COSTENOBLE
moving possibilities forward

Costenoble Anti-Friction Coatings and PTFE Coatings

Costenoble Anti-Friction-Coatings

General information

Anti-friction coatings are lubricants applied onto the surface. They form a permanently adhering dry lubricant film with high efficiency. The coatings consist of solid lubricants, organic or inorganic thickeners and a solvent. In addition to the main components, they may also contain functional additives such as corrosion inhibitors or UV additives. The most commonly used solid lubricant is MoS_2, PTFE or other synthetic lubricants.

Anti-Friction Coatings of Costenoble

The Molykote® anti-friction coatings, PTFE coatings by Chemours™ and our own products from the OSIXO® series, compose a series of high-quality coatings for a variety of applications offered by Costenoble. They have been used for decades in almost all areas of industrial production, because of their reliability and quality. They provide extensive opportunities to optimize design and production.

Applications

Anti-friction coatings are used in all industries. Due to ongoing automation of the production and assembly processes their importance continues to grow. During operation, the use of anti-friction coatings often replaces the various lubrication processes. You can, for example, apply a layer of anti-friction coating on items to be mounted, which will provide protection against corrosion and contamination during transport. During installation the anti-friction coating replaces a liquid or solid assembly lubricant or assembly mechanical support.

Anti-friction coatings are used more and more often also in order to support the process of running-in of machine parts. They provide additional protection against wear, defined coefficient of friction and make the whole process more predictable and safe.

In many cases antifriction coatings provide lifetime lubrication and in comparison to the conventional lubricants they are simpler in design.

Due to their versatility, easy application and easy use, anti-friction coatings are used in many production processes in almost all industries. Applications include cut edges of self-sealing ring, locking systems and cylinders, springs, camshafts, gears, spindles, slide bearings, o-rings, seals for doors, windows and luggage, fittings, hinges, switches, screws, bolts, chain elements, sintered metal bushings, bearing setting, linear guides, gears, valves, carburettors, pumps, nuts, screws and bolts, pistons and many others.

Advantages

- clean and dry lubrication
- reduced friction and wear
- fixed and defined friction values with a very small deviation
- use in extreme conditions such as high / low temperature, vacuum and dirty environment
- lifetime lubrication possible
- simplified assembly and disassembly
- minimizing maintenance costs
- replaces, supports or complements oil grease or solid lubricant
- better running-in of machine parts
- additional properties to ensure the correct operation after the consumption of the lubricant layer
- suitable for nearly all materials such as metals, plastics, elastomers, timber
- very good protection against corrosion
- long shelf life
- coatings resistant to mineral oils and chemicals
- no contamination at friction point and environment
- reduced formation of rust as a result of fretting
- the application of a very thin layer
- high performance
- the possibility of partial varnishing
- no hydrogen embrittlement
- avoiding the effect of „stick-slip”
- noise reduction

Costenoble Anti-Friction-Coatings

Effectiveness

Anti-friction coatings even up uneven surfaces and form a smooth film. This way, even in case of high loads and unfavourable conditions there is a spontaneous optimization of the coefficient of friction.

Anti-friction coatings provide dry and clean lubrication, and the solid lubricants or oils may therefore become useless. The coating may, however, be also used in combination with oils or solid lubricants. In such cases, the slide bearings support lubrication in the border areas and ensure correct operation after the consumption of layer of grease.

Application

Also in this regard, anti-friction coatings are more similar to industrial coatings than conventional lubricants. They may be applied with the use of conventional coating techniques such as spraying, dipping or brushing.

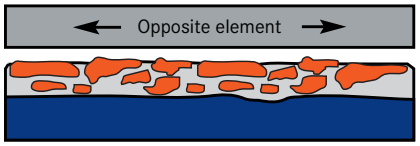
Anti-friction coatings may be applied also in the centrifuge spray drum or by automatic spraying or coating under pressure or by roller coating.

Functioning

After drying and curing the anti-friction coatings form a dry thin (a few micrometers) film, which strongly adheres to the base. This film is the lubrication and separation layer between the friction partners which reduces friction and abrasive wear.

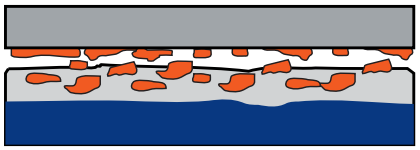
During the relative movement of the abutting elements, first comes the smoothing of the surface of the anti-friction varnish. As a result of the transfer of the lubricating components from layer of anti-friction varnish on the opposite part, a transfer film is created. The introduction of this layer of lubricant between the sliding elements leads to reduced friction value.

1)



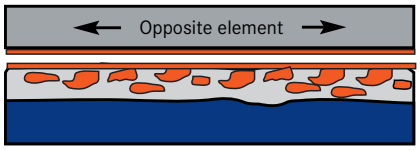
Smoothing the surface and partial use of solid lubricant of the anti-friction varnish by the opposite element.

2)



The transfer of some particles of solid lubricant on the opposite element.

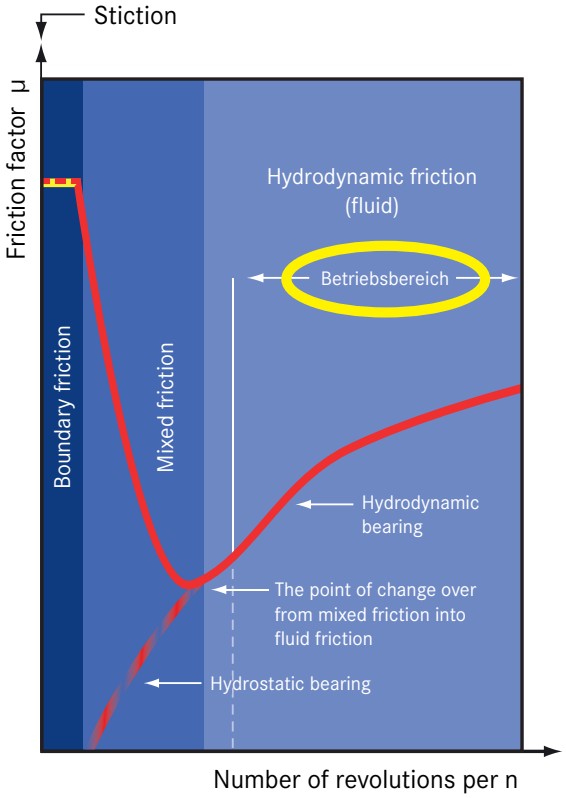
3)



Creation of transfer film - the introduction of a layer of lubricant between the friction partners

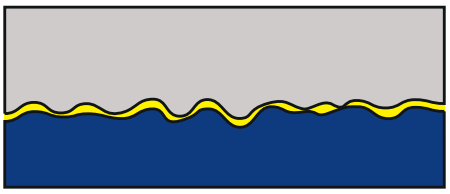
Anti-friction coatings are particularly effective in the case of boundary and mixed friction. In both cases hydrodynamic lubrication is not possible and the direct contact of friction partners leads to wear. The use of anti-friction coating prevents direct contact. Therefore the surfaces are always separated by a layer of lubricant, even with very low speed, oscillation or high load.

