United States Patent [19]

Izumi et al.

[11] **3,899,625**

[45] **Aug. 12, 1975**

---

[54] **SHEET METAL TREATED WITH LUBRICANT FOR PRESS WORK**

[75] Inventors: **Soichi Izumi; Takeo Ashiura,** both of Muroran; **Yoshiji Ito,** Noboribetsu; **Nobutaka Miura,** Tokyo, all of Japan

[73] Assignee: **Nippon Steel Corporation,** Tokyo, Japan

[22] Filed: **Dec. 21, 1972**

[21] Appl. No.: **317,142**

[30] **Foreign Application Priority Data**

Dec. 27, 1971 Japan 47-1988

[52] **U.S. Cl.** **428/457;** 72/46; 252/49.5; 427/421; 427/428; 427/435

[51] **Int. Cl.**^{2} **B32B 15/08**

[58] **Field of Search** .... 117/132 C, 161 F; 72/46; 252/49.5; 428/457; 427/421, 428, 435

[56] **References Cited**

UNITED STATES PATENTS

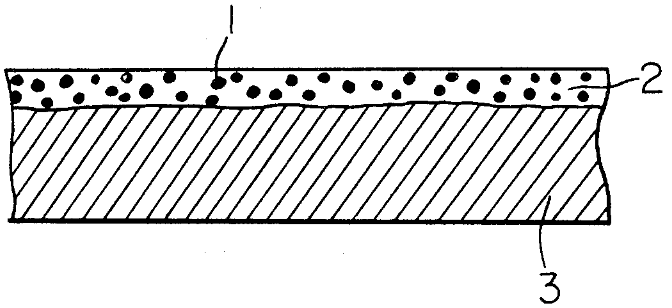
3,258,319	6/1966	Cox	117/132 C
3,287,264	11/1966	Topper	117/132 C
3,298,954	1/1967	Brown	252/49.5 X
3,501,404	3/1970	Klaiber et al.	252/49.5
3,549,037	12/1970	Moloney	117/132 C
3,568,486	3/1971	Rosenberg et al.	117/132 C

Primary Examiner—Harry J. Gwinnell
Attorney, Agent, or Firm—Watson Leavenworth Kelton & Taggart

[57] **ABSTRACT**

A sheet metal to be subjected to press work having a film thereon which film has been formed by dispersing a hotmelt type lubricant in a water-soluble or water-dispersible resinous solution and then coating the resultant solution on the surface of said sheet metal. Said lubricant is in solidified or semi-solidified form at ordinary temperatures. The film formed is of lubricative nature having a high coefficient of statical friction, and shows an effect of preventing sliding before the press work and also an effect of lubricating by melting the lubricant at the time of the press work.

2 Claims, 4 Drawing Figures



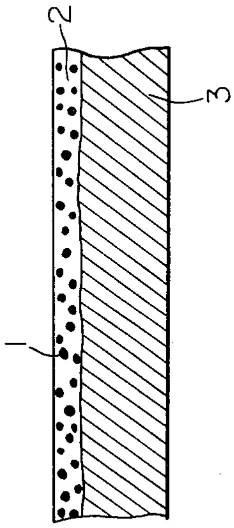


Fig. 1

Fig. 2(A)

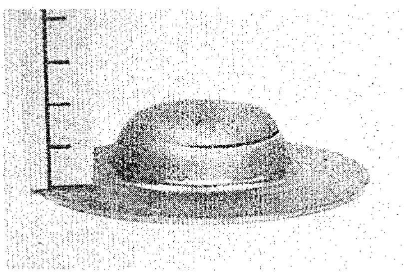


Fig. 2(B)

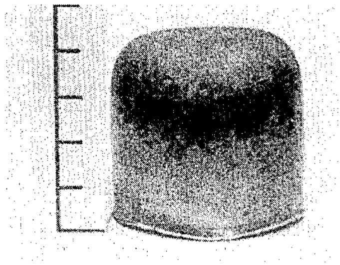
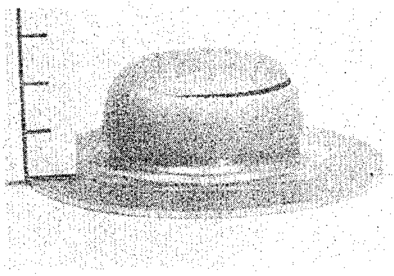


