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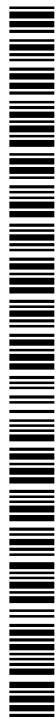


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(54) Title: LUBRICANT LACQUER

(57) Abstract: The invention relates to a lubricant lacquer and the use thereof. Lubricant lacquers are compositions of lubricating solid particles, in a matrix of organic binder. In extensive research, the present inventors have studied the effect of the addition of particular additives on desired properties, such as the tribological behavior and the prevention of corrosion, as well as the mutual interaction of the different components of the lubricant lacquer. This research has shown that it is advantageous to add so-called slip additives to a lubricant lacquer. Consequently, the invention relates to a lacquer, comprising, in a liquid medium, a tribologically active component, a resin, and a slip additive. Slip additives are components, which have the inclination to move to the lacquer-air interface in the lacquer systems. The lubricant lacquer according to the present invention provides an improved run-in behavior. In this connection, further, the protective action against environmental factors of the slip additives on the tribologically active pigment can be mentioned. In this manner, the life of the lubricant lacquer is considerably extended and the frequency for carrying out maintenance is reduced.

Title: Lubricant lacquer

The invention relates to a lubricant lacquer, objects provided with such a dried lacquer, and the use thereof. Lubricant lacquers are compositions of lubricating solid particles, in a matrix of organic binder.

The most commonly used components present in the lubricant lacquer to effect lubrication are molybdenum sulfides (particularly MoS₂), fluoropolymers such as Teflon, graphite and tungsten sulfides (particularly WS₂). These lubricating solid particles usually need to be stabilized in the lubricant lacquer. Therefore these particles are suspended or dispersed in a binder. This binder is usually a resin, such as an alkyd, phenol, epoxy or acrylate resin.

Such a resin is cured and cross-linked by means of a temperature treatment. In order to be able to apply a lubricant lacquer, further, a solvent needs to be added to dissolve the binder. Often, environmentally damaging substances are used for this, but presently, environmentally friendly solvents such as water, alcohols, etc. are preferred.

Lubricant lacquers are often the appropriate lubricants for use in vacuum, at relatively high temperatures and in case of high surface pressures, due to the absence of the building up of a hydrostatic pressure in the lubricant. Lubricants are likewise used in cases where wet lubrication is undesired, for instance in connection with the adherence of dust in electronic equipment. Release of solid lubricants to the environment is prevented by a very good adhesion to the substrate surface and the use of very thin layers. The action of the solid lubricants is based on avoiding a large, counteracting shearing force in the material surfaces. In the prior art, a distinction is roughly made between three types of solid lubricants:

1. the crystal surfaces of inorganic pigments, such as sulfides, are used to have shearing take place along these; the pigments are present in a lacquer system;

2. materials with a small friction, such as ceramic materials, are used to minimize the occurrence of shearing to the surface; and

3. the use of very small spherical particles as micro bearings, which, as such, bridge the occurring speed difference.

Lubricant lacquers have already been known for a long time. The use of MoS₂ as a solid organic lubricant, for instance, dates back to the 17th century. However, the first investigation into the technical action of MoS₂ was carried out no earlier than 1938 by the Westinghouse Electric Company.

Although lubricant lacquers have thus already been known for a long time, in the past twenty years, there was little need for further research and development. Because the existing knowledge about the lubricant lacquers is largely based on "trial and error" methodologies, the technical insight into the (action of) lubricant lacquers is small. On the other hand, there is a great need for new lubricants with improved properties, which are better geared to the requirements set with regard to specific uses.

For instance, patent application US-A-4,937,010 describes a product and method for suspending a substantially non-dissolved liquid lubricant in a non-metallic binder. A lubricant lacquer is obtained, in which the lubricant is enclosed in a matrix. Due to wear, the matrix breaks open and the lubricant is then released, by means of which a lubricating action is obtained. The essence of the invention in this US patent specification is different than in the present application. Further, WO-A-01/70918 discloses a coating composition in which a binder such as a resin is combined with a friction-reducing additive. Further, the coating contains a substance which releases a gas. The object of the invention is preventing two adjoining parts from being stuck.

US-A-5,171,622 shows compositions with resin and solid lubricants in which these solid lubricants form islands with a larger thickness than the rest of the resin layer. There is no homogenous distribution of particles throughout the lacquer.

