

PREPARATION OF BASIS METALS FOR PAINTING

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Metals to be painted must be cleaned as if they were to be plated, except that it may not be necessary to remove the natural oxides. In fact, for very active metals, enhancement of the natural oxide may be advantageous; however, removal of the natural oxide so that it can be replaced with an artificially formed one, such as anodizing, is often desirable.

While each metal requires its own processing, as will be shown below, there are some general treatments which will be required by each one.

"New work", i.e., materials not already primed and painted will require degreasing or the removal of all oils, greases, waxes and fatty compounds. Immersion into a vapor phase "degreaser" containing one of the chlorinated hydrocarbons has traditionally been the way to accomplish this; however, since some of these are not environmentally safe, they have been replaced by materials such as 1,1,1 trichloroethane or methylene chloride/fluorocarbon mixtures. These operate at somewhat lower temperatures than those containing per- or trichloroethylene, so are not as effective at removing some greases and waxes, but with some additional scrubbing should be completely satisfactory.

With "solvent" air pollution becoming more of a problem and pollution rules becoming more strict, the use of emulsion cleaners should be considered for this job. Racking here is no different than for vapor degreasing and the time involved is no longer. There may be a longer dry period after the cleaning since water is involved, but there is an added advantage in that a number of emulsion cleaners will leave the surface in a "water-break-free" condition, whereas the vapor phase degreaser will not. (See the section in this handbook on emulsion cleaners for complete details of this degreasing/cleaning method.)

Just prior to painting, a solvent wipe of the previously cleaned part is necessary. Either a commercial tack-rag (i.e. a cloth saturated with a low volatile, tacky solvent designed to remove lint, fingerprints, etc.) or a clean cloth wetted with a clean solvent can be used. For this final solvent cleaning, the solvent should contain no more than 100 parts per million (ppm) of dissolved contamination and the cloth should be lint free and one which would pass the following criteria:

1. Contain less than 0.7 dry weight percent of trichloroethylene or carbon tetrachloride extractable material.

2. Contain less than 1.0 dry weight percent of acetone soluble material.

3. A water extract should change no more than 1 pH unit.

Cheese cloth and rymple cloth are materials which, when new, will meet these criteria. Before the solvent dries, it should be wiped off with a dry cloth. This way the grease is removed, not simply spread around. Since these solvents will find their way into the atmosphere, they should be locally approved by the EPA.

"Old work", which is defined as having been painted or primed before, will require different handling, in general. If the work is to be stripped of the coating and started over, one should proceed with the stripping and, when completed, remove or arrest the corrosion and start as if it were new work.

Chemical strippers of either the "brush-on" or tank type are available for stripping all organics. The epoxies and polyurethanes, however, will require the very strong phenolic/methylene chloride strippers, which are most usually available in the brush-on formulas. Tank strippers of both strong caustics and acids are available. These need to be chosen with the substrate in mind, i.e., magnesium and steel can be stripped in strong caustic, while cadmium, zinc and aluminum are best stripped in mild acid solutions. After stripping by a chemical method, it is usually necessary to reverse or arrest any corrosion by the usual techniques.

If it is not necessary to remove the old paint, the surfaces can be prepared by mechanically removing any loose material. Wire brushing either by hand or with a motor, or with a light brush-off blast are all methods which work well. The wire brushes should be devoted to a substrate. While stainless steel can work on all substrates, if it has been used on iron or copper it should not be used on aluminum or magnesium unless thoroughly cleaned, including an acid pickle to remove all foreign metal. Iron wire and copper or brass brushes should only be used on like substrates.

Finally, hand sanding using sandpapers, or the mat abrasives, or the "dust blasting" should be used on the surface of good materials to roughen the surface and to remove the surface oxidized layers of materials. This will promote better adhesion between the old and new paint.

After any of the above mechanical treatments, the work should be solvent washed or wiped to remove all of the loose material and then final wiped as above just prior to painting.

ALUMINUM

The normally corrodible surface of aluminum should be passivated prior to painting. The two normal and accepted ways of accomplishing this are to anodize it or to apply a chromate conversion coating.