Fig. 2(C)



SHEET METAL TREATED WITH LUBRICANT FOR PRESS WORK

BACKGROUND OF THE INVENTION

As for a metallic sheet or plate treated for lubrication, the one having a dry film, instead of press oil, coated thereon which is in a solid form at ordinary temperatures has heretofore been developed for the purpose of improving the circumstances around the press work. This is composed of lubricant having wax, metallic soap, etc. as the main components, which is usually coated on the sheet metal by means of hot-melt or solvent-dilution.

These wax or metallic soap, etc. have such an excellent lubricative function that when applied on the surface of the metal as the single film, they will make the metal very slidable owing to its small coefficient of statical friction.

Accordingly, in case of using such treated sheet metal, there are many problems that when it is stacked it is apt to fall off, or when it is subjected to a continuous blanking resulting from automation of the press work, the accuracy of its size is decreased owing to slipping from the transfer machine, etc.

In addition, there is also a problem in the manufacture technique that when it is desired to coil a strip metal, there is difficulty in coiling because some slipping occurs at the tension bridle roll or pinch roll, etc.

Many attempts have so far been made to solve the problem of each sliding or slipping caused by the excellent lubrication property. For example, one process is to form on the easily slidable lubricant film another film having a higher coefficient of statical friction. Another process is to use an organic film, such as a resinous film of polyvinyl chloride, polyacrylic ester, which has less lubrication property but is not lubricative because of its higher coefficient of statical friction under ordinary conditions. In order to elevate the lubrication function of this film, there is a process developed which comprises coating on said film a substance having an effect of softening and melting the organic film to a semi-fluidized condition at the time of press work as shown in U.S. Pat. No. 3,568,486.

In the first mentioned process, however, there is a disadvantage that two coating steps are necessary and the resulting film becomes naturally thicker because an organic film having a higher coefficient of statical friction on such film as wax or metallic soap, etc. having an excellent lubrication property. In the latter mentioned process, there still remains a problem in the prevention of pollution of the circumstances of the press work or the omission of the step of applying oil since a substance for changing the film to a semi-fluidized conditions is used at the time of press work.

It is therefore an object of the invention to provide a product adapted for use in the omission of the step of applying an oily lubricant normally used and for prevention of pollution of the circumstances of the work.

It is another object of the invention to provide a well-protected product which can display an excellent lubrication effect at the time of press work of the sheet metal but is easy of handling without slipping at ordinary times because of its higher coefficient of statical friction.

It is still another object of the invention to provide a product having a coating which may easily be removed, for example, by an alkaline detergent.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a sheet metal treated by lubricant for press work which comprises a lubrication film having a higher coefficient of statical friction, said film formed by dispersing a hot-melt type lubricant in a resinous layer and coating the resulting solution of the surface of said metal, said lubricant being in a solidified or semi-solidified form at ordinary temperatures and having an excellent lubrication property.

It is the portion where the pressure is focussed such as the shoulder of the die which requires the particular lubrication property at the plastic deformation of the sheet metal. In case of the lubrication film according to the invention, the resin covering the lubricant is destroyed by a strong, external force at the above portion while the hot-melt type lubricant dispersed in the organic film melts by the heat caused by deformation of the metal or facial friction thereof, which exerts a very excellent lubrication effect.

On the other hand, in the other portions where the lubrication property is not so strongly required, the function of the hot-melt type lubricant is not displayed due to lesser generation of the heat so that the character of the organic film having higher coefficient of statical friction can act as it should.

Generally, it is well known that the lubrication effect at the time of press work will give an important influence upon the deformability of the sheet metal. It is also a well-known fact that the difference in lubrication property between the punch side and the die side will have a great influence upon the deformability of the sheet metal. At the press work, it is possible to obtain an excellent property of deep drawing of the sheet metal by promoting the lubrication property on the die side while controlling the lubrication property on the punch side.