Anti-friction coatings may in addition effectively support the hydrodynamic lubrication during running-in and ensure proper operation even after consumption of a layer of grease.

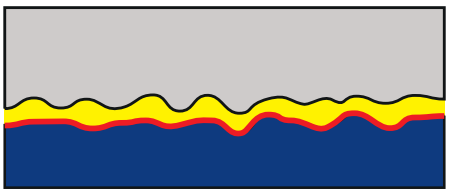


The share of lubrication agents in anti-friction coating is up to 70%. Solid lubricants with the layered structure, first “float” in the wet film but set horizontally during the drying process. They settle in different layers and even up irregularities of the surface of the support material. Under load the structure of the film is compressed. That is how the extremely smooth surface is created.

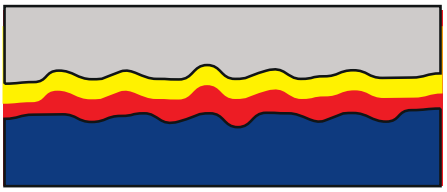
1. Boundary friction



2. Mixed friction



3. Hydrodynamic friction



antifriction
coating oil

Basic raw materials and differences

Productivity and the quality of anti-friction coatings depend on solid lubricant applied and its volume fraction. However, other components - thickeners, solvents and additives - are the determining factors for the performance. The following table compares the most common solid lubricants and thickeners.

Solid lubricants

Type	Advantages	Possible disadvantages
MoS_2 (molybdenum disulfide)	+ high load capability + wide temperature range + can be painted + excellent adhesion + low friction factor at a high load + protection against fretting + extends the life + electrical insulator	- strong friction at low load - running-in at high load - high friction factor under humidity conditions
Graphite	+ high temperature resistance + separation effect (metal processing) + good lubricant under humidity conditions	- shorter durability at room temperature - electrically conductive - only in black
PTFE	+ colourless and odourless + good separation function and corrosion protection + application in extreme conditions + low friction factor + electrical insulator + good chemical stability + lifetime lubrication possible + a very small thickness of layer is possible + constant friction factors	- low load capability - cannot be painted
Synthetic solid lubricants	+ colourless / can be coloured + extremely low friction factor at low load (the curing temperature) + good chemical stability + good protection against fretting + low curing temperature + electrical insulator	- low load capability - limited temperature range

Thickeners

Type	Chemical stability	Temperature stability	Air-cured	Corrosion resistance	Notes
Epoxy resin	+++	+++	-	+++	high hardness, water based
Polyamidimide	+++	+++	-	++	self-lubricating - difficult application
Phenolic resin	++	+++	-	+	water based available
Acrylate	++	++	+++	-	water based available
Titanate	-	+++	+++	-	limited production of film

Advantages compared to conventional lubricants

The following table provides an overview of the advantages of anti-friction coatings compared to conventional - "classic" - lubricants.

		„Classic" solid lubricants					
		Grease with mineral oil	**Synthetic lubricant**	**Silicone grease**	**Lubricating paste**	**Thread paste**	**Paste with MoS_2**
Anti-friction coatings	**MoS_2**	+ load capability + temperature range + adhesion + fretting + external friction + chemical stability + corrosion protection	+ load capability + temperature range + adhesion + fretting + external friction + chemical stability + corrosion protection	+ load capability + temperature range + adhesion + fretting + external friction + low friction factor	+ load capability + corrosion protection + adhesion	+ adhesion + corrosion protection	+ corrosion protection + adhesion
	PTFE	+ temperature range + adhesion + fretting + external friction + chemical stability + separation effect + colourless + corrosion protection	+ temperature range + adhesion + fretting + external friction + chemical stability + separation effect + colourless + corrosion protection	+ load capability + temperature range + adhesion + fretting + external friction + chemical stability + colourless + corrosion protection	+ corrosion protection + adhesion + separation effect + chemical stability + colourless	+ adhesion + corrosion protection + separation effect + chemical stability + colourless	+ corrosion protection + adhesion + separation effect + chemical stability + colourless
	Graphite	+ load capability + temperature range + adhesion + fretting + external friction + chemical stability + oil resistance + solvent resistance	+ load capability + temperature range + adhesion + fretting + external friction + chemical stability* + oil resistance* + solvent resistance	+ load capability + temperature range + adhesion + fretting + external friction + low friction factor + corrosion protection + solvent resistance	+ load capability + corrosion protection + adhesion + separation effect + oil and solvent resistance	+ adhesion + corrosion protection + separation effect + oil and solvent resistance	+ corrosion protection + adhesion
	synthetic	+ load capability + temperature range + adhesion + fretting + external friction + chemical stability + separation effect + colour	+ load capability + temperature range + adhesion + fretting + external friction + chemical stability + separation effect + colour	+ load capability + adhesion + fretting + external friction + low friction factor + colour	+ load capability + corrosion protection + adhesion + separation effect + colour	+ adhesion + corrosion protection + colourless + low friction factor	+ corrosion protection + adhesion + separation effect + colour

* only conditionally or with restrictions

MOLYKOTE
FROM DOW CORNING

Dow Corning® Molykote® Anti-Friction-Coatings

Molykote® Anti-Friction Coatings

Molykote® series of anti-friction coatings occupy an important place among the lubricants from Dow Corning®. Their essence lies in the reliable and load resistant anti-friction paints with MoS2 as a solid lubricant. Most of Molykote® anti-friction coatings that since decades have proved to work well come from this group. The Molykote® series includes also products which contain other solid lubricants.

