>10**	**p>10**	**p>10**
Solid lubricant	PTFE	●	●	●	●	●			
	MoS_2							●	●
	Graphite						●		
Air hardening[2)]					●				●
Thermosetting[2)]		●	●	●		●	●	●	
Binder base	organic	●	●	●	●	●	●	●	
	inorganic								●
Water-miscible					●				
Corrosion protection[2)]		●	●	●	●	●	●	●	
Resistance to chemicals[2)]		●	●	●	●	●	●	●	
Single-part application		●	●	●	●	●	●	●	●
Bulk application, centrifuging			●	●			●	●	●
Bulk application Tumbling			●	●				●	●

**) The stress at high temperatures depends on the type and frequency of frictional load.*

1) Service temperatures are guide values which depend on the lubricant's composition, the intended use and the application method. Lubricants change their consistency, apparent dynamic viscosity or viscosity depending on the mechano-dynamical loads, time, pressure and temperature. These changes in product characteristics may affect the function of a component.

2) For further details please see the corresponding product information leaflets.

Technical questionnaire – bonded coatings

Klüber Lubrication München KG
Geisenhausenerstraße 7

D-81379 München

Sender:

Company .....

.....

P.O. Box/Street .....

City/Post-Zip Code .....

Phone number .....

Person to contact .....

Please make a sketch of your specific application. For technical details, please use reverse side.

Technical questionnaire – bonded coatings

1. Component description

Name of component: .....

Material: ..... hardness: ..... HRC

Surface condition as delivered: ..... depth of roughness (R_a): ..... µm

Material of sliding partner: ..... depth of roughness (R_a): ..... µm

Intended use: .....

2. Technical requirements

Is it possible to coat the entire part?
(any covered areas?): .....

Surface pressure p = ... N/mm^2 (constant, alternating, impact)

Movement uniform ◯ oscillating ◯

n = ... rpm v = ... m/s frequency: ..... to ..... Hz amplitude: ..... to ..... m

Thermal resistance +/– °C: .....

Resistance to chemicals: .....

Dirty environment: .....

Ambient media: .....

Vacuum: .....

Radioactive radiation: .....
(type and dose)

Desired service life (cycles): .....

max. layer thickness: .....

Corrosion protection: yes ◯ no ◯ test method (DIN): .....

3. Quality requirements

Test specifications: .....

Corrosion around edges acceptable: yes ◯ no ◯

Further requirements/specifications/
technical delivery instructions: .....

Reference data required for subject component: yes ◯ no ◯

4. Estimated consumption (units/year) .....

Price range (cost/unit): .....

5. Enclosures

Sample ◯ Drawing ◯

Note: At least one reference sample has to be retained for internal documentation. Series application is subject to prior manufacture of a pilot lot (the number of components depends on the respective geometry of the part).

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The data in this technical brochure is based on our general experience and knowledge at the time of printing and is intended to give information of possible applications to a reader with technical experience. It constitutes neither an assurance of product properties nor does it release the user from the obligation of performing preliminary tests with the selected product. We recommend contacting our Technical Consulting Staff to discuss your specific application. If required and possible we will be pleased to provide a sample for testing.

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Innovative tribological solutions are our passion. Through personal contact and consultation, we help our customers to be successful worldwide, in all industries and markets. With our ambitious technical concepts and experienced, competent staff we have been fulfilling increasingly demanding requirements by manufacturing efficient high-performance lubricants for more than 80 years.

Freudenberg

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