5 US-A-5,641,578 relates to a weldable steel plate, which is provided with a coating. This coating may comprise a lubricant.

Therefore, the inventors have carried out extensive technical research into the use of new components in lubricant lacquers, resulting in lubricant lacquers with improved properties, such as a reduced resistance.

10 The action of inorganic substances with a hexagonal crystal structure, such as MoS_2 and graphite, as a solid lubricant is known to a skilled person. Due to the layered structure of the crystals, these crystal layers can relatively easily slide along one another. In the case of MoS_2 , the repellent action of adjoining sulfur layers further contributes thereto. The
15 layers thus have a low friction coefficient. This results in a lubricating action. On the other hand, the load-bearing capacity of such a system is very high. This capacity is in fact determined by the compression strength, or mutual cohesion, of the material used, for instance MoS_2 .

Another important property of solid lubricants which is desired is the
20 stability. The stability depends on *inter alia* the environment. At least two aspects play an important role here. Pollutions which are present in, for instance, the air, such as oxygen and water, may have interaction with the lamellar MoS_2 structures. The presence of water results, for instance, in hydrolysis of the MoS_2 , so that the lubricating action decreases. The oxygen
25 may be included and incorporated in the MoS_2 crystal lattice, so that oxidation occurs and MoO_3 is formed. In the long term, this results in a brittle layer which forms blisters and flakes off. In this manner, the life of the lubricant is shortened. In an environment where no oxygen and water are present, such as a vacuum, the MoS_2 maintains a low friction and it has
30 a very long life.

The current generation of lubricant lacquers provides insufficient protection against atmospheric influences. As a result, in the long term, is brittle layer is still created and detachment of the substrate occurs. Uncovered spots are then created, with all its consequences. The extent of degradation of the lubricant lacquer depends on *inter alia* the conditions in which the lubricant lacquer is to function.

Thus, a lubricant such as MoS₂ can function for an insufficiently long time under atmospheric conditions. It is therefore important that the MoS₂ is used as a very fine powder, in combination with a curing organic binder, usually on the basis of an artificial resin. In this manner, the adhesion to the substrate surface is promoted. Further, an organic solvent may be present as a thinner. A thus obtained lubricant lacquer functions for a longer period, if the underlying substrate is sufficiently protected from atmospheric influences. Further, oxidation of the solid lubricants, such as, in this example, MoS₂, needs to be prevented because this shortens the life.

Further, there is a need for lubricant lacquers with improved tribological properties. *Inter alia* the run-in behavior of the lubricant lacquer, the friction coefficient, the surface tension and the anticorrosive action can be improved.

As said, in the past years, the "trial and error" method has not yielded any materially modified lubricant lacquers. The composition of lubricant lacquers has not changed; the most important components are still conventional resin types with MoS₂, PTFE or graphite therein. The organic solvents and additives used are often toxic and/or damaging to the environment, *inter alia* due to the poor biodegradability. Opposed to the standstill in development of lubricant lacquers, there is the optimization and innovation in the coating industry. Here, new cover layers have been developed, with a decorative or protective action, for instance against corrosion; antifouling, etc., or with a different or improved functionality, such as antistatic, wear-resistant and dirt-repellent coatings. Further, the

development of coatings on a water basis, such as water-based lacquers and paints, also attracts the attention. These innovations have, as far as relevant, found no application utility in the development of new lubricant lacquers.

5 In extensive research, the present inventors have studied the effect of the addition of particular additives on desired properties, such as the tribological behavior and the prevention of corrosion, as well as the mutual interaction of the different components of the lubricant lacquer. Further, research was carried out into the effect of pre-treating the substrate, on
10 which the lubricant lacquer is applied, such as grit blasting and enduring, on the tribological and corrosion-resistant properties of that lubricant lacquer.

This research has shown that it is advantageous to add so-called slip additives to a lubricant lacquer. Consequently, the invention relates to a
15 lacquer, comprising, in a liquid medium, a tribologically active component, a resin, and a slip additive, where the tribologically active component is present in an amount of 15-60 wt.% and preferably of 25-50 wt.% based on the total amount of lubricant lacquer, of which the solid content is between 0 and 70 wt%. Slip additives are components which have an inclination to
20 move to the lacquer-air interface in the lacquer systems.