Dow Corning® with its Molykote® anti-friction coatings, offers a comprehensive range of anti-friction varnishes of high quality for many applications.

Molykote® products series

Colour distinction between anti-friction layers, heat-cured (red) and air-cured (blue).

Product	Lubricant	Thickener	Solvent
Molykote® D-321R	MoS_2	Titanate	MOLYKOTE® L-13
Molykote® 3402-C LF	MoS_2	Special product	MOLYKOTE® L-13
Molykote® D-3484	MoS_2	Phenolic resin	MOLYKOTE® L-13
Molykote® 3400A LF / Aero	MoS_2	Epoxy resin	MOLYKOTE® L-13
Molykote® 106	MoS_2	Epoxy resin	MOLYKOTE® L-13
Molykote® D-7409 / D-7620	MoS_2	Polyamidimide	MOLYKOTE® 7415
Molykote® D-106	MoS_2	Epoxy resin	Water
Molykote® 7400	MoS_2	Acrylate	Water
Molykote® PTFE-N UV	PTFE	Acrylate	MOLYKOTE® L-13
Molykote® D-708	PTFE	Epoxy resin	MOLYKOTE® L-13
Molykote® D-96 / D-9610	PTFE	Polyurethane (PU)	Water
Molykote® D-7405	Synthetic lubricant	Polyamidimide	MOLYKOTE® 7415
Molykote® D-10 NMP frei	Graphite	Polyamidimide	MOLYKOTE® 7415
Molykote® D-88	Special pigments	Polyamidimide	MOLYKOTE® 7415

Molykote® L-13 is a mixture of organic solvents, Molykote® 7415 is an organic solvent with a flash point >90°C.

Anti-friction coatings based on PTFE and synthetic solid lubricants - comparison of advantages *

	Molykote® PTFE-N UV	Molykote® D-708	Molykote® D-96/D-9610	Molykote® D-7405
Molykote® PTFE-N UV		Colourless, air drying, aerosol	Temperature resistance, adhesion, aerosol	Colourless, air drying, aerosol
Molykote® D-708	Load capability, chemical stability, corrosion protection, adhesion		Temperature resistance, load capability, chemical stability, corrosion protection, adhesion	Chemical stability, corrosion protection
Molykote® D-96/D-9610	Water-based, low friction	Transparent / black, air drying, water-based		Transparent / black, air drying, water-based
Molykote® D-7405	Load capability, low friction, chemical stability, corrosion protection	Low friction, higher flash point	Temperature resistance, load capability, chemical stability, corrosion protection, adhesion	

* Advantages of anti-friction coatings in a row compared with anti-friction coatings in a column

MOLYKOTE
FROM DOW CORNING

Dow Corning® Molykote® Anti-Friction-Coatings

MoS_2 -based anti-friction coatings;– comparison of advantages *

	Molykote® D-321R	Molykote® D-3484	Molykote® 3400A LF / Aero	Molykote® 3402-C LF	Molykote® 106	Molykote® D-7409 / Molykote® D-7620	Molykote® D-106	Molykote® 7400
Molykote® D-321R		Temperature resistance, extreme loads, an aerosol, air-cured	Low friction, air-drying, aerosol higher flashpoint	Temperature resistance, low friction, aerosol, higher flashpoint, non-toxic	Temperature resistance, good adhesion, air-drying, an aerosol	Air-drying, an aerosol	Temperature resistance, air-drying, an aerosol	Temperature resistance, good adhesion, aerosol
Molykote® D-3484	No chalking, chemical stability, corrosion protection		Low friction, fast curing, higher flash point	Low friction, higher flash point, non toxic	Low friction, corrosion protection, fast curing	Fast curing	Low friction, fast curing	Temperature resistance, corrosion protection
Molykote® 3400A LF / Aero	Corrosion protection, chemical stability, no chalking	Temperature resistance, corrosion protection		Temperature resistance, corrosion protection	Temperature resistance, corrosion protection	Temperature resistance, corrosion protection	Temperature resistance, chemical stability, corrosion protection	Temperature resistance, chemical stability, corrosion protection
Molykote® 3402-C LF	No chalking, corrosion protection, military class	Temperature resistance, air drying, military class	air drying		Temperature resistance, corrosion protection, air drying, military class	air drying, military class	Storage stability, lower curing temperature, military class	Temperature resistance, chemical stability, corrosion protection, military class
Molykote® 106	Chemical stability, no chalking	military class	Low friction, low curing temperature, higher flash point	Low friction, higher flash point, non toxic		lower curing temperature, military class	Storage stability, lower curing temperature, military class	Temperature resistance, chemical stability, military class
Molykote® D-7409 / Molykote® D-7620	Chemical stability, corrosion protection, no chalking	Temperature resistance, chemical stability, corrosion protection	Low friction, chemical stability, higher flash point	Temperature resistance, low friction, chemical stability, corrosion protection, higher flashpoint, non-toxic	Temperature resistance, chemical stability, corrosion protection		Temperature resistance, chemical stability, corrosion protection, storage stability	Temperature resistance chemical stability, corrosion protection
Molykote® D-106	corrosion protection, no chalking, water-based	water-based	Low friction water-based	Low friction water-based, non toxic	corrosion protection, water-based	water-based		Temperature resistance, corrosion protection, chemical stability
Molykote® 7400	water-based, no flashpoint	air drying, water-based, no flashpoint	Low friction, air drying, water-based, no flashpoint	low friction water-based, no flashpoint, non toxic	air drying, water-based, no flashpoint	air drying, water-based, no flashpoint	air drying, no flashpoint	

* Advantages of anti-friction coatings in a row compared with anti-friction coatings in a column

