

[54] **METHOD OF TREATING ALUMINUM STRIP**

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[58] **Field of Search**..... **156/21, 22, 23; 117/49, 118; 148/6.27; 204/33**

[56] **References Cited**

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[57] **ABSTRACT**

The disclosure teaches a method for producing an improved surface on certain aluminum alloys. The process is characterized by applying certain organic compounds to aluminum strip, heating the coated strip to decompose said compound and generate atomic hydrogen, whereby said hydrogen is adsorbed and absorbed by the aluminum strip, cooling said strip, and physically altering the surface of said strip by applying at least one chemical compound thereto which reacts with said strip.

**9 Claims, No Drawings**

## METHOD OF TREATING ALUMINUM STRIP

### BACKGROUND OF THE INVENTION

The present invention relates to chemically treated aluminum and aluminum alloys and specifically to aluminum or aluminum alloys having a pleasing or decorative surface thereon.

It is well known that aluminum is chosen for many applications because of its decorative appearance and excellent resistance to corrosion. Such applications include, for example, outdoor furniture, automotive trim, and railings. The aluminum, or alloys thereof, employed is generally chemically treated before use in order to provide a matt appearance, anodized to increase corrosion and wear resistance, or bright dipped in order to provide a shiny and highly reflective surface. A frequent problem, however, is that the aforementioned operations frequently result in an uneven or streaked appearance due to surface imperfections in the metal or localized attack due to impurities or traces of oxides in the surface, or attack at lattice imperfections such as vacancies and grain boundaries.

It is therefore a principal object of the present invention to provide a method of producing chemically treated aluminum which is uniform and pleasing to the eye.

It is a further object of the present invention to provide a method wherein anodized, bright dipped, or etched aluminum is uniform in appearance.

It is a still further object of the present invention to provide a method which is expeditious and convenient to use.

Further objects and advantages of the present invention will appear hereinafter.

### SUMMARY OF THE INVENTION

In accordance with the present invention it has now been found that the foregoing objects and advantages of the present invention may be readily obtained. The method of the present provides an improved surface on non-heat treatable aluminum or aluminum alloy strip. The method comprises: providing a material in strip form selected from the group consisting of non-heat treatable aluminum and aluminum alloys; coating said material with an organic compound which decomposes over 400° F and which forms atomic hydrogen upon decomposition, preferably, said compound contains at least 14 carbon atoms; heating said coated material to a metal temperature of at least 800° F for at least 1 minute to decompose said compound and generate atomic hydrogen whereby said hydrogen is adsorbed and absorbed by said material, cooling said material, and physically altering the surface of said material by applying at least one chemical compound thereto which reacts with said material, preferably chemically etching or bright dipping.

In accordance with the foregoing process, a chemically treated aluminum material is provided which is uniform and pleasing to the eye. Furthermore, an uneven or streaked appearance is substantially eliminated.

Further advantages of the present invention will appear from the ensuing discussion.

### DETAILED DESCRIPTION

The aluminum provided should be in strip form and may be high purity aluminum or EC grade aluminum or

generally any non-heat treatable aluminum alloy. The present invention relates to the non-heat treatable alloys, such as the American Aluminum Association alloys of the following series: 1,000; 3,000; 4,000; 5,000; and 6,000. For example, the 1,000 alloy series covers high purity and commercial purity aluminum. The 3,000 alloy series contains manganese as the major alloying addition in an amount up to about 2 percent. The 4,000 alloy series contains silicon as the major alloying addition in an amount up to about 15 percent. The 5,000 alloy series contains magnesium as the major alloying addition in an amount up to about 8 percent. The 6,000 alloy series contains magnesium plus silicon as the major alloying additions in an amount up to about 4 percent of magnesium plus silicon. Naturally, other alloying additions may readily be employed.

As indicated hereinabove, the aluminum should be provided in strip form. The strip may be cold worked, annealed, or partially annealed dependent upon particular requirements. Furthermore, as indicated, the aluminum should be a non-heat treatable material.

The aluminum is coated on a surface thereof with an organic compound or a mixture of organic compounds. Although only one surface of the material need be coated, all of the surfaces may be coated if desired. In those areas of the surface which are to be coated the coating should be uniformly applied. Thickness of the coating is not critical so long as the surface is uniformly covered with the coating. Naturally, the thickness of the coating is dependent upon the method of application, such as by brush or cloth and also upon the viscosity of the particular coating applied.

It is necessary that the particular organic compound or mixture thereof decompose at a temperature above 400° F and not be highly volatile so as to vaporize away from the surface before the aluminum is heated to temperature; however, volatile carrier materials may be employed in addition to the particular organic compound. It is also necessary that the organic compound or mixture liberate hydrogen upon decomposition.

It is preferred that the organic compound employed be a long chained hydrocarbon having at least 14 carbon atoms and having no functional groups, such as an OH group. These compounds are not highly volatile and thus prior heating of the aluminum need not be employed before application. Heating of the aluminum prior to application, however, may be necessary when more highly volatile compounds having fewer than 14 carbon atoms are employed in order to minimize loss by volatilization of the compound during heat-up. Thus, ease of handling and preparation are facilitated by using a compound having at least 14 carbon atoms.