The lubricant lacquer according to the present invention provides an improved run-in behavior. Without wishing to be bound to any theory, it is assumed that, due to diffusion of slip additive molecules, such as for instance polyolefin wax molecules, in the direction of the sliding surface, the
25 tribologically active component (pigment), such as the MoS₂, is oriented substantially parallel in advance (pre-orientation).

The lubricant lacquer according to the present invention further provides a reduced friction coefficient to the sliding surface with a reduction of sometimes up to 40%. A reduction of the friction coefficient leads to less

wear of the underlying substrate. The friction coefficient is determined with the SRV test according to DIN 51834.

A further improvement is a great reduction in surface tension. In particular systems, the inventors have found reductions from 37 to
5 11 mN/m, the only difference being the addition of a slip additive. Due to a lower surface tension, the adhesion of the sliding surface also decreases, resulting in a greatly reduced friction coefficient. A reduced surface tension also leads, in turn, to less wear. Further, the gloss is increased and consequently the surface smoothness.

10 Further, the anticorrosive action of the new slip additives can be mentioned. This considerably extends the life of the lubricant lacquer. In the long term, this means less wear and less maintenance of the parts.

One of the problems of the currently known solvents is that they last for an insufficiently long time relative to the life of the apparatus. Ideally,
15 providing a lubrication once should be sufficient to, on the one hand, effect sufficient lubrication during the life and, on the other hand, provide sufficient stability of the lubricant lacquer and protection against environmental factors. It is known to a skilled person that the life of a lubricant lacquer is a function of:

- 20 (i) the surface treatment of the substrate;
(ii) the constitution of this surface;
(iii) the wear which occurs of the surfaces between which the lubricant lacquer is present;
(iv) environmental factors, such as the temperature, relative
25 humidity, acidity;
(v) the adhesion of the lubricant lacquer to the substrate;
(vi) the protection which the lubricant lacquer provides against corrosion of the underlying substrate; and
(vii) the negative influence of environmental factors on the
30 lubricant lacquer, such as oxidation and hydrolysis.

The lubricant lacquer according to the invention, which usually comprises a dispersion of at least one lubricating solid component as a tribologically active component, a matrix of at least one organic binder (resin), at least one solvent, and at least one slip additive, where the
5 tribologically active component is present in an amount of 15-60 wt.% and preferably of 25-50 wt.% based on the total amount of lubricant lacquer, of which the solid content is between 0 and 70 wt.%, has an extended life. The addition of slip additives leads to improved sliding behavior, and a lower friction coefficient. Further, the addition of slip additives provides a lower
10 surface tension compared to conventional lubricant lacquers, so that less adhesion to the surface takes place and, consequently, a relatively lower friction coefficient results.

A further advantageous effect of the invention is that the substrate on which the lubricant lacquer is applied is better protected against
15 environmental factors, such as moisture and oxygen, by the addition of slip additives according to the present invention. As a result, the lubricant lacquer protects the substrate better and for a longer period of time, resulting in less corrosion. Optionally, a corrosion-resistant agent may be added to this. In a so-called neutral salt spray test (NSS) carried out
20 according to ASTM B117-73 for 24 hours, there is an improvement compared to conventional lubricant lacquers from Re 6 to Re 4. This visual assessment of the samples for corrosion is carried out in conformity with the European rust scale. This assessment varies from Re 0 (0% corrosion) to Re 9 (100% corrosion).

25 In this connection, further, the protective action against environmental factors of the slip additives on the tribologically active pigment should be mentioned. This considerably extends the life of the lubricant lacquer and the frequency for carrying out necessary maintenance is reduced.

In a preferred embodiment, the slip additives consist of polysiloxanes or modified polysiloxanes. Such polysiloxanes are of the type polyalkylsiloxanes or polydialkylsiloxanes, preferably polydimethylsiloxanes. These may be modified with polyether or polyester side chains. Optionally, these polydimethylsiloxane copolymers modified with polyether or polyester may be functionalized with hydroxyl groups. The number of repeating siloxane units is 2 to 3000, preferably 40 to 250. Examples of these substances are BYK 307, BYK 310, BYK 333, BYK 373, EFKA 3031 and EFKA 3522 of the firms BYK Chemie and EFKA, respectively.

