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METAL COATING COMPOSITION AND METHOD OF COATING TITANIUM THEREWITH

George F. Otto, Oreland, Pa., assignor to American Chemical Paint Company, Ambler, Pa., a corporation of Delaware

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This invention relates to the art of metal coating and is particularly concerned with the provision of a method and a material for coating titanium or alloys thereof in which titanium is the principal ingredient. In the following specification and claims, wherever the word "titanium" appears it is to be understood as including its alloys.

As is well known, titanium is a metal which is difficult to work with. It is not readily attacked by most acids and alkalies and has a severe tendency to galling when in frictional contact with other metal surfaces or when subjected to mechanical cold-working operations.

My invention has for its principal object the provision of a method as well as of a material for producing a useful coating on titanium particularly with respect to lessening its galling tendencies.

The present invention is based upon the discovery that a useful coating may be produced upon titanium by subjecting the metal to the action of a substantially homogeneous dispersion or solution, the essential and principal ingredients of which are as follows: from 0.1% to 2.0% of acid from the class consisting of hydrofluoric, hydrofluosilicic and fluoboric acids and from 0.3% to 30% of an organic lubricant which is substantially resistant to the action of said acids. The remainder constitutes the vehicle for the principal ingredients and, where the formulation is substantially consolute, this vehicle should consist primarily of a solvent system which is resistant to the attack of the acids mentioned and also capable of rendering the acid and the lubricant substantially consolute. If the formulation is in the form of a dispersion, the vehicle is water which should contain sufficient emulsifying or thickening agent, substantially resistant to the action of the acids, to emulsify and hold in homogeneous admixture the acids and the lubricant. The percentages given above are weight/volume percentages, i. e. grams per 100 ml.

With respect to the percentages of acid and of organic lubricant mentioned above I wish to point out that, while good results are obtainable within the limits set forth, I have found that optimum results are generally obtained where the acid content ranges between 0.5 and 1.5% and the lubricant content between 8 and 12%.

Among the organic lubricants which are useful in my invention may be mentioned paraffin wax, chlorinated paraffin wax, saturated straight chain fatty acids, (preferably those having a chain length of at least 12 because of their greater lubricity), glycerides of such straight chain fatty acids, etc.

Typical examples of the saturated straight chain fatty acids which are particularly useful with my invention are stearic acid, lauric acid and myristic acid. Typical examples of the paraffines are petroleum paraffines, whether or not chlorinated. Specifically, the high melting point paraffines are preferred especially where the coated metal is afterwards dried with the application of heat.

Where homogeneity is secured through solution the solvent system should be substantially non-aqueous and typical examples of suitable blending solvents which are useful in rendering the composition consolute are methyl isobutyl carbinol, butyl Cellosolve, butyl Carbitol, hexyl

Cellosolve, mineral spirits, such as kerosene, Stoddard solvent, high flash naphtha from both petroleum and coal tar origin, hydrogenated petroleum solvent, etc.; and pine oil. The main requirement of the solvents is that they be substantially resistant to the attack of the fluorine-bearing acids.

In the case of certain alloys of titanium such as RC 130B,[1] the production of a coating is rather difficult and for this reason I prefer to include in the composition from 0.5% to 2% of phosphoric acid. It is to be understood, however, that in the coating of titanium itself as well as of some of its alloys the presence of phosphoric acid is not essential although its inclusion usually produces a better result. The chief advantage of including the phosphoric acid is that the coating can be produced in much less time. Additionally, the coatings produced by such composition have shown exceptionally good lubricant properties when the coated pieces are tested on the Faville Le Vally "Falex" Lubricant Testing Machine.