The invention is based upon the finding of the difference in lubrication property at the time of press work whereby the lubrication function can be timely exerted where it is particularly required.

Conventionally, the deformation or shaping of the metal by press has been made under entirely identical conditions with respect to lubrication. Thus, when the lubricant having an excellent lubrication property is used, it will often give an adverse effect upon the deformability of the material since said property will also be exerted where lubrication is not essentially required.

In this invention, the lubrication film acts such that the lubrication property is effectively given where it is required while it is restricted or controlled where it is not required very much, which makes it possible to obtain an ideal lubrication function at the time of deformation by press work.

When the sheet metal for press work to which the lubrication film has been applied according to the present invention is handled in the ordinary step, there is no problem regarding the stack-crumbling due to slipping or the other slipping problem in the blanking line or other lines because of higher coefficient of statical friction of the dispersion medium of said film.

As for the lubricant to be a dispersed phase, materials which are in solidified or semi-solidified form at ordinary temperatures such as wax, higher fatty acid, metallic salts of higher fatty acids, various hydrocarbons and their derivative, for example, acrylic acid, methacrylic acid, ester of higher fatty acid, monopolymer thereof or copolymer of these monomers as the main component mixed with a small amount of other monomers and so on may be used. In case that the lubricant is in a form of powders having size between about 0.01 and 10 μ, said powders can be added portionwise into an aqueous solution with stirring but without heating so that a uniform dispersion layer may be obtained.

The resinous layer to be a dispersion medium can be water-soluble or water-dispersible. In case it is water-soluble, one method to disperse the hot-melt type lubricant in this aqueous resinous solution is to heat the same to a temperature near the melting point of the lubricant, if the lubricant is in a form of a solid lump at ordinary temperatures, then heat and melt said the lump-like lubricant and add said molten lubricant portionwise into said aqueous solution with stirring by means of a homo-mixer or suitable agitater whereby the dispersion layer having particle size of 10 μ or less can be obtained.

When the temperature of the aqueous solution is low, the molten lubricant solidifies so rapidly that the dispersed phase shows an irregular suspension of a size between several milimeters and several ten milimeters, which results in troubles in forming a film on the sheet metal.

The materials which may form an organic film as the dispersion medium are an water-soluble resin which has higher coefficient of statical friction than that of the lubricant or the dispersed phase and shows difficult slipping, such as polyacrylic acid, polymethacrylic acid, amine salt or ammonium salt of copolymer of acrylic acid and acrylic ester, amine salt or ammonium salt of copolymer of methacrylic acid and methacrylic ester, amine salt or ammonium salt of copolymer of acrylic acid and methacrylic ester, amine salt or ammonium salt of copolymer of methacrylic acid and acrylic ester, water-soluble copolymer of polyethyleneiminestyrene-maleic anhydride, styrene-acrylamide, polyvinyl pyrrolidone, methylvinylether and so on, water-soluble alkyd resin, water-soluble phenol resin, polyamide resin, water-soluble copolymer of vinyl acetate system, and other water-soluble resin capable of forming a film when dried on the surface of the sheet metal.

Considering also about the merits of operation and economy up to the degreasing step, it is desirable that the lubricant film can be degreased by an alkaline solution after shaping by press work.

Accordingly, as for the organic film to be a dispersion medium, a water-soluble type of polyacrylic acid and polymethacrylic acid are preferable water-soluble resin which can be used in the present invention.

On the other hand, the resinous layer to be a dispersion medium can be of water-dispersible nature. In the case, such general organic solvents as ketone, ester or hydrocarbon system are not suitable since they tends to swell or dissolve the lubricants and not to disperse the same. In this respect, water is preferable. Water-soluble alcohols, ethyleneglycol monoalkylethers or diethylene monoglycolethers are also not recommendable for the same reason as above, but they may be used because the degree of unsuitableness is lower than above. Moreover, it is effective to a certain extent in the manufacture of the water-dispersible resin to mix a water-insoluble material such as toluene or xylene with the monomer so as to obtain the film-forming ability at lower temperatures. The use of the organic solvents suitable for that purpose is never excluded in the practice of this invention.