Typical properties of Molykote® anti-friction coatings

	Solid lubricant	Thinner / tolerated solvent	Colour	Temperature range in °C	Load capacity (Falex test, ASTM D 2625) [N]	Durability (LF testW 1, ASTM D 2714) [revolutions 1000]	Oscillation 1000	Resistance to fretting (Deyber test) [oscillations]	Typical levels of corrosion resistance (*) (ISO R 1456) [h]	Curing conditions min./°C	Flashpoint °C	The surface coverage m²/kg
Molykote® D-321R	MoS_2	Molykote® L 13	gray	-180/450	15.000	s=480	s=210	14 x 106	-	5/20	23	7
Molykote® 3402-C LF	MoS_2	Molykote® L 13	gray	-200/315	15.500	s=150	s=15	5 x 106	p+sp=120	120/20	12	15
Molykote® D-3484	MoS_2	Molykote® L 13	gray	-70/250	15.500	p=300	p=350	28 x 106	p+sp=24	10/170	23	10
Molykote® 3400A LF/ Aero	MoS_2	Molykote® L 13	gray	-200/430	20.000	p=100	p= > 50	7 x 106	p+sp=500 p+dp=240	30/200	< 21	15
Molykote® 106	MoS_2	Molykote® L 13	gray	-70/250	15.500	p=380	p=280	24 x 106	-	60/150	24	15
Molykote® D-7409	MoS_2	Molykote® 7415	gray	-70/380	15.800	p=350	p=100	> 36 x 106	p+sp=300 p+dp=96	30/220	28	12
Molykote® D-7620	MoS_2	Molykote® 7415	gray	-70/380	15.800	p=400	p=100	> 36 x 106	p+sp=300	20/220	28	14
Molykote® 7.400	MoS_2	Water	gray	-70/200	13.000	p=200	p=100	9 x 106	-	40/20	-	16
Molykote® D-106	MoS_2	Water	gray	-70/250	13.500	p=300	p=180	24 x 106	p+sp=24	60/200	84	15
Molykote® PTFE-N UV	PTFE	Molykote® L 13	transparent	-180/240	4.000	p=15	p=36	24 x 106	p+sp=24	120/20	-19	18
Molykote® D-708	PTFE	Molykote® L 13	black	-180/240	1.220	p=9	p=13	1 x 106	p+sp=500 p+dp=360	20/200	0	18
Molykote® D-96 / D-9610	PTFE	Water	transparent	-40/80	-	-	-	-	-	120/20	>100	-
Molykote® D-7405	synthetic solid lubricant	Molykote® 7415	yellowish transparent	-70/200	15.000	p=150	p=100	> 36 x 106	p+sp=200 p+dp=96	60/120	41	16
Molykote® D-10	graphite	Molykote® 7415	black	-70/380	13.600	p=6	p=1	> 36 x 106	-	30/180	63	8
Molykote® D-88	special medium	Molykote® 7415	silver-gray	-70/380	-	-	-	-	p+sp=300 p+dp=120	20/210	63	-

dp = dipping-spinning application - sp = spraying application - p = phosphated surface - s = blasted surface

MOLYKOTE FROM DOW CORNING

Dow Corning® Molykote® Anti-Friction-Coatings

Molykote® Anti-Friction-Coating - Lösungen für Maschinenelemente

Solutions for	Damages associated with the running-in	Welding, scratches, seizure	High wear, pitting	Short life due to high load	Fretting	Stick-slip	Variable friction factor	Short intervals between lubrication	Pollution, chalking	unsatisfactory surface quality	Short life due to extreme temperatures	Grease malfunction caused by the influence of aggressive chemicals	Application problems related to the environment	Corrosion
Hinges, springs, locks, switches, screws, pins, belts, ski bindings	D-321R	D-3484, 3402-C LF, 3400A LF, 3400A Aero, D-7409, D-106	3400A LF, 3400A Aero, D-7409, 106	D-3484, 3400A LF, 3400A Aero, D-106	106, D-7409	D-3484, 3400A LF, 3400A Aero, D-7409, D-106	PTFE-N UV, D-7405	D-3484, 3400A LF, 3400A Aero	D-7405, D-7409, D-708	D-321R, D-3484, 3400A LF, 3400A Aero	D-321R, D-7409, 3400A LF, 3400A Aero	D-7409, 3400A LF, 3400A Aero, D-708, D-10	7400, D-106	3400A LF, 3400A Aero, D-7409, D-708
brake components, clutches, electromagnet coils	D-321R, 7400	106, D-7409, 3400A LF, 3400A Aero	D-106, D-7409	3400A LF, 3400A Aero, D-106, D-7409	106	D-106, D-7405, D-7409	D-7405	106	D-7405, D-7409, D-708	D-321R, 106	D-321R, 3400A LF, 3400A Aero, D-7409		7400, D-106	D-7409, 3400A LF, 3400A Aero, D-708
Slide bearings, self-aligning, chain elements, sintered metal bushings, bearing settings	D-321R	106, 3400A LF, 3400A Aero	106, D-7409	3400A LF, 3400A Aero, D-106, D-7409	106	D-321R, D-7409	D-7405	106	D-7405, D-7409	D-321R, 106	D-321R, 3400A LF, 3400A Aero, D-7409	3400A LF, 3400A Aero, D-7409	7400, D-106	D-7409, 3400A LF, 3400A Aero, D-708
Linear guides, sliding, spindles, shafts, adjusting wedges, racks	D-321R	D-321R, 106, D-106	3400A LF, 3400A Aero, 106, D-7409, D-106	D-321R, 106, D-106	106	D-321R, 106, D-106	D-321R, 106, D-7405	D-3484, 3400A LF, 3400A Aero, 106	D-7409	D-321R, D-106	D-321R, D-7409, 3400A LF, 3400A Aero	D-7409, 3400A LF, 3400A Aero	7400, D-106	D-7409, 3400A LF, 3400A Aero, D-708
Valves, carburetors, pumps	D-7409	D-7409	D-7409	D-7409	D-7409	D-7409	D-7409	D-7409	D-7409	3400A LF, 3400A Aero	D-7409	D-7409	D-7409	D-7409
Nuts, bolts and pins		D-708, D-7405		3402-C LF	3402-C LF	D-7405, D-708	D-7405, D-708		D-7405, D-708	D-7405	D-321R	D-7405, D-708	7400, D-7405	D-7405, D-708
gaskets / elastomer profiles, plastic parts	D-96, D-9610			D-96, D-9610		D-96, D-9610	PTFE-N UV, D-96, D-9610	D-96, D-9610		D-96, D-9610		D-96, D-9610		
Aircraft, rockets, helicopters, space stations	D-321R	3402-C LF, D-7409	3402-C LF, D-7409, 3400A LF, 3400A Aero	3402-C LF, 3400A LF, 3400A Aero, D-7409	106, D-7409	3402-C LF, D-321R, 3400A LF, 3400A Aero	3402-C LF, D-7409	3402-C LF, 3400A LF, 3400A Aero	D-7409	D-321R, 3402-C LF	D-321R, 3400A LF, 3400A Aero, D-7409	D-7409, 3400A LF, 3400A Aero	D-321R	D-7409, 3400A LF, 3400A Aero
Pistons, hydraulic components, camshafts, gears	7400, D-10, D-88, D-7409	D-10, D-7409, D-88	D-7409, D-10, D-88	D-7409	D-7409	D-7409	D-7409	D-7409, D-10, D-88		3400A LF, 3400A Aero	D-7409	D-7409, D-10, D-88	7400, D-7409, D-10	D-10, D-7409, D-88
Military technique	3402-C LF	3402-C LF, D-7409, 3400A LF, 3400A Aero	3402-C LF, 3400A LF, 3400A Aero	3402-C LF, 3400A LF	-	3402-C LF, 3400A LF, 3400A Aero	D-7409, D-708	D-7409, 3400A LF, 3400A Aero	D-7409	3402-C LF	D-7409, 3400A LF, 3400A Aero	D-7409, D-708		3400A LF, 3400A Aero, D-7409, D-708