In different embodiment, the slip additives consist of polyolefin waxes, such as polyethylene (PE) and polypropylene (PP) homopolymers and copolymers, as well as modified variants of these polymers. Such copolymers may, for instance, consist of ethylene vinyl acetates, ethylene acrylic acids, ethylene acrylates. Examples of these substances are Ceracol 600 and 601 and Cerafac 59 of the firm Byk Chemie, as well as Ultralube E-671 of the firm Keim-Additec.

Other examples are polypropylene waxes (PP) or modified polypropylene waxes. An example of these substances is Ultralube E-668-H of the firm Keim-Additec (35 wt.% polypropylene wax emulsion, non-ionic/anionic, pH=8.5-9.0). In addition, paraffin-like substances and Caranuba and modified versions thereof may also be used as slip additives.

Other examples of slip additives are polytetrafluoroethylenes (PTFE) or modified polytetrafluoroethylenes. These PTFE additives are supplied as powders, emulsions and dispersions. Manufacturers are, for instance, DuPont, 3M, Diakin, Ausimont, etc. Specific examples of these substances are: Zonyl MP 1100 (powder, average particle size 4 μm), Zonyl MP 1600 (powder with average particle size 12 μm), Zonyl TE-5069 AN (dispersion with average particle size of 12 μm), Zonyl TE-3667N (dispersion in water with average particle size of 0.22 μm) (Zonyl products all of DuPont) and

Ultralube E-801 (a non-ionic/anionic 46 wt.% PTFE dispersion of Keim-Additec, pH=6.5-7.5).

Slip additives of the type polysiloxanes are advantageously added in amounts of 0.001 to 10.0 wt.% based on the total amount of tribologically active pigments and preferably in amounts of 0.01 to 1.0 wt.% based on the total amount of tribologically active pigments.

Slip additives of the type polyolefin waxes are advantageously added in amounts of 0.01 to 20.0 wt.% based on the total amount of tribologically active pigments and preferably in amounts of 0.1 to 10.0 wt.% based on the total amount of tribologically active pigments.

Slip additives of the type polytetrafluoroethylenes are added in amounts of 0.01 to 20.0 wt.% based on the total amount of tribologically active pigments and preferably in amounts of 0.1 to 5.0 wt.% based on the total amount of tribologically active pigments.

An important component of the lubricant lacquer is the tribologically active component, for instance MoS₂, graphite, WS₂, PTFE and other fluorine-containing polymers, CeF₃, SnS₂, Bi₂Se₃. So, PTFE may function as both tribologically active component and a slip additive. For an optimal action of this component, the sliding surfaces need to be parallel to the surface of the substrate as much as possible. As already stated hereinabove, the tribologically active component is oriented substantially parallel to the sliding surface in advance. This is achieved by a diffusion of the slip additives in the direction of the sliding surface. By this mechanism, the tribologically active components, such as MoS₂, are forced to arrange themselves parallel to one another. Suitable amounts of tribologically active component are contents between 25 and 50 wt.% of the total amount of lubricant lacquer, of which the solid content is between 40 and 70 wt.%. In the solid content, all ingredients are included, exclusive of the liquid solvents. (For MoS₂, very suitable MoS₂ granule sizes are between 0.1 and 50 μm, and preferably between 1 and 20 μm.)

The lubricant lacquers according to the invention can find conventional application utility, where particularly the improved properties as mentioned hereinabove are important. Explicit reference is made to use in the automotive industry or in the field of exceptional transport, or for use
5 in exceptional operations, such as extremely large tackling and hoisting apparatuses. In addition, use in so-called niche markets, in, for instance, the high-end industry, where relatively high requirements are set with regard to purity, behavior under vacuum and durability, is advantageous. Further, uses of the lubricant lacquers according to the invention in the white goods
10 industry and space travel can be mentioned.

The matter of the invention relates to a lacquer, where the liquid medium comprises 10 wt.% - 50 wt.% and preferably 15 wt.% - 40 wt.% based on the solid content of the ready lubricant lacquer of an organic binder (resin).