As is the case with the water-soluble resin, the water-dispersible resin to be used should preferably be such that the organic film made therefrom can be removed by an alkaline detergent. In this case, the film is usually dispped in a detergent liquid of pH 8 to 13 at 40° to 60°C, or it can be sprayed upon the film and it can thus be removed in several minutes. The mechanism of removing the film may be solubilization or may be simple separation without solubilization.

It has now been found that the water-dispersible resin having the resin acid value of 30 to 400 and the glass transition temperature of 35°C or less is very suitable for this purpose. When this water-dispersible resin is produced, a predetermined amount of α, β-unsaturated carboxylic acid is used as the monomer to give carboxylic group in the resin, and when the film is removed, the reaction between the carboxylic group and the alkali is utilized. In case that the resin acid value is below 30, the removal of the film does not take place well. When a hydrophilic monomer is used as other copolymer component than the acid component in order promote this, it becomes difficult to manufacture the waterdispersible resin in a stabilized manner. On the other hand, when the resin acid value is above 400, it becomes difficult to manufacture the water-dispersible resin, which is almost solidified during polymerization. It is thus necessary to make the resin acid value between 30 and 400 from the viewpoint of easy removal of the film and stabilized manufacture of the resin. In the film of the present case, the water-dispersible resin becomes a body of the film which should include the lubricant under dispersed conditions. When the water-dispersible resin forms the film, it is not consistent with the lubricant becomes fluidized.

Consequently, the softening temperature of the waterdispersible resin must be at least lower than that of the lubricant.

In this respect, in case that the lubricant is for example zinc stearate (m.p. about 140°C), the glass transition temperature of the water-dispersible resin can be in the order of 80°C. However, when the resin film is too hard, the film tends to be cracked under dry or cold circumstance, and at the worst conditions it may be peeled off from the sheet metal. In order to avoid these phenomena, the glass transition temperature of the water-dispersible resin should be below 35°C, and preferably, below 30°C. The acid components suitable for producing such water-dispersible resin are α, β-unsaturated carboxylic acid, such as acrylic acid, methacrylic acid, itaconic acid, crotonic acid, maleic acid, anhydrous maleic acid and the like. The other monomers to be copolymerized therewith are, for example, acrylic esters, methacrylic esters, styrene, vinyl acetate, acrylonitrile and any other α,β-unsaturated compounds copolymerizable with the above acid components. As set forth above, the resin which can be obtained from these monomers must have the restricted glass transition temperature. Therefore, it is impossible to exclusively use such materials as methyl methacrylate or styrene which will give a hard film. In this case, a method to copolymerize 2-ethylhexyl acrylate, butyl acrylate, etc. may be used. The water-dispersible resin can be obtained by means of emulsion-polymerization method using those monomers. Any known initiator or emulsifier can be used. If necessary, a chain transfer agent may be added.

In order to disperse the lubricant in the water-dispersible resinous layer in a stable, pulverized form, an emulsifier is usually dissolved in water, which is then heated with vigorous agitation. The lubricant in the heated and melted conditions or in the solid form is then gradually added to the above solution for emulsification. As the emulsifier, the anion system, nonion system, or combination thereof may be used. The amount of the emulsifier used is usually 0.1 to 5 parts per 100 parts of the lubricant. The concentration of the lubricant thus emulsified is preferably about 0.1 to 2.0%.

The coating composition according to the present invention includes (1) water, (2) water-dispersible resin and (3) lubricant. It is necessary that the weight ratio of (2)/(3)should be in the range of 0.05 to 10, and preferably 0.1 to 6. Above 10, (3) is so small that the lubrication effect can not be exerted well, while below 0.05, slipping often occurs, which makes it difficult to handle the treated sheet metal. This range, however, can not be determined by the exact figures. Even outside the range, preferable results may often been obtained.