Anodizing is a generic process covered in the section on "Anodizing Aluminum" found elsewhere in this handbook. The conversion coating processes are proprietary, so one is forced to rely on manufacturers' instructions for process details. MIL-C-5541, Chemical Films and Chemical Film Materials for Aluminum and Aluminum Alloys, contains the inspection properties of such films and MIL-C-81706, Chemical Conversion Materials for Coating Aluminum and Aluminum Alloys, contains not only the properties of these chemicals, but in its "Qualified Products List" it provides all of the commercial products meeting the MIL-C-5541 criteria.

After cleaning and anodizing, the anodized surface can be sealed in hot water, dichromate solution, etc., for maximum corrosion resistance prior to priming. In this case the primer/aluminum adhesion is at a minimum. It can be primed as soon as possible (within eight hours), after anodizing without sealing where the maximum adhesion will result. Partial sealing is sometimes done to average both conditions. If the maximum adhesion is required of an anodized surface, phosphoric anodizing in a process meeting the requirements of SAE-APR-1524 followed by immediate priming should be accomplished.

Conversion coatings can be primed and painted anytime after the coating has fully dried, so they work well on a conveyerized system. They can, however, be stored for long periods prior to painting. After storage, final solvent cleaning (see above) should be all that is needed before painting.

Aluminum can be prepared for painting by just acid cleaning. Following solvent and any alkaline cleaning required to get a water-break-free surface, the parts can be "pickled" in a solution which removes the oxides, followed by painting within four hours after cleaning. This method is recommended for priming prior to adhesive bonding. A popular solution for this is:

Sodium dichromate	10 oz/gal
Sulfuric acid	40 oz/gal
Temperature	150 ± 10°F
Maintain etch rate of 0.0002 to 0.0003 inch/hr/side by additions of sulfuric acid. Discard when dissolved aluminum reaches a point that the etch rate is difficult to maintain.	

CADMIUM

Cadmium surfaces require either a phosphate or a chromate conversion coating prior to painting. The cadmium plating specification QQ-P-416 type III is a phosphate conversion coating designed to be painted and while the type II (chromate conversion coating) is designed

to add corrosion resistance to the cadmium it, also, may be painted. Both of these coatings are usually applied from proprietary baths, but immersion in these solutions will give a sufficient passivated surface for painting.

Chromate Solution:

Sodium dichromate	10 oz/gal
Sulfuric acid	10 oz/gal

Phosphate Solution:

Phosphoric acid	10 oz/gal
Zinc phosphate	3 oz/gal

CHROMIUM

A fine sandblasting with one of the hard abrasives, aluminum oxide or silicon carbide, to remove the gloss or smooth surface followed by priming as soon as possible will develop a satisfactory adhesion.

COPPER

Conversion coatings on copper prior to painting are usually not necessary, however, copper which is primed prior to adhesive bonding is usually treated in a mild acid oxidizing solution prior to primer.

After cleaning, a mild abrasive treatment followed by the primer is sufficient to paint copper. Since corrosion resistance is usually not a reason to paint copper, the primer can be the so-called "wash-primer".

IRON AND STEEL

Iron and steel products which are rusted or covered with heat treat scale need to be cleaned prior to painting. The usual ways of doing this are to pickle the steel to remove the rust or to mechanically remove the rust. Pickling can be accomplished as indicated in the pickling section using hydrochloric or sulfuric acid. If smut is found, it must be removed following the usual procedures (sandblasting is satisfactory). Both of these operations should be followed immediately by priming with a good anticorrosive primer.

Heat treat scale (blue scale) which is firm and uniform does not necessarily need to be removed from steel prior to painting. If it is not removed, however, the parts may suffer more severe pitting or oxygen cell type corrosion where there is a break down in the primer coating in service.

Steel which cannot be primed immediately should be phosphate coated. The light zinc phosphate meeting TT-C-490, type I or DOD-P-16232, type Z are recommended (See "Phosphate Coatings"). The time delay between phosphating and painting can be as required, but it is best to keep the parts as clean as possible since it is difficult to get oil off the crystalline surface of the phosphate.