15 The resin is for instance and preferably chosen from the group consisting of polyurethane/polyacrylate, polyurethane/polyester, polyisocyanate/polyacrylate, polyurethane/polyamide, polyamide/polyimide, epoxy resins, polyester/melamine, polyacrylate/melamine etc. The advantage of lubricant lacquers in which melamine is used is that, during
20 manufacture, application and curing, that is, cross-linking, the lubricant lacquers are insensitive to moisture, which may be present in the atmosphere or which may be released from the substrate under the influence of temperature during the curing. Consequently, with
25 melamine-containing lubricant lacquers, products can be obtained of a constant quality, which quality is less dependent on the underlying substrate or other environmental factors.

The lacquer according to the invention usually also contains a thickening agent. Such an agent is usually present in an amount of
30 0.1 wt.% - 50 wt.% and preferably 1.0 wt.% - 20.0 wt.% based on the solid content of the ready lubricant lacquer.

The matter of the invention relates to a lacquer which, before application, contains a solvent. Solvents are generally present in the lacquer composition in an amount of 15 wt.% - 75 wt.% and preferably of 35 wt.% - 55 wt.%. Preferred examples of suitable solvents are liquids
5 chosen from the group comprising 1-methoxy-2-propyl acetate (MPA), butyl acetate, Solvesso 100[®], Solvesso 150[®], Solvesso 200[®], butyl glycol, dibasic esters, n-butanol, 2-butoxyethanol, N-methylpyrrolidone, dimethylethanolamine, glycol, methoxypropanol, aminomethyl propanol and water.

10 In addition, the invention relates to the use of the lacquer as protection against wear, corrosion, as friction-reducing agent, as lubricant; and objects treated with the lacquer. Incidentally, the lubricant lacquer can be applied in the usual manner, for instance with a squeegee or a foam roller, or via spray or dip spin technologies. Optionally, the substrate may
15 be pre-treated in a conventional manner. For instance, substrates may first be degreased and/or be grit-blasted, for instance with fine corundum. Curing takes place by heating at a temperature suitable to effect the cross-linking and to remove the light solvents.

The invention will be elucidated hereinbelow in and by non-limiting
20 examples, where, in Example 5, a basic material is described which can suitably be used in a lubricant lacquer according to the present invention.

Example 1: Lubricant lacquer on the basis of an organic solvent

25 In the following preferred embodiment, the tribologically active pigments consisted of MoS₂, particularly Molyform 15 of the firm H.C. Starck.

Slip additives are Ceracol 600 and BYK 373 of the firm Byk Chemie, as well as Zonyl TE 5069 AN (DuPont).

The resin system was on the basis of an acrylate resin with functional hydroxyl groups, namely Uracron CY 474E of DSM Resins. The oxime-blocked isocyanate Uradur YB147 of DSM Resins was used as well.

As a thickener, a silica thickener was chosen: Aerosil 380 of Degussa.

5 As a dispersant, Disperbyk 110 of BYK-Chemie was chosen. This is a solution of a copolymer with acid groups.

As corrosion additives, Heucophos ZPA of Heubach and Nacor 1151 of King Industry were used.

The solvent was 1-methoxy-2-propyl acetate (MPA).

10 The lubricant lacquer was prepared in the manner stated hereinafter, where the corrosion-resistant agent Heucophos ZPA was added optionally together with the slip additives.

20.67 g of Uracron CY 474 E and 16.27 g of Uradur YB S1 were mixed by means of a Dispermat at 5000 to 6000 rpm with water cooling. With
15 stirring, 30 g of MPA was added, thereby creating a vortex shape. After this, gradually 80.10 g of MoS₂ was added. Because the viscosity of the paste obtained was too high, 6.0 g of MPA was added. With stirring, 0.18 g of BYK 373 and 1.6 g of Ceracol 600 were added, after which firm dispersion took place for 30 minutes. After addition of 4.0 g of Aerosil, thereby forming
20 a vortex, again, dispersion took place for 30 minutes. After this, 50 g of MPA was added to reach the desired viscosity (a flow rate of 30 seconds). The viscosity was measured by means of a viscosity cup with an opening of 4 mm (DIN 53211).