In this invention, the treated sheet metal can display an excellent lubrication effect even when the amount coated is very small. Thus even about 0.05 mg/m^2 of the coating from which the solvent has been dried off will give an excellent lubrication effect.

The way of applying or coating the material to the sheet metal may be dip coating, roller coating or spray coating, etc. The thickness of the coating or film can be easily controlled by means of control of the concentration of the aqueous solution of the resin.

The thickness of the coating should preferably be not more than 10 μ in view of the problem of build-up to the metal mold for press work or the prevention of blocking of the film when the sheet metals are stacked.

It is necessary to regulate the mixing ratio of the lubricant to be added to the aqueous solution of the synthetic resin depending upon the material of metal used, the thickness of the sheet or other deforming conditions. The mixing ratio of the lubricant at which the difference in the lubrication effect between the die side and the punch side becomes maximum may vary with the decrease of concentration of an aqueous solution of the synthetic resin, but it can be seen within the concentration range within which the 0.1% dispersion medium will be converted.

At the concentration at which the dispersion medium is converted so as to change the dispersed phase into a continuous layer, it becomes substantially same as a single lubricant film so that remarkable promotion of the lubrication property can not be obtained. On the other hand, below 0.1%, it becomes substantially same as the lubrication effect of a single synthetic resin film so that any lubrication effect can not be expected.

Brief description of the drawing

FIG. 1 is a schematic sectional view of a sheet metal treated according to the present invention; wherein the discrete hotmelt type lubricant **1** is dispersed in the resinous layer **2** applied to the sheet metal substrate **3.**

FIG. **2**(A) is a photograph showing the depth of deformation after deep drawing of a sheet metal on which a single film of water-soluble resin or the dispersion medium has been applied.

FIG. **2**(B) is a photograph showing the depth of deformation after deep drawing of a sheet metal treated according to the present invention.

FIG. **2**(C) is a photograph showing the depth of deformation after deep drawing of a sheet metal on which a single film of the dispersed phase has been applied.

PREFERRED EMBODIMENTS OF THE INVENTION

EXAMPLE 1

An aqueous solution of the synthetic resin consisting of 10 parts of water-soluble polyacrylic ester (solid 30%), 0.5 parts of carboxylic acid salt (rhodinic acid soap) and 89.5 parts of water was heated to 50°C, to which was added with stirring 2% by weight of hot-melt type lubricant (m.p. 46°C) under heated and melted conditions composed of 20 parts of calcium stearate and 80 parts of wax of polyethylene system so that a uniformly dispersed lubricant solution was obtained. Into this solution a pickled, hot-rolled steel sheet, SPHD (a hot-rolled mild steel plate corresponding to ASTM standard A569-66T and J.I.S. (Japanese Industrial Standard) G3131 as Grade No. 2, drawn grade), in the form of a disc of 88 mm diameter and 1.6 mm thickness was dipped so as to coat the solution thereon, dry the same and produce a film of 0.05 μ on the surface of said steel disc. The result of deep drawing test of this lubricant-treated steel disc (punch dia.: 40 mm flat bottom, die dia.: 45 mm, wrinkle push 1 ton) showed such excellent lubrication effect that it was completely drawn through. The result of the same test regarding the single film of the synthetic resin and the single film of the lubricant showed 18 mm and 23 mm respectively as shown in FIG. **2.**

As for the coefficient of statical friction on the surface, the result of measuring by the sloping angle showed that the single film of lubricant indicated 0.12 while the film of the present invention showed 0.68, causing no troubles about slipping on the surface.