LEAD

The cleaned lead can be coated with "wash-primer" followed by the topcoat for satisfactory adhesion.

MAGNESIUM

Magnesium must be treated with a conversion coating or anodized before painting. Products to be used in mild environments and not mechanically abused can be given a

treatment in boiling dichromate solution, MIL-M-3171, type III.

Sodium dichromate (dihydrate)	4.5-6 oz/gal
Calcium or magnesium fluoride	0.1 oz/gal
Minimum temperature	93°C

This treatment will not work well on those magnesium alloys containing a rare earth element in the alloying chemistry, however, immersion in the following bath will give equal results.

Sodium dichromate (dihydrate)	5 oz/gal
Sodium sulfate	0.5 oz/gal
Temperature	Room
pH (adjust with CrO ₃)	1.6-1.9
Use with filtered air agitation	

This bath will work with all alloys. The coating is not as heavy as the boiling dichromate, but the cost of application is less.

Parts used in more severe environments and those used where mechanical abuse is likely, can be anodized. The dichromate process and permanganate solutions popular in Europe can be used. Both of these, including bath chemistry and operating conditions are thoroughly covered in MIL-M-45202.

MOLYBDENUM

After cleaning, to provide a water-break-free surface, the paint coatings can be applied. Wash-primer can be used, but is not necessary.

NICKEL

Nickel will respond to the wash-primer pretreatment before applying the topcoat. A light sandblasting to produce a mat surface, which can be primed with the wash-primer or a regular primer, will produce satisfactory topcoat adhesion.

SILVER

The cleaned surface can be painted without further processing. Silver which has been chromate conversion coated will also paint satisfactorily. The conversion coating stabilizes the silver from sulfide tarnishing. Surfaces with sulfide tarnish, so long as it is not powdery, will accept paint.

STAINLESS STEEL

Stainless steel should be cleaned and can then be given one of the passivation treatments followed by wash primer or it can be sandblasted and followed as soon as possible with either a wash primer or a regular primer.

The heat treated materials, which have been put through an alkaline scale conditioner and have then either been acid cleaned (see pickling section) or hydroblasted to remove scale residues, can be painted without further processing.

TITANIUM

Untreated titanium only exists in atmosphere as a passive material and paint bonding to such material is mostly mechanical; therefore, if the surface is sandblasted to provide more surface area and a "tooth" it will have better adhesion. Immersion in a bath containing:

Sodium phosphate (Na ₃ PO ₄)	6-7 oz/gal
Potassium fluoride (KF·2H ₂ O)	2-3 oz/gal
Hydrofluoric acid (HF)	2-3 oz/gal

for 2-3 minutes at room temperature will produce a thorough conversion coating which can be primed and painted. This treatment will give adhesion satisfactory to serve as an adhesive bonding base.

ZINC

A phosphate coating immediately after electroplating will render zinc plated parts paintable. A solution containing 10% phosphoric acid (85%) and zinc phosphate or dissolved zinc 0.5-2.0 oz/gal will provide a coating satisfactory for painting; however, the proprietary processes intended for heavy phosphate coating are also satisfactory. A good chromate conversion coating is also satisfactory, but is generally not recommended.

New galvanize is difficult to paint. It should first be thoroughly solvent and alkaline cleaned followed by treatment with phosphoric acid, then treated completely with an alkaline resisting primer. The wash primer treatment of new galvanize will not be effective unless the material can be cleaned and acid treated thoroughly. Sheet metal which has weathered will be paintable after cleaning if a wash primer is used as the first coat.

"The Surface Treatment and Finishing of Aluminum and its Alloys"

by: S. Wernick, R. Pinner, and P. G. Sheasby . \$222.00

This is the classic work of reference on the subject and should meet the requirements of designers, engineers, anodizers and others concerned with the finishing of aluminum. The work is in two volumes and covers every conceivable aspect of aluminum treatment.

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