This lubricant lacquer was cured at 180 °C for 20 minutes. The following results were found:

some characteristics of lubricant lacquer	value
weight percentage of solid substance	53.08
weight percentage of MoS ₂ based on total lubricant lacquer	38.36
stoichiometry (NCO/OH)	78.71
viscosity (DIN 4 mm)	20-25 sec.
ratio of MoS ₂ /resin	2.90
weight ratio of the resins Uracron/Uradur	1.30
pigment volume concentration	40%
gloss value at angles of 60° and 85°	1-1.5
surface tension of polar component (mN/m)	0.1-1.0
surface tension of disperse component (mN/m)	12-17

Table 1. Characteristics of lubricant lacquer from Example 1.

5 Example 2: Water-based lubricant lacquer

In different preferred embodiment, the tribologically active pigments also consisted of MoS₂, and particularly Molyform 15 of the firm H.C. Starck. Slip additives were BYK 333 of the firm Byk Chemie, as well as Zonyl MP
 10 1600 N (DuPont) and Ultralube E-668-H of Keim-Additec.

The resin system was based on a polyester with functional hydroxyl groups, namely Bayhydrol D 155 of Bayer AG. The blocked isocyanate Bayhydur of Bayer AG was found to be equally usable. A polyester with functional
 15 hydroxyl groups, such as Uradil SZ 255 of DSM Resins; or the oxime-blocked isocyanate Uradur YB147 of DSM Resins, were also usable.

As a thickener, a silica thickener was chosen, Aerosil COK 84 of Degussa and a urethane thickener Tafigel PUR 61 of Münzing Chemie.

As a dispersant, Disperbyk 180 and Disperbyk 190 of BYK-Chemie (a copolymer with acid groups) and EFKA 4530 of EFKA (polyacrylate in methoxypropanol) were chosen.

As corrosion additives, Heucophos ZPA of Heubach and Irgacor 252 FC of
5 Ciba Geigy were used.

The solvent was water.

The lubricant lacquer was prepared in the following manner, where optionally the corrosion-resistant agent Heucophos ZPA was added together
10 with the slip additives.

32.74 g of Bayhydrol D 155 and 26.48 g of Bayhydur BL 5140 were mixed by means of a Dispermat at 5000 to 6000 rpm with water cooling. The viscosity increased very much. With stirring, 22 g of demineralized water and 1.50 g of aminomethyl propanol were added, so that the pH increased to 10. 10.0 g
15 of EFKA 4530 was then admixed for 15 minutes. After this, gradually, 88.6 g of MoS₂ and 0.12 g of BYK 333 were added. Dispersion took place for 15 minutes, thereby forming a vortex. Because the viscosity of the paste obtained was too high, 32 g of demineralized water was added. After addition of 2.50 g of Aerosil COK 84, dispersion again took place for
20 15 minutes, thereby forming a vortex. After this, 25.0 g of demineralized water was added to reach the desired viscosity (a flow rate of 30 seconds). The viscosity was measured by means of a viscosity cup with an opening of 4 mm (DIN 53211).

This lubricant lacquer was cured at 150 °C for 20 minutes.

Example 3

The table below shows non-limiting examples for the different components for the categories water-based lubricant lacquer and lubricant lacquer with organic solvent.

components	organic solvent	water-based
resin system	Uracron CY 474 E	Uradil SZ 255
	Uradur YB147	Uradur YB147
		Bayhydrol D 155
		Bayhydur BL 5140
pigment	MoS ₂	MoS ₂
thickener	Aerosil 380	Aerosil COK 81
		Tafigel PUR 61
dispersant	Disperbyk 110	Disperbyk 180
		Disperbyk 190
		EFKA 4530
slip additive	BYK 373	BYK 333
	Zonyl TE 5069 AN	Zonyl MP 1600 N
	Ceracol 600	Ultralube E-668-H
		PTFE
corrosion additive	Heucophos ZPA	Heucophos ZPA
	Nacor 1151	Irgacor 252 FC
solvent	1-methoxy-2-propyl acetate (MPA)	Demineralized water

Table 2. Different components for lubricant lacquer.

