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THIXOTROPIC CHEMICAL CONVERSION MATERIAL FOR CORROSION  
PROTECTION OF ALUMINUM AND ALUMINUM ALLOYS

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1           **THIXOTROPIC CHEMICAL CONVERSION MATERIAL FOR CORROSION**

**PROTECTION OF ALUMINUM AND ALUMINUM ALLOYS**

**ABSTRACT OF THE DISCLOSURE**

5           A conventional Newtonian chemical conversion material is mixed  
with water, a thickener and a surfactant to produce a thixotropic non-  
Newtonian chemical conversion material with improved application properties.

**STATEMENT OF GOVERNMENT INTEREST**

10           The invention described herein may be manufactured and used by  
or for the Government of the United States of America for governmental  
purposes without the payment of any royalties thereon or therefor.

**BACKGROUND OF THE INVENTION**

          This invention relates to chemical conversion materials for  
aluminum and aluminum alloys and in particular the invention relates to a  
thixotropic chemical conversion material.

15           Chemical conversion materials are applied to aluminum and aluminum  
alloys to react therewith to form a corrosion resistant coating thereon and  
to provide a surface for improved bonding of organic finishes such as paints  
and lacquers which may be applied to the coating.

20           A currently used conversion material is formulated from chromates,  
inorganic salts such as phosphates or fluorides, catalysts, activators and  
accelerators. Although this material reacts with aluminum to form an  
adequate corrosion resistant coating it has several drawbacks. When the  
material is prepared in an aqueous solution its consistency is too thin for  
proper spray application, i.e., rapid run off occurs. The material does  
25           not always produce a uniform coating of sufficient thickness for maximum

1 corrosion protection. The material cannot be applied to vertical and curved  
surfaces without rapid run off which produces uneven discontinuous coatings  
of varying thickness resulting in ineffective corrosion protection and paint  
adhesion as well as waste of material.

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#### SUMMARY OF THE INVENTION

Accordingly it is an object of this invention to provide an  
improved chemical conversion material which overcomes the aforesaid drawbacks.  
It is a further object of this invention to provide an improved chemical  
conversion material having superior application performance, which can be  
10 sprayed onto vertical and curved surfaces in the form of a wet, uniform,  
gelatinous, reactive layer and which reacts with aluminum and aluminum  
alloys to form a uniform, continuous, corrosion resistant and paint adhering  
coating.

It is a further object of this invention to provide an improved  
15 chemical conversion material having thixotropic properties to thereby prevent  
rapid run off and to reduce the amount of material needed for a particular  
application.

It is a further object of this invention to provide an improved  
chemical conversion material which deposits approximately twice as much  
20 coating in a given time as compared to currently used conversion materials  
and which remains in a wet activated state for periods in excess of fifteen  
minutes.

It is a further object of this invention to provide an improved  
chemical conversion material which reduces chromate pollution of water,  
25 which gives greater corrosion protection than currently used materials and

1 which can be removed with minimum effort by rinsing with water when spent.

These and other objects are achieved as follows. A standard chemical conversion material such as that disclosed in Example IX of U. S. Patent No. 2,796,370 is mixed with water, a thickener such as CAB-O-SIL and one of two alternative surfactants such as Tergitol or ARP-2 to produce a non-Newtonian thixotropic chemical conversion material having improved application properties.

Other objects, advantages and novel features will become apparent from the following detailed description.

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#### DESCRIPTION OF THE PREFERRED EMBODIMENT

The following examples are illustrative of the composition of the present invention. It is understood that various changes may be made therein in relation to proportions of ingredients and numerous other compositions can readily be evolved in light of the teachings disclosed herein. All parts given are by weight.

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	Example (1)	Example (2)	Example (3)	Example (4)	Example (5)	Example (6)
<u>Ingredients</u>						
Standard Chemical Conversion Coating Material	4.0	3.5	3.0	2.5	1.5	2.5
Thickener	3.0 - 5.0	3.0 - 5.0	3.0 - 5.0	3.0 - 5.0	3.0 - 5.0	3.0 - 5.0
Surfactant #1	0.1 - 0.4	0.1 - 0.4	0.1 - 0.4	0.1 - 0.4	0.1 - 0.4	_____
Surfactant #2	_____	_____	_____	_____	_____	0.1 - 0.4
Water	100	100	100	100	100	100

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1           The formulation of example (1) deposits a coating at a rapid  
rate. It can be most usefully applied over small areas for touch-up  
maintenance operations. The formulations of examples (2), (3), (4) and  
5           (5) respectively produce less dense (thinner) coatings. The formulation  
of example (6) releases film depositing constituents at a slow rate to  
thereby form a uniform lightweight coating. The formulation of example (4)  
has been extensively tested and is the preferred formulation for large  
scale applications.

          The amount of standard chemical conversion material may vary from  
10          1.5 to 4.5 parts by weight; if the amount of standard material is increased  
above 4.5, coating formation becomes too rapid to permit formation of a  
coating with good adhesion and the thickness of the coating becomes difficult  
to control. The amount of thickener may vary from 3.0 to 5.0 parts by weight  
with 4.0 parts by weight deemed preferable. Use of less than 4.0 parts thick-  
15          ener requires that additional surfactant be used to obtain the same thixotropic  
stability obtained with 4.0 parts thickener. Both surfactants may vary from  
0.1 to 0.4 parts by weight; use of more than 0.4 parts results in excessive  
thixotropic properties and spray application of the formulation becomes  
difficult.