EXAMPLE 2

An aqueous solution composed of 20 parts (1:1) of water-soluble polyacrylic ester: water-soluble polymethacrylic ester, 0.5 parts of emulsifier of alkylarylether type and 98.5 parts of water was heated to 60°C, to which was added with stirring 10% by weight of lump-like hot-melt type lubricant (m.p. 61°C) under heated and melted conditions composed of 10 parts of calcium sterate, 40 parts of stearic acid and 50 parts of spermaceti. A uniformly dispersed lubricant solution was thus obtained. Into this solution, a hot-rolled steel sheet with mill scale, SPHC (a hot-rolled mild steel plate corresponding to ASTM standard A569-66T and J.I.S. (Japanese Industrial Standard) G3131 as Grade No. 1, commercial grade), in the form of a disc of 425 mm diameter and 4 mm thickness was dipped so as to coat the solution thereupon. After drying, 1.5 μ of film was formed on the steel disc. The result of the deep drawing test of this treated steel disc (punch dia. 200 mm; die dia. 209 mm; press velocity 420 mm/min, wrinkle push 5 ton) showed such excellent result that it was completely drawn through. The result of the same test upon the single film of the synthetic resin and the lubricant showed that the depth of deep drawing was broken at 31 mm and 78 mm, respectively.

The result of test by sloping angle of the coefficient of statical friction on the surface showed 0.41, presenting no problem about slipping.

The following lubrication compositions were prepared, to which the test similar to that shown in Example 1 was conducted. The excellent results were also obtained.

Ex. No.	Water-soluble resin (A)	Solid lubricant (B)	Mixing ratio B/A
3	polyacrylic acid (1% aqueous solution)	mixture of calcium stearate and wax	4/100
4	polyvinyl pyrrolidone-methylvinyl ether (15% aqueous solution)	palm oil	10/100
5	polyethyleneimine (10% aqueous solution)	rolling oil of tallow system	10/100
6	alkyd resin (10% aqueous solution)	stearate of trimethylolethane	8/100

EXAMPLE 7

A 3l flask with a cooling pipe and agitater was set in a hot bath, to which was charged 700 g of water and 15 g of emulsifier (10 gm of Emulgen 930, a polyoxyethylenealkyl of Kao Soap Co., Ltd., and 5 gm of Emal 10, sodium lauryl sulfate of Kao Soap Co., Ltd. After uniform dissolution, the temperature --; and was allowed to elevated to 70°C. A mixture monomer of 240 g of butyl acrylate and 60 g of methacrylic acid and 15g of ammonium persulfate were prepared, which were then added by three portions at 1 hour interval, caused to polymerize over 5 hours. A water-dispersible resin having 30.2% of resin concentration and 126 of resin acid value was thus obtained. A film was formed from this resin, which film was tested by a spectrometer with respect to its viscoelasticity. A curbed dotted line between logarithm of modulus of elasticity and temperature was made where the glass transition temperature, i.e. the temperature at intersection of tangents of the glass region and the transition region was –30°C.

90 gm of water and 0.5 g, of the aforesaid Emulgen 930 were charged into a homo-mixer and allowed to dissolve in it uniformly.

After heating to 50°C, the solution was added with 10 g of stearyl methacrylate with stirring for 10 minutes, then allowed to cool to form a lubricant solution. 150 g of the resin solution and 50 g of the lubricant solution were charged to a 3l beaker, to which was added 800 g of water to make a coating material. The material thus obtained was allowed to flow over 1.6 mm pickled steel sheet, which was then passed to a ventilation dryer at 30°C. After allowed to stand overnight, it was tested with respect to the coating amount, slip-preventing ability, deformability and washability. The test was conducted as follows: The amount of coating was determined as the value expressed by mg/m^2 obtained by dividing the increased weight after coating by the area. After this was measured, the slip-preventing ability and the washability were tested. Deformability was tested by another coated sheet.

For testing the slip-preventing ability, an anti-rust oil was applied by wiping on two 10 cm^2 steel plates. The two plates were rested upon a slope of 12° with the coated surface facing each other. When a 3 kg load was put on the plates, slipping occurred between the two plates. Under the same conditions, the above composition was coated instead of said anti-rust oil on the plates and tested. One which does not slip, one which was same as with the anti-rust oil and one which easily slips were marked by **0**, Δ and X, respectively.