Resistance of cured film layer

	Fuels	Brake fluid	Acids	Alkaline environment	Aromatic compounds	Alcohols	Deionised water	Ketone	Processing fluids	Mineral oils	Synthetic oils	Water-displacing agent	Cleaner	Radiation	Electrical strength	The possibility of painting
Molykote® D-321R	≈	≈	≈	+	≈	+	++	≈	≈	≈	≈	≈	+	++	≈	+
Molykote® 3402-C LF	++	+	+	+	++	≈	++	≈	++	+	+	++	+	+	+	+
Molykote® D-3484	++	++	+	≈	++	++	++	++	++	++	++	++	+	-	≈	+
Molykote® 3400A LF / Aero	++	++	+	+	++	++	++	++	++	++	++	++	+	++	++	++
Molykote® 106	++	+	+	≈	++	++	++	++	++	++	++	++	++	++	≈	++
Molykote® D-7409 / D-7620	++	++	++	+	++	++	++	++	++	++	++	++	++	++	+	++
Molykote® D-106	++	++	++	+	++	++	++	++	++	++	++	++	+	-	-	++
Molykote® 7400	+	+	≈	≈	≈	+	+	≈	+	≈	+	+	+	-	-	+
Molykote® PTFE-N UV	+	+	+	+	≈	++	++	≈	+	++	+	+	++	-	+	≈
Molykote® D-708	++	++	++	+	++	++	++	++	++	++	++	++	++	-	++	≈
Molykote® D-96 / D-9610	+	≈	≈	≈	≈	+	+	≈	-	+	+	-	-	-	+	≈
Molykote® D-7405	+	≈	+	≈	+	++	++	++	++	++	++	+	++	-	++	≈
Molykote® D-10 NMP frei	++	++	++	+	++	++	++	++	++	++	++	++	++	-	++	+
Molykote® D-88	++	++	++	+	++	++	+	++	++	++	++	++	++	-	-	+

Suitability for various coating methods

	Centrifugation	Spray drums	Immersion method	Spraying	Brushing	Printing	Coil-Coating
Molykote® D-321R	+	≈	++	++	++	≈	-
Molykote® 3402-C LF	+	+	++	++	++	+	++
Molykote® D-3484	+	++	+	++	+	≈	++
Molykote® 3400A LF / Aero	++	++	+	++	++	+	++
Molykote® 106	+	+	+	++	+	≈	++
Molykote® D-7409 / D-7620	+	++	++	++	+	+	++
Molykote® D-106	+	+	+	++	+	≈	++
Molykote® 7400	+	≈	+	++	++	≈	≈
Molykote® PTFE-N UV	≈	≈	≈	++	+	≈	≈
Molykote® D-708	++	+	++	++	+	+	++
Molykote® D-96 / D-9610	+	≈	+	++	+	++	≈
Molykote® D-7405	+	+	++	+	++	++	++
Molykote® D-10 NMP frei	+	+	≈	≈	≈	++	++
Molykote® D-88	+	+	≈	≈	≈	++	++

++ = excellent + = good ≈ = limited - = not applicable

Chemours™

Chemours™ DryFilm™ Anti-Friction-Coatings

DryFilm™ Anti-Friction Coatings

DryFilm™ - a series of anti-friction coatings based on polytetrafluoroethylene (PTFE). They are dispersed in a specific solvent or in water at various concentrations.

DryFilm™ series products are chemically inert, and thus resistant to corrosive chemicals and oxygen. They are thermally very stable, have a low friction factor, and good non-stick properties.

Use and Application

DryFilm™ is most effective when combined with low speeds and light loads. It can also be used as an additive for various products, such as paints, solid greases, resins and paper coatings. Here DryFilm™ is used inter alia to improve lubricating properties and delay the fouling effect.

Due to their characteristics and working temperature of over 300 °C, products, are suitable for many applications. These include the specific application, such as coating of industrial knives and razor blades. DryFilm™ products are also used as separating agents in moulding of rubber and plastics. Their high stability and long life guarantee optimum performance and high efficiency.

The following list shows examples of possible use of the DryFilm™ products:

- Coating for sliding surface and elements
- Bearings, seals, chain drives and gears
- Plastic laminates and laminated wood
- Belt conveyors
- Separating agents for rubber or plastic parts
- Paper, self-adhesive labels
- Tanks and containers
- Coating of the knife blade
- Impregnation of the skin
- Coating for fabrics, thread and yarn of natural or synthetic fibres
- Production of machine parts and pipe connectors
- Audiovisual precision instruments and accessories, such as musical instruments, magnetic recording tapes, camera shutter and film

Chemours™

Chemours™ DryFilm™ Anti-Friction-Coatings

Use as a separating agent

DryFilm™ products are based on the inert PTFE. Neither the moulding process itself nor the materials used affect the characteristics of the products or change them. Transfer of DryFilm™ on the shaped mould is small. The impact on product is limited to the minimum.

In the hot melt forming process the DryFilm™ RA/W is used. The aqueous formulation may be further diluted with water to the desired degree of dilution. DryFilmTM RA/W is usually used in the forming processes at a temperature of 66°C to 177°C.