20           By standard chemical conversion material is meant a material such  
as those set forth in U. S. Patent No. 2,796,370 the contents of which are  
incorporated by reference as though fully set forth herein. Such a material  
consists essentially of hexavalent chromium, a fluorine bearing compound and  
a soluble cyanide selected from the group consisting of ferricyanide and  
25          ferrocyanide. As an example, a particular standard chemical conversion

1 material comprises in percent by weight, as set forth in Example IX of  
said patent,

	Chromic acid	54
	Potassium ferricyanide	11
5	Barium nitrate	20.5
	Sodium fluosilicate	14.5

The foregoing dry powder mix is normally prepared in an aqueous solution with about 0.1 to 5 ounces of the dry powder mix per gallon of water.

The standard chemical conversion material must meet the require-  
10 ments of Military Specifications MIL-C-5541 and MIL-C-81706.

By thickener is meant a material having the following properties:

(a) ability to form a homogeneous, non-hard settling, gelatinous, thixotropic fluid; (b) ability to make the standard conversion material cling to vertical and curved aluminum, aluminum alloy surfaces without rapid run off or sagging;

15 (c) thickener must be a non-oxidizable, inert, inorganic, finely divided, preferably siliceous material, that has the property to render acid and oxidizing solutions of electrolytes into thixotropic fluids; (d) thickener must be suitable for spray application using a standard spray gun system without clogging spray orifices at approximately 30 psi pressure and must be

20 suitable for spray application using a self-pressurized non-flammable aerosol disposable spray kit such as that set forth in Military Specification MIL-S-22805 (Wep); (e) thickener must be a hydrophillic material (compatible with water; water wetttable); and (f) thickener must retain moisture in excess of 15 minutes without complete drying, while the applied wet coating is

25 reacting with the aluminum or aluminum alloy substrate.

1           A suitable thickener for use in the invention is CAB-O-SIL  
grade M-5 manufactured by the Cabot Corporation of Boston, Massachusetts.  
CAB-O-SIL is a submicroscopic fire-dry fumed silica. On a dry basis  
CAB-O-SIL is approximately 99% silicon dioxide and is practically free  
5   from contaminating metallic oxides. Typical properties of Grade-M5 CAB-O-SIL  
are as follows: specific gravity 2.2, refractive index 1.46, surface area  
200 $\pm$ 25 m<sup>2</sup>/gm (BET), nominal particle size 0.012 micron, density 2.3 lbs./cu.  
ft. max., 4% aqueous dispersion pH 3.5 - 4.2.

          By surfactant is meant a material having the following properties:  
10 (a) low foam formation; (b) noncorrosive to metals; (c) resistant to acids;  
(d) resistant to oxidation by oxidizing agents such as chromic acid solu-  
tions; (e) suitable for use in high electrolyte systems; (f) in liquid form  
for ease of handling; (g) good reactability; (h) usable at elevated tempera-  
tures; (i) biodegradable; (j) preferably must contain a compound with a chain  
15 of eight or more carbons on one end of the surfactant molecule and a hydroxyl,  
amino, or carboxylic group at the other end of the surfactant molecule; and  
(k) non-ionic.

          The surfactant causes the thickener (CAB-O-SIL) chains to migrate  
toward each other, and link together causing an increase in viscosity and  
20 thixotropy.

          Surfactant No. 1 is a liquid non-ionic surface active agent comprising  
a 19-20% by weight water solution of poly-oxy ethylene (23) laurel ether, a  
white waxy solid which is soluble in water, alcohol and propylene glycol and  
which may be obtained from Atlas Chemical Co., Wilmington, Delaware, under  
25 the name, BRIJ-35. Surfactant No. 1 may also be obtained from The Richardson  
Co., Allied Kelite Division, Des Plaines, Illinois, under the name ARP2.

1            Surfactant No. 2 is a non-ionic, surface active, biodegradable polyethylene glycol ether of a linear alcohol containing from ten to twenty five moles of ethylene oxide. Surfactant No. 2 may also be obtained from Union Carbide under the name Tergitol 15-S-12.

5            The standard chemical conversion material is a Newtonian fluid and is an electrolyte. When the standard material is applied to vertical and curved surfaces it runs off and the previously mentioned drawbacks of this material ensue. The material of this invention is a non-Newtonian thixotropic fluid which clings to vertical and curved surfaces thereby  
10 eliminating rapid run off.

            Rendering the standard material thixotropic was not accomplished by merely adding an arbitrarily chosen thickening agent. Any substance having thickening properties cannot be effectively used with the standard conversion material. The thickener must not be degraded by the highly  
15 acidic and oxidizing agents which are present in the standard conversion material.

            Through experimentation it was determined that CAB-O-SIL satisfies the requirements of the postulated thickener. CAB-O-SIL added to a solution of the standard conversion material does change its rheological properties.  
20 However, it was discovered that CAB-O-SIL alone does not produce permanent thixotropic properties in the standard conversion material. Therefore, a second substance, a surfactant, which is compatible with the mixture of the standard conversion material and the CAB-O-SIL is introduced for viscosity stabilization. The end result is the transformation of the standard conversion material from a Newtonian fluid to a non-Newtonian fluid having permanent  
25 thixotropic properties.

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Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that [REDACTED] the invention may be practiced otherwise than as specifically described.

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[REDACTED]

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