By way of exemplification only and not necessarily by way of limitation, I wish to list the following as typical examples of homogeneous compositions which have been found to be especially useful in connection with my invention:

Example 1

Stearic acid	gm.	10
Mineral spirit	ml.	56
Butyl Cellosolve	ml.	16
Pine oil	ml.	16
Hydrofluoric acid, 50%	ml.	1

Example 2

Paraffin wax	gm.	2
Mineral spirit	ml.	44
Butyl Cellosolve	ml.	24
Pine oil	ml.	24
Fluoboric acid, 50%	ml.	4

Example 3

Stearic acid	gm.	5
n-Butyl alcohol	ml.	47
Butyl Cellosolve	ml.	45
Hydrofluosilicic acid, 30%	ml.	2

Example 4

Oleic acid	gm.	10
Mineral spirit	ml.	52
Tertiary butyl alcohol	ml.	35
Hydrofluoric acid, 50%	ml.	1

Example 5

Stearic acid	gm.	10	
Mineral spirit	ml.	56	
Butyl Cellosolve	ml.	15	
Pine oil	ml.	15	
Hydrofluoric acid, 50%	ml.	1	(.5%)
Phosphoric acid, 85%	ml.	1	(.85%)

Example 6

Flexrock Paste (50%) [2]	gm.	4
Stearic acid	gm.	1
Xylol	ml.	20
Mineral spirit	ml.	40
Butyl Cellosolve	ml.	16
Pine oil	ml.	16
Hydrofluoric acid, 50% Soln.	ml.	1
Phosphoric acid, 85%	ml.	1

[1] An alloy composed of 4% manganese, 4% aluminum and 92% titanium.

[2] A high temperature stable chlorinated paraffin wax.

Example 7

Flexrock paste (50%)	gm.	4
Stearic acid	gm.	1
Xylol	ml.	20
Mineral spirit	ml.	38
Butyl Cellosolve	ml.	16
Pine oil	ml.	16
Hydrofluoric acid, 50% Soln	ml.	4
Phosphoric acid, 85%	ml.	1

Example 8

Myristic acid	gm.	0.5
Brij 35 (polyoxyethylene lauryl alcohol in which the ethylene oxide chain length is 12)	gm.	0.5
Water	ml.	98
Hydrofluoric acid (50%)	ml.	1.0

Example 9

Aluminum stearate	gm.	0.5
Stearic acid	gm.	0.5
Water	ml.	97
Methocel (high viscosity methyl cellulose)	gm.	1.0
Fluoboric acid (50%)	ml.	1.0

Example 10

Stearic acid	gm.	5.0
Brij 35 (polyoxyethylene lauryl alcohol in which the ethylene oxide chain length is 12)	gm.	2.0
Brij 30 ((polyoxyethylene lauryl alcohol having a chain length of 4)	gm.	1.0
Water	ml.	89
Hydrofluoric acid (50%)	ml.	2

Example 11

Oleic acid	gm.	26.8
Mineral spirits	ml.	39
Butyl Cellosolve	ml.	15
Pine oil	ml.	15
Hydrofluoric acid	ml.	1

In the preceding examples the total volume of each is approximately 100 ml. Examples 1 to 7 inclusive and 11 form substantially non-aqueous solutions and Examples 8 to 10 form dispersions.

In order to carry out the process of the present invention it is preferable that the titanium should be reasonably clean. The cleaning step, per se, forms no part of the present invention and may be performed in any desired manner as by solvent cleaning, alkali cleaning or acid cleaning, after which the cleaned parts are treated with a solution according to the present invention by immersing, spraying or otherwise applying the solution to the surface and permitting it to remain thereon or to be repeatedly applied thereto for a length of time which is sufficient to produce a visible coating. After the visible coating has been obtained, if the treatment has been by means of immersion or spray processes, the object should be removed from contact with the treating solution and dried. If desired, this drying may be done with the application of heat but if so care should be taken so that the heat employed is not high enough to cause the lubricant to melt and run from the surface of the work. In this connection also it will be obvious that, where the coated titanium is to be employed in a hot atmosphere a suitably high melting point lubricant should be incorporated in the treating solution.

The exact chemical nature of the coatings produced by my new process and material is not fully known although it is possible that the coatings are conversion coatings which adsorb or absorb the lubricant in such a fashion that there is co-action between the conversion coating and the lubricant and that this produces the desirable results characteristic of my invention.

The present application is a continuation-in-part of my earlier application Serial No. 408,593, filed February 5, 1954, now abandoned.