The deformability was measured by the Ericksen value under the following conditions. The unit of figures is mm and that more than 30 mm means draw-through.

punch dia. : 40 mm dia. (flat bottom)
die caliber : 45 mm dia.
drawing speed : 50 mm/min.
wrinkle push : 1 ton
Blank dia. : 88 mm dia

As for test of washability, a 2% aqueous solution (60°C: with stirring) of fine cleaner was used, into which the material was dipped for 2 minutes. In order to inspect the separation condition of the film more fully, it was further dipped into a 5% solution of copper sulfate for 2 minutes. One that was entirely plated on the surface from which the film had been separated and one that plated partially were marked by O and X, respectively.

The result of the test showed that when the above composition was used the amount of coating was 0.15 mg/m^2, the slip-preventing ability was 0, the depth by drawing was at least 30 mm. and the washability was 0.

EXAMPLE 8

Using the same apparatus for manufacturing the resin of Example 7, the same polymerization operation was conducted. The materials used are the following resins A to E.

A. 600 g of water, 13 g of polyoxyethylenealkylether, 7 g of sodium lauryl sulfate, 400 g of mixed monomers (20 parts of vinyl acetate, 40 parts of styrene, 30 parts of 2-ethylhexyl acrylate, 10 parts of acrylic acid) and 2.0 g of ammonium persulfate. From this, a resin having 39.1% of the resin concentration, 61 of the resin acid value and 26°C of the glass transition temperature was obtained.

B. 800 g of water, 7 g of polyoxyethylenealkylether, 3 g of sodium lauryl sulfate, 200 g of mixed monomer (70 parts of ethyl acrylate and 30 parts of methacrylic acid) and 1.0 g of ammonium persulfate. From this, a resin having 20.0 % of the resin concentration, 192 of the resin acid value and 5°C of the glass transition temperature was obtained.

C. 700 g of water, 10 g of polyoxyethylenealkylether, 5g of 300 g of mixed sodium lauryl sulfate monomer (85 parts of ethyl acrylate and 15 parts of methacrylic acid) and 1.5 g of ammonium persulfate. From this, a resin having 30.5% of the resin concentration, 99 of the resin acid value and –11°C of the glass transition temperature was obtained.

D. 700 g of water, 10 g of polyoxyethylenealkylether, 5 g of sodium lauryl sulfate, 300 g of mixed monomer (85 parts of ethyl acrylate and 15 parts of crotonic acid), and 1.5 g of ammonium persulfate. From this, a resin having 29.8% of the resin concentration, 95 of the resin acid value and –7°C of the glass transition temperature was obtained.

E. 600 g of water, 13 g of polyoxyethylenealkylether, 7 g of sodium lauryl sulfate 400 g of mixed monomer (60 parts of butyl acrylate, 30 parts of methyl methacrylate and 10 parts of crotonic acid) and 2.0 g of ammonium persulfate. From this, a resin having 40.3% of the resin concentration, 63 of the resin acid value and −12°C of the glass transition temperature was obtained.

Instead of the lubricant stearyl methacrylate used in Example 7, palmitic acid Rubcoat Z-174 of Nihon Kohsakuyu Kabushiki Kaisha, a lubricant of hot-melt type used in Example 1 and stearic acid were used and formulated just as in Example 7, to give the lubricant solutions *a*, *b* and *c*.

The above resin, lubricant solution and water were mixed as below, further diluted with water for better coatability.

Coating composition	Resin solution		Lubricant solution		Water
	Kind	Amount(g)	Kind	Amount(g)	
1	A	2	a	80	82
2	B	2	b	40	42
3	C	9	b	27	500
4	D	9	b	27	300
5	E	10	c	40	300

Using the above composition, the same coated sheets as those of Example 7 were prepared and tested.