Example 4

Tribological tests were carried out to determine the influence of slip additives on the friction coefficient at low pressing force (4000 N, corresponding with a maximum hertzian contact potential of 738 MPa). For this purpose, measurement took place for 2.5 hours; in this interval the effect should be demonstrated. It was found that slip additives have a large effect on the run-in behavior when the lubricant lacquer has been applied to a ring which has been corundum-blasted in advance, on which a pin was placed. The rotational speed of the ring was set such that a sliding speed between pin and ring of 5 mm/s was reached. A reciprocal movement over 180° was used. The friction signal f was measured. The composition of Example 1 moved to the surface of the lubricant lacquer. Addition of 0.1 wt.% BYK 373 resulted in a large reduction of the friction coefficient. It needs to be noted that f increased after 1.5 hours to a value of 0.10. Addition of the PE wax Ceracol 600 in combination with 0.1 wt.% BYK 373 resulted in a slightly declining friction coefficient of about 0.09. The result is comparable with BYK 373 alone, on the understanding that the f declines for the combined system and rises for BYK 373 alone. Apparently, the additives enhance one another in their action: the PE wax possibly provides pre-orientation of the MoS₂ platelets and the siloxane BYK 373 provides a reduced friction during the running in so that further orientation of the MoS₂ platelets can take place.

Example 5: Basic material for lubricant lacquer

It is a resin system with melamine as a cross-linker. The principle is based on a blocked melamine which, at an elevated temperature, reacts with an OH-functional resin, in this specific example an OH-functional polyester. However, different OH-functional resins are also usable, such as polyacrylates, etc.

The starting material is a same PVC (MoS_2) as in the standard lubricant lacquer (see Example 1). The resin formulation has been chosen on the basis of a recommended formulation of DSM Resins. This is a resin formulation for a coating still without tribological pigments and without slip additives. These can be added in a simple manner, if desired. This is part of the expertise of a skilled person.

The resin system is based on an OH-functional polyester resin Uralac SN 841 S2G3-60 (DSM Coating Resins), and melamine cross-linker, hexamethoxymethylmelamine (Cytec, Cymel 303). In this connection, other blocked melamines are also possible.

The tribologically active pigment is MoS_2 . Here, Molyform 15 of the firm H.C. Starck was used.

As catalysts, Dynapol BL1203 (Degussa) and K-cure 1040 (King Industries) were used.

The chosen dispersing additive was Disparlon L1984 (Kusumoto Chemicals).

To such a basis for a lubricant lacquer, slip additives can be added. Possible slip additives are Ceracol 600 and BYK 373 of the firm Byk Chemie, as well as Zonyl TE 5069 AN (DuPont).

The solvents used were a mixture of 75% Solvesso 150 and 25% butyl glycol. Other types of solvent which are suitable are: methoxy propyl acetate (MPA), Solvesso 200, dibasic esters, butyl glycol, n-butanol or Solvesso 150.

The basic formulation is the following:

Component	amount (g)
Uralac SN 841 S2G3-60 (DSM Coating Resins)	45.2
MoS ₂	100.0
Disparlon L1984	0.2
Solvent	35.5
Cymel 303	4.8
Catalyst Dynapol BL 1203	1.8
Catalyst K-cure 1040	0.6

A mixture of 45.2 g of Uralac SN 841S2G3-60 and 35.5 g of solvent
5 (which was a mixture of 75 % Solvesso 150 and 25 % butyl glycol; methoxy propyl acetate (MPA) is suitable as well) were firmly stirred by means of a Dispermat (5000 to 6000 rpm) with water cooling. With stirring, 100.0 g of MoS₂ and 0.2 g of Disparlon L1984 were added, after which firm dispersion took place for 20 minutes with water cooling.

10 Then, with stirring, 4.8 g of melamine resin Cymel 303, 1.8 g of catalyst Dynapol BL1203 and 0.6 g of catalyst K-cure 1040 were subsequently added. After this, 20 g of extra solvent (a mixture of 75% Solvesso 150 and 25% butyl glycol, methoxy propyl acetate (MPA) is also suitable) were added to reach the desired viscosity for application (at a flow
15 rate of 30 seconds). The viscosity was measured by means of a viscosity cup with an opening of 4 mm (DIN 53211).

Optionally, a thickener may be added for stabilization (deposition) of the MoS₂ pigment.

20 The lubricant lacquer is to be mixed in such a manner that the fineness of grind is 0-0.25 mm. This is measured by means of a fineness of grind gauge. This measurement is to be carried out at least 3 times.