In the air-dried coating it is possible that - even in the case of epoxy resin which is hard to separate – there are usually eight to ten layers. Air-dried coating provides good separation especially in the case of laminates. Even more layers can be obtained with the DryFilm™ sintered coating. In this method it is possible in general, to obtain even more than 25 layers.

DryFilm™ products are excellent separating agents for numerous industrial applications. They provide much better separating properties than conventional oils or silicones.

Use as an additive

DryFilm™ products can be added to liquids and semi-solid agents as a thickener to improve lubricity or to delay the fouling effect. DryFilm™ products can be used as additives in the following applications:

- painting and finishing, coating of paper and carbon paper, printing ink and writing ink
- the mixtures of elastomers and resins, grinding mixtures or mixtures for grinding wheels and carbon brushes
- waxing and polishing agents for cars, appliances, furniture, shoes and leather, as well as skis, bicycles, roller skates and other sports equipment
- Solid lubricants

	DryFilm™ RA	DryFilm™ RA/IPA	DryFilm™ LXE/ IPA	DryFilm™ 2000/ IPA	DryFilm™ RA/W
Share of solid component	15 %	25 %	10 %	20 %	20 %
Melting temperature	295 °C–305 °C	295 °C–305 °C	320 °C-330 °C	320 °C-330 °C	295 °C–305 °C
Solvent	decafluoropentan	isopropanol	isopropanol	isopropanol	water
The density of telomere					
Molecular weight	3.000	3.000	30.000	40.000	3.000
Density	2,2 g/cm³	2,2 g/cm³	2,16 g/cm³	2,16 g/cm³	2,2 g/cm³
Size of particles					
average	25	25	25	4-12	25
range	1-15	1-15	1-15	1-20	1-15
Suspended matter					
Volatility	80 %	80 %	70 %	80 %	80 %
Smell	alcohol	alcohol	alcohol	alcohol	slightly sweet
Appearance	All DryFilm™ products are a liquid suspension				
Colour	transparent, whitish	transparent, white	transparent	transparent	cream
Specific gravity	0.9	0.94	0.86	0.89	1.1
Density	1,63 g/cm³	0,96 g/cm³	0,84 g/cm³	0,99 g/cm³	1,09 g/cm³

Applying for thickening solid lubricants

DryFilm™ as a thickener in synthetic oils is responsible for the improved lubricating and anti-adhesion properties under conditions of thermal load in excess of 360 °C.

Compared to other PTFE thickeners the advantage of the DryFilm™ is the form and the size of the particles. A large area of the particles increases the effect of the thickener. Due to the small share of the solid component, the problems with friction and temperature fluctuations are eliminated at the very beginning thus better results are achieved in a long-term. Due to the low molecular weight of DryFilm™ when used for lubrication of bearings, no precipitate is formed. This reduces the noise and prevents premature failure.

Coating of blades

As a razor blade coating, industrial knives and cutting tools coating, the DryFilm™ provides much better results in terms of slip, cutting and separation. It prevents the stick-slip effect and prevents the cut material from adhering to the blade. In the case of razor blades we found that the blades coated with DryFilm® slide much better. DryFilm® is sprayed on the cutting edge and fused with it. In most applications the required melting temperature is 329 °C.

DryFilmTMdilution and solubility

DryFilm™ LXE/IPA is diluted in a 10 percent solution, DryFilm™ RA in a 15 percent solution, DryFilm™ RA/W, DryFilm™ 2000/IPA in a 20 percent solution and DryFilm™ RA/IPA in a 25 percent solution.

It may be diluted in any proportion depending on the application. In general the DryFilm™ solid lubricants are insoluble in all non-fluorinated solvents. Due to the different molecular weight of PTFE base, approximately 10% fraction having the lowest molecular weight is dissolved in fluorinated solvents.

DryFilm™ Table of thinners

	Solvent	Share of solid component	Final concentration	The share of DryFilm®	The share of solvent
DryFilm™ RA	Decafluoropentan	15 %	10.0 %	2	1
			5.0 %	1	2
			2.5 %	1	5
			1.0 %	1	14
DryFilm™ RA/IPA	isopropanol	25 %	10.0 %	2	3
			5.0 %	1	4
			2.5 %	1	9
			1.0 %	1	24
DryFilm™ LXE/IPA	isopropanol	10 %	5.0 %	1	1
			2.5 %	1	3
			1.0 %	1	9
DryFilm™ 2000/IPA	isopropanol	20 %	10 %	1	1
			5 %	1	3
			2.5 %	1	7
			1.0 %	1	19
DryFilm™ RA/W	H_2O*	20 %	10.0 %	1	1
			5.0 %	1	3
			2.5 %	1	7
			1.0 %	1	19

* Deionised water, warm to hot.

OSIXO®

OSIXO® Anti-Friction-Coatings

OSIXO® Anti-Friction Coatings

OSIXO® anti-friction coatings complement the existing series of products manufactured by DuPont® and Dow Corning®. Stability even at high loads and long life mean that they are effective in use. OSIXO® products are suitable for many applications and have worked well in numerous applications.

The series consists of PTFE suspension based on water or alcohol. The cured sliding coating is non-inflammatory, non-flammable and has fixed friction values. It is suitable for use in environments where heavy impurities are possible.

With the admixture of special additives OSIXO® products provide long-term corrosion protection. Products already corroded can again be smoothed through the use of OSIXO® products.

Application

Installation aid, separating agent or lubricant, not absorbing liquids impregnation, prevents from squeaking and creaking noises: regardless of the use OSIXO® the anti-friction coatings achieve reliably and consistently the best possible results.

For example, the coating of the heating element may prevent damage caused by lime scale in coffee machines or water heaters as well as in washing machines and dishwashers. Also in many industrial applications such as cooling liquid ducts coatings can prevent the damage caused by lime scale. They are suitable for machine parts or installations where re-lubrication is undesirable or impossible. They combine protection against scaling, corrosion and wear, providing the distinctive sliding properties.

Some of the OSIXO® anti-friction coatings have been developed specifically for use as a base in universal PTFE sprays. This gives bottlers and manufacturers enough rope in matching their products to the wishes of clients or specific applications.