Coating composition	Amount coated (mg/m²)	Slip-preventing ability	(mm)	Wash-ability
1	1.294	0	27	0
2	2.449	0	at least 30	0
3	0.567	0	at least 30	0
4	0.812	0	at least 30	0
5	0.840	0	29	0

Comparative Example 1

Using the resin *c* and the lubricant solution *b* used in Example 8, the coating compositions were prepared as follows:

Coating composition	Resin solution		Lubricant solution		Water
	Kind	Amount(g)	Kind	Amount(g)	(g)
1	c	2	b	180	200
2	c	50	b	10	300

Using the above composition, the same coated sheets as those of Example 7 were prepared and tested. The result was as follows:

Coating composition	Amount coated (mg/m²)	Slip-preventing ability	Deformability (mm)	Wash-ability
1	1.241	Δ	27	0
2	0.372	0	17	0

Comparative Example 2

Using the apparatus for making resin of Example 7, the same polymerization was conducted. The materials were the resins F to H as follows:

F. 600 g of water, 13 g of polyoxyethylenealkylether, 7 g of sodium lauryl sulfate 400 g of mixed monomer (97 parts of butyl acrylate, and 3 parts of methacrylic acid) and 2.0 g of ammonium persulfate. From this, a resin having 40.5% of the resin concentration, 19 of the resin acid value and −54°C of the glass transition temperature was obtained.

G. 800 g of water, 7g of polyoxyethylenealkylether, 3 g of sodium lauryl sulfate 200 g of mixed monomers (45 parts of butyl acrylate and 55 parts of acrylic acid) and 1.0 g of ammonium persulfate. From this, a stable water-dispersible resin could not be obtained. The resin produced during polymerization was solidified. For reference, when the above mixed monomers were subjected to solution polymerization using 800 g of ethylene glycol monobutyl ether and 4 g of azobisisobutylonitryl, the resin concentration was 20.8% and the resin acid value was 410.

H. 600 g of water, 13 g of polyoxyethylenealkylether 7 g of sodium lauryl sulfate 400 g of mixed monomers (30 parts of ethyl acrylate, 60 parts of methyl methacrylate and 10 parts of methacrylic acid) and 20 g of ammonium persulfate. From this a resin having 40.1% of the resin concentration, 65 of the resin acid value and 52°C of the glass transition temperature was obtained.

Instead of the lubricant stearyl methacrylate of Example 7, a lubricant of hot-melt type of Example 1 and stearic acid were used and formulated as in Example 1 to give the lubricant solutions *b* and *c*. The resin, the lubricant solution and water were mixed to give a coating composition below.

Coating composition	Resin solution		Lubricant solution		Water
	Kind	Amount(g)	Kind	Amount(g)	(g)
1	F	10	c	40	300
2	G	50	b	100	400
3	H	10	c	40	300

As for G, the resin obtained by solution polymerization was used. The result of the test using the above compositions and the coated material as in Example 7 was as follows:

Coating composition	Amount coated (mg/m²)	Slip-preventing ability	Deformability (mm)	Wash-ability
1	0.523	0	at least 30	X
2	0.545	0	18	0
3	1.522	0	21	0

We claim:

1. A sheet metal coated on at least one surface thereof with a dried lubricant film having a high coefficient of static friction to prevent sliding of said coated sheet metal when stacked, said film comprising a dis-

crete lubricant dispersed in at least one member selected from the group consisting of

a. a water soluble resin which has a higher coefficient of static friction than said lubricant, and

b. a water dispersible resin containing carboxylic groups and having an acid value of about 30 to 400 and a glass transition temperature of 35°C. or less,

said discrete lubricant being selected from at least one member of the group consisting of solidified to semi-solidified waxes, higher fatty acids, esters of higher fatty acids and metallic salts of higher fatty acids, wherein the weight ratio of said resin to said discrete lubricant is between 0.05 and 10.

2. A sheet metal coated on at least one surface thereof with a dried lubricant film having a high coefficient of static friction to prevent sliding of said coated sheet metal when stacked, said film comprising a lubricant dispersed in at lease one member selected from the group consisting of

a. a water-soluble resin which has a higher coefficient to static friction than said lubricant, and

b. a water dispersible resin containing coarboxylic groups and having an acid value of about 30 to 400 and a glass transition temperature of 35°C. or less,

said lubricant being selected from at least one member of the group consisting of solidified to semi-solidified waxes, higher fatty acids, esters of higher fatty acids and metallic salts of higher fatty acids and wherein said lubricant has a particle size between 0.1 mu and 10 mu and wherein the weight ratio of said resin to said lubricant is between 0.05 and 10.

* * * * *