The lubricant lacquer can preferably be cured at 160°C for 15 minutes. This period of 15 minutes is the time that the lubricant lacquer actually experiences the indicated temperature. So the heating-up time needed to heat up the lubricant lacquer to the curing temperature (in the present Example 7 minutes) is not included in this.

Other curing conditions may be:

160°C, 20 minutes

180°C, 10 minutes

180°C, 20 minutes

210°C, 10 minutes

300°C, 2 minutes (excluding heating-up time of lubricant lacquer).

CLAIMS

1. A lacquer, comprising, in a liquid medium, a tribologically active component, a resin, and a slip additive, wherein the tribologically active component is present in an amount of 15-60 wt.% and preferably of 25-50 wt.% based on the total amount of lubricant lacquer, of which the solid content is between 0 and 70 wt.%.
5
2. The lacquer according to claim 1, wherein the slip additive has been chosen from the group comprising polysiloxanes and modified polysiloxanes, polyolefin waxes and modified polyolefin waxes, polytetrafluoroethylenes (PTFE) or modified polytetrafluoroethylenes or mixtures thereof.
10
3. The lacquer according to claim 1 of 2, comprising as a slip additive (a) polysiloxanes and/or modified polysiloxanes in amounts of 0.001 tot 10.0 wt.% based on the total amount of tribologically active component and preferably in amounts of 0.01 tot 1.0 wt.% based on the total amount of tribologically active component; (b) polyolefin waxes and/or modified polyolefin waxes in amounts of 0.01 tot 20.0 wt.% based on the total amount of tribologically active component and preferably in amounts of 0.1 tot 10.0 wt.% based on the total amount of tribologically active component; (c) polytetrafluoroethylenes and/or modified polytetrafluoroethylenes in amounts of 0.01 tot 20.0 wt.% based on the total amount of tribologically active component and preferably in amounts of 0.1 tot 5.0 wt.% based on the total amount of tribologically active component.
15
20
4. The lacquer according to any one of the preceding claims, wherein the tribologically active component is chosen from the group comprising MoS₂, graphite, WS₂, PTFE and other fluorine-containing polymers,
25

CeF₃, SnS₂, Bi₂Se₃, on the understanding that, if PTFE is the tribologically active component, the slip additive is not PTFE.

- 5 5. The lacquer according to any one of the preceding claims, wherein the liquid medium comprises an organic binder in an amount of 10 wt.% - 50 wt.% and preferably 15 wt.% - 40 wt.%, based on the solid content of the ready lubricant lacquer.
- 10 6. The lacquer according to claim 5, wherein the resin is chosen from the group comprising polyurethane/polyacrylate, polyurethane/polyester, polyisocyanate/polyacrylate, polyurethane/polyamide, polyamide/polyimide, epoxy resins, polyester/melamine, polyacrylate/melamine, etc.
7. The lacquer according to any one of the preceding claims, further comprising a corrosion-resistant agent.
- 15 8. The lacquer according to any one of the preceding claims, wherein the liquid medium is chosen from the group comprising 1-methoxy-2-propyl acetate (MPA), butyl acetate, Solvesso 100[®], Solvesso 150[®], Solvesso 200[®], butyl glycol, dibasic esters, n-butanol, 2-butoxyethanol, N-methylpyrrolidone, dimethylethanolamine, glycol, methoxypropanol, aminomethyl propanol and water, wherein the liquid medium is present
20 in an amount of 15 wt.% - 75 wt.% and preferably of 35 wt.% - 55 wt.% based on the weight of the lacquer composition.
9. Use of the lacquer according to any one of the preceding claims as a protection against wear, corrosion, as a friction-reducing agent and/or as a lubricant.
- 25 10. Object provided with a layer of dried lacquer according to any one of claims 1-9.
11. Use of polysiloxanes, modified polysiloxanes, polyolefin waxes, modified polyolefin waxes, polytetrafluoroethylenes or modified polytetrafluoroethylenes in a lubricant lacquer as a wear inhibitor.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/NL2004/000545

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 C09D7/12		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) IPC 7 C09D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
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<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C.		
<input checked="" type="checkbox"/> Patent family members are listed in annex.		
° Special categories of cited documents :		
A document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed		
T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *&* document member of the same patent family		
Date of the actual completion of the international search 23 November 2004		Date of mailing of the international search report 02/12/2004
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer Matthijssen, J-J

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