OSIXO® anti-friction coatings may be used for covering the sliding parts, bearings and gears. They can be used as separating agents and coatings for knives and blades.

They are used not only in metal processing, but also in mining, automotive and shipping industries, processing of paper and textiles as well as in wind and water turbines.

The applications of OSIXO® Anti-Friction varnishes are at the same time as diverse as materials, for which they are used:

- Metals and alloys
- Plastic, wood and laminates
- Ceramics and glass
- Rubber
- Leather and fabric

Special products

The series of OSIXO® Anti-Friction Coatings extends along with the requirements of customers who want to receive products better and more closely tailored to the particular application. In addition to solutions tailored to the individual needs of the customer or for a specific application, some products have been used in industry for many years already. They are distinguished by their high quality and reliability.

For example the OSEXO® Orange Aerosol is a wax suspension of PTFE specially disposed in the aerosol container. The base is a high quality short chain polytetrafluoroethylene. Isopropanol is used as a solvent. For a better adhesion OSEXO® Orange Aerosol is mixed with a substance which increases adhesion. Unlike traditional PTFE sprays, OSEXO® Orange Aerosol has a high amount of solid material fractions and a substance which increases adhesion particularly effectively.

OSIXO® KM is a wax suspension with short chain polytetrafluoroethylene. It is dissolved in isopropanol and includes a special agent which increases adhesion. OSIXO® KM can be applied to many types of surfaces. It is distinguished by low friction factor and excellent dissolving anti-adhesive properties and. OSIXO® KM was originally developed as a base suspension for aerosols containing PTFE.

The initial preparation of surfaces

When applying anti-friction coatings, the preparation of the surface is really important. Good grip and long life can be achieved only by appropriate pre-treatment. The first step is always to remove dust, dirt and rust and thorough degreasing. Even if the corrosion has been removed with an acid, it is necessary to degrease thoroughly. This is the only way which guarantees the coverage of the work piece.

The best degreasing is obtained with the use of organic solvents. Because of toxicology and safety issues, it is recommended to use organic solvents with a very low content of aromatic additives. The installation for vapour degreasing is the best choice. If you do not have one, the residual oil and fat can also be removed by washing.

	steel	galvanized parts	aluminium alloy	copper alloy	magnesium alloy	titanium alloy	stainless steel
Distance	x	x	x	x	x	x	x
Removal of oxide:							
- by etching				x			x
- by sandblasting with aluminium oxide or cast steel (55 µm)	x		x	x		x	
anodizing in accordance with							
-MIL-A-8625 C			x				
-AMS 2488 (titanium oxide type II)						x	
Treatment with dichromate (MIL-M-3171 C)					x		
Phosphating (DOD-P-16 232)	x	x					
Treatment with oxalic acid							x

After evaporation of the solvent, there should be no leftover. The washing process should be repeated several times with fresh solvent. If necessary, it is also possible to use an ultrasonic cleaner.

Pre-treatment of plastic surfaces

Degreasing of plastics and elastomers can be carried out using aqueous cleaners or solvents. When using solvents pay attention to mutual tolerance of the substances. The adhesion of anti-friction coatings can be increased by additional roughening of the surface. The useful methods are grinding and blasting using CO2 or sand. Alternatively, physical methods such as plasma activation, corona treatment or flame treatment may be used for the pre-treatment of plastics.

The pre-treatment of metal surfaces

Degreasing of metals is performed typically using organic solvents such as benzene or acetone. However, more eco-friendly and user friendly is the use of alkaline or neutral aqueous cleaners. Combined with ultrasound or heat treatment, the effect of the cleaning agent usually can be enhanced.

Special pre-treatment of corroded surfaces

The corroded surfaces are pre-treated with chemical or mechanical methods. The recommended mechanical method is sanding with aluminium oxide or cast steel (grain size: 55 µm). This way, the surface gets additional roughness and the adhesion of antifriction coatings increases. A typical in galvanization, treatment with acid and alkali is usually sufficient. The corrosion should be removed in the bath, but the metal constituting the substrate remains unaffected. All traces of chemicals or cleaning solutions must be removed. Do not touch the parts with bare hands. You should avoid leaving fingerprints.

Phosphating

Phosphating is suitable for pre-treatment of iron and steel (not stainless steel) as well as for galvanized iron elements. Manganese phosphating increases the load-carrying ability of the coating. Zinc phosphating improves corrosion protection. Use only the phosphate bath to form very thin crystalline layers. During this process, the coating should reach a maximum thickness of 3 to 8 mm. This corresponds to a weight gain from 5 to15 g/m^2.

The structure of the phosphate layer should be uniform and homogeneous, and its colour from grey to black. No stains are allowed on work piece - especially no traces of dried phosphate solution or corrosion. After machining the parts, please do not touch with bare hands. In most cases, anti-friction coatings must be applied to the phosphated metal surfaces within 24 hours, otherwise corrosion can occur.

The use of oxalic acid for processing stainless steel

In the case of stainless steel due to its resistance to corrosion it is necessary to use special bath in oxalic acid. Observe the manufacturer's operating instructions.

Sandblasting (after degreasing)

Sand blasting is recommended in the case of components made of steel, titanium, aluminium, copper, magnesium or alloys thereof. Best suited for this purpose is aluminium oxide or cast steel (grain size: 55 µm). This way a surface roughness is achieved, wherein Ra varies from 0.5 µm to 1.0 µm In most applications the dimensional change resulting from the blasting is of little importance, because it is less than 1.3 microns. The adherent sand particles can be removed by using dry, oil-free compressed air. To avoid corrosion, do not touch treated surfaces with bare hands and apply coating as soon as possible.

Anodic oxidation (eloxal processing) of aluminium and aluminium alloys

Aluminium and aluminium alloys should be pre-treated with the use of electrolytic oxidation. Alloys with a copper content of 0.5% or more, or a total content of alloying elements of more than 7.5% must be subjected to a bath in sulfuric acid. Aluminium and all other aluminium alloys may be subjected to a bath in the chromic acid. This way, a thin surface layer is formed, which provides good protection against corrosion. To make this layer good in quality, you must use water of high purity (low level of chlorides and sulphates) for all baths.

a) Chromic acid - procedure:
The minimum weight of the surface layer: 2,15 g/m^2
Layer thickness: 2.5 µm
Application: rinse thoroughly with hot water (65° C) and dry in the air.

b) Sulphuric acid - procedure:
The minimum weight of the surface layer: 6,5 g/m^2
Layer thickness: 5 µm
Application: Rinse the parts thoroughly with water and fix the coating by dipping into 5% solution of sodium or potassium dichromate. Rinse and leave to dry. The drying temperature should not exceed 102 °C. Do not then touch the work piece with bare hands.