I claim:

1. A method of coating titanium which includes the step of treating the surface with an admixture consisting essentially of from 0.1% to 2.0% of acid from the class which consists of hydrofluoric, hydrofluosilicic and fluoboric acids and from 0.3% to 30% of an organic lubricant substantially resistant to the action of said acids with the remainder constituting a vehicle which is substantially resistant to the attack of said acids and capable of rendering the admixture homogeneous, the treatment with said admixture being continued until a visible coating is produced.

2. The method of claim 1 wherein the organic lubricant is chosen from the class which consists of paraffin wax, chlorinated paraffin wax, saturated straight chain fatty acids and glycerides of such fatty acids.

3. The method of claim 1 wherein the organic lubricant is chosen from the class consisting of the saturated straight chain fatty acids having a chain length of at least 12.

4. The method of claim 1 wherein the organic lubricant is chosen from the class which consists of stearic acid, lauric acid and myristic acid.

5. The method of claim 1 wherein the treated surface is dried at a temperature below that at which the lubricant will melt and run from the surface.

6. The method of claim 1 wherein the admixture includes from 0.5% to 2% of phosphoric acid.

7. A method of coating titanium which includes the step of treating the surface with an admixture consisting essentially of from 0.1% to 2.0% of acid from the class which consists of hydrofluoric, hydrofluosilicic and fluoboric acids and from 0.3% to 30% of an organic lubricant chosen from the class consisting of paraffin wax, chlorinated paraffin wax, saturated straight chain fatty acids having a chain length of at least 12 and glycerides of such fatty caids and with the remainder constituting a vehicle wherein homogeneity is secured through use of a solvent system which is chosen from the class which consists of methyl isobutyl Carbinol, butyl Cellosolve, butyl Carbitol, hexyl Cellosolve, kerosene, Stoddard solvent, high flash naphtha, hydrogenated petroleum solvent and pine oil, the treatment with said admixture being continued until a visible coating is produced.

8. A metal coating bath the essential coating producing ingredients of which are from 0.1% to 2% of acid from the class which consists of hydrofluoric, hydrofluosilicic and fluoboric acids and from 0.3% to 30% of an organic lubricant substantially resistant to the action of said acids with the remainder constituting a vehicle which is substantially resistant to the attack of said acids and capable of rendering the admixture homogeneous.

9. A bath according to claim 8 which includes also from 0.5% to 2% of phosphoric acid.

10. A bath according to claim 8 wherein the lubricant is chosen from the class which consists of paraffin wax, chlorinated paraffin wax, saturated straight chain fatty acids and glycerides of such fatty acids.

11. A bath according to claim 10 wherein the fatty acids have a chain length of at least 12.

12. A consolute metal coating bath the essential coating producing ingredients of which are from 0.1% to 2% of acid from the class which consists of hydrofluoric, hydrofluosilicic and fluoboric acids and from 0.3% to 30% of an organic lubricant substantially resistant to the action of said acids with the remainder constituting a solvent system which also is substantially resistant to the attack of said acids and capable of rendering the acid and the lubricant substantially consolute.

13. A bath according to claim 12 wherein the lubricant is chosen from the class which consists of paraffin wax, chlorinated paraffin wax, saturated straight chain fatty acids and glycerides of such fatty acids and wherein the

solvent system is chosen from the class which consists of methyl isobutyl Carbinol, butyl Cellosolve, butyl Carbitol, hexyl Cellosolve, kerosene, Stoddard solvent, high flash naphtha, hydrogenated petroleum solvent and pine oil.

14. A bath according to claim 13 wherein the fatty acids have a chain length of at least 12.

15. A bath according to claim 13 which includes also from 0.5% to 2% of phosphoric acid.

16. A bath according to claim 12 which includes also from 0.5% to 2% of phosphoric acid.

17. A bath according to claim 12 wherein the organic lubricant is chosen from the class consisting of the saturated straight chain fatty acids having a chain length of at least 12.

18. A bath according to claim 8 wherein the content of acid lies between 0.5 and 1.5% and the content of lubricant between 8 and 12%.

19. The method of claim 1 wherein the content of acid lies between 0.5 and 1.5% and the content of lubricant between 8 and 12%.

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