Acid etching of copper and copper alloys

In the case of copper and copper alloy, a blend of at least two of the following acids is used: sulfuric acid, phosphoric acid, chromic acid, nitric acid and hydrochloric acid. Mixing ratio and the concentration vary. The immersion time is from 5 seconds to 5 minutes. A metal substrate should not be unduly manipulated. When using nitric acid, its poisonous vapours must be sucked. In the case of flat parts or components of complex shape, use slow acting etching bath. After etching, parts must be thoroughly rinsed to remove any residual acid.

OSIXO®

OSIXO® Anti-Friction-Coatings

Application

Depending on the type of the work pieces and the required surface condition, anti-friction coatings are applied by spraying or dipping, or using spray drums or centrifuges. Work pieces must be prepared in an appropriate way.

In case of partial coating, it is recommended to use protective templates or removable protective film. Both should be removed before curing. Antifriction coatings are usually available in the form of immediately ready for use. Dilution is necessary only when the film thickness is to be less than 5 microns. In the case of anti-friction coatings, which are not water-based, use only electrical mixing devices with explosion-protected motors. When applying such coatings you must always follow local safety regulations regarding the handling of paints and lacquers.

Spraying

If the spraying process is not carried out in the paint booth you'll need to take care of a good venting. In case of majority of products, the share of solid fraction is checked (nfA: „nicht flüchtiger Anteil" – share of non-volatile fraction) from 20% to 30%. The share of solid fraction corresponds to the dry leftover after evaporation of the solvent. You can use all standard spray guns. Atomization pressure should be from 2 to 5 bar.

In the case of spray coating, the layer thickness is generally from 10 µm to 30 µm. If you need a thicker film, you can apply several layers of antifriction coating. Each subsequent layer should, however, be applied only when the previous is almost dry. When applying several layers, it is important that the film is extremely thin and homogeneous.
In many applications, it is advantageous to heat the work pieces to a temperature of 60 °C-80 °C. This enables you to put layers of greater thickness without any content of air between them.

There should not be any cracks or bubbles during the application. Use anhydrous and oil-free compressed air for atomization. In order to apply thickener and solid lubricant homogeneously, the product must be pre-mixed. In addition to compressed air method you can also try electrostatic method. As long as the coating is not cured, the sprayed parts must be handled with caution. Anti-friction coating should be left to dry in the air for at least 10 minutes before touching.

Aerosol sprays

Application with the use of aerosol sprays is trouble-free, safe and clean. They are suitable for fast coating of large surfaces. Aerosol cans are easy to use and provide a relatively uniform coating of the treated surface.

Immersion method and centrifugation

The share of solid fraction from 20% to 25% was suitable for spinning-dipping. Heating to 80-85 °C may also be advantageous. Generally, higher temperatures lead to the accumulation of paint and rough surfaces. At lower temperatures very thin layers can be obtained. Ideal level of centrifuge charge depends on the device. Efficiency of materials in this method can be up to 90%. However, it is difficult to obtain a homogeneous layer with a thickness above 10 microns.

There is a risk of sticking during immersion and centrifugation. That is why parts should be in constant motion - also during drying or baking. The process of immersion and centrifugation should always be carried out twice to cover the gaps (contact points). In the case of special requirements (thicker layers, better protection against corrosion) coating in several subsequent steps is recommended.

Immersion method in the case of single components

The immersion bath coating can be applied also in case of flat parts and large screws or bolts, bushings of bearings, rods, metal profiles and hoses. To avoid penetration of air the immersion process must be controlled. The speed of taking the object off the bath must be adjusted in order to avoid the formation of cracks and bubbles and to obtain the desired film thickness. The contents of immersion bath should circulate. In the case of anti-friction coatings with organic solvents there must be suction device placed above the maximum level. During a break immersion container should be covered. This way you can minimize evaporation and avoid pollution.

Abrading or brushing

This method is specially designed to cover the enclosed area such as rods, tubes, plates or sheets. Moreover, the abrading and brushing methods are the optimal form of coating in case of small areas of larger parts.

Roller coating method or coating under pressure

Anti-friction coating can be applied to even surfaces with the help of machines designed for coil coating or using simpler methods of roller coating. Partial coating is obtained with silk-screen printing or pad printing.

Barrel plating

Barrel plating is particularly suitable for loose parts with simple geometry (e.g., disks, pins, bolts, o-rings). The coated parts get smoothed in the drum as they rub in the drum. The homogeneous surface of coating can be achieved this way. In combination with spray coating in so-called “spray drums” You can precisely control the amount of agent applied, which may result in further improvement in the results of the coating.

Curing and coating by melting

Air-drying anti-friction coatings dry at room temperature. Heat treated anti-friction coatings must be baked after application. The baking temperature is between 100 and 200 °C. In the case of a PTFE-based product of DuPont™ baking temperature must be as follows:

Product	Temperature
DryFilm™ RA	305 °C to 316 °C
DryFilm™ RA/IPA	305 °C to 316 °C
DryFilm™ RA/W	305 °C to 316 °C
DryFilm™ 2000/IPA	360 °C to 382 °C

Use the thermocouple for direct measurement of surface temperature. The coating may change colour during the drying. The temperature of the surface being machined (not ambient temperature) should be maintained for 5 to 10 minutes at normal levels. Residues on the metal surface can be removed with a soft cloth. When coating by melting adequate ventilation must be ensured and all the precautions listed in the safety data sheet observed.

The general rule for calculation of material

In the case of layer with a thickness of 15 microns, you will need approx. 1 g/100 cm^2 (100 g/m^2) of anti-friction coating. Approx. 10 kg of anti-friction coating is required for 1 ton of small metal parts.

Quality control

The criteria used to monitor the quality of anti-friction coatings include primarily a smooth surface, the thickness of the coating and adhesion to the substrate. Transparent antifriction coatings often contain special UV index used to control the layer. Further control possibilities depend on the element and the coating.

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