Representative organic compounds which may be employed in the present invention include hexadecane, the stearates, such as butyl stearate and methyl stearate, and fatty acids such as stearic acid, oleic acid, lauric acid, etc. Esters, such as tri-butyl phosphate and tricetyl phosphate and the acrylates such as butyl acrylate and methyl methacrylate, as well as the long chained polymers.

Following application of the aforementioned compounds to the aluminum strip, the coated material is heated in a conventional furnace to a temperature of at least 800° F for at least 1 minute to decompose said compound and generate atomic hydrogen, whereby said hydrogen is adsorbed and absorbed by said material. Thus, the particular atmosphere in which the alu-

minum is heated is not critical and any suitable method may be employed. Resistance or induction heating may also be readily employed, if desired.

Likewise the rate of heating is not critical so long as the aluminum reaches the temperature of 800° F and remains at temperature for at least 1 minute. The maximum time at temperature is not critical, being limited only by practical considerations, and is generally about 1 hour.

The maximum temperature employed is also not critical although as a practical matter the upper temperature limit would be that of the melting point of the particular material employed. It is preferred, however, for the temperature to be from about 850° to 1,050° F since below 850° F the reaction becomes somewhat sluggish and above 1,050° F the aluminum tends to soften and thereby distortion may occur. In addition, temperatures above 1,000° F may result in excessive grain growth.

Following the heating step, the material is cooled to ambient temperature and chemically treated in accordance with the present invention. The chemical treatment must be such as to physically alter the surface of the aluminum strip by applying thereto at least one chemical compound which reacts with said aluminum strip. The chemical treatment may take the form of bright dipping, such as in a mixture of nitric and phosphoric acids. The chemical treatment may also be chemically etching in a suitable alkaline solution, such as caustic soda.

In addition to the foregoing, after said chemical treatment the material is preferably anodized in a suitable anodizing bath, such as chromic acid or sulfuric acid. In fact, it has been found that preferred results are obtained if the material is anodized after the chemical treatment step in order to obtain better corrosion and abrasion resistance and ability to be colored, as well as other advantages.

In accordance with the present invention, it has been found that when the aluminum strip having an organic coating on its surface is heated to a temperature of at least 800° F for at least 1 minute, that hydrogen is produced by the decomposition of the organic compound. The hydrogen produced is atomic hydrogen and is adsorbed at the oxide surface, diffuses through the oxide and is absorbed by the aluminum, thereby entering the lattice of the alloy. A hydrogen atom present in the lattice of the aluminum tends to readily migrate to areas of high energy, such as vacancies and grain boundaries. When the atomic hydrogen enters, for example, a vacancy, the energy of the vacancy is reduced to a level more nearly approximating that of the surrounding lattice. As a result of this, when the aluminum is chemically treated in accordance with the present invention, a more uniform appearance is produced since the activity of lattice imperfections has been substantially reduced and thus selective attack at these high energy points does not occur. Thus, for example, upon subsequent bright dipping or chemical etching a more uniform and pleasing surface is produced.

Such a treated material also produces a better and more corrosion resistant anodized film since likewise selective attack does not tend to occur should the anodizing film be in some way penetrated by an outside corrosion, thereby resulting in localized attack at these high energy points.

The present invention thus provides a method of producing an improved surface on aluminum and its alloys thereby resulting in greatly increased esthetic or decorative appeal.

The present invention is readily applicable to producing patterns in desired configurations on the surface of the material. This is accomplished by coating the material with the aforementioned organic compound only in those areas in which it is desired to increase the uniformity of the chemical treatment. Thus, the present invention is subject to a wide variety of uses and applications in which decorative patterns are highly desirable. Such applications would include, for example, home furnishings of various types, such as towel racks and shower curtain rods.

The present invention will be more readily apparent from the following illustrative examples.

#### EXAMPLE I

The present example illustrates the formation of hydrogen on an aluminum surface and on its entry into the metal.

A continuous length of Aluminum Alloy 5052 tubing was connected to a source of Geiger counting gas and a Geiger counting chamber. Part of the tube was painted with an organic ink in which part of the hydrogen atoms was replaced by tritium, a radioactive isotope of hydrogen. This painted portion was introduced into a furnace at 930° F and the counting gas allowed to continuously sweep through the tube and then through the counter. In about 5 minutes the counting rate was at least double normal background (35 d/m) and within about 20 minutes the rate was at least 20 times background. This indicated the entry of the radioactive atoms into and through the metal and finally into the counter volume.

#### EXAMPLE II

The present example illustrates that hydrogen formed by reaction with aluminum and organic ink produces a physical nonuniformity before chemical treatment.

AA alloy 5252, 5005, 5052, 5086, and 5457 panels (0.030 inch thick) were painted (pattern on one side) with the untritiated ink used in Example I and heated for 30 minutes at 930° F. They were then removed from the furnace and the ink pattern was clearly visible on both sides of the panels. The side opposite the painted area did not have the characteristic light white stain characteristic of aluminum magnesium alloys heated in this way.

#### EXAMPLE III

The present example shows the effect of hydrogen in aluminum upon the uniformity of etching.

The alloys of Example II were treated by the procedure in Example II and then immersed in a caustic etch from 1 minute to a time required to almost completely dissolve the sample. During this entire period the pattern of original ink application was visible from both sides as evidenced by a more uniform and glossy appearance of the metal in the pattern area as contrasted with the uncoated area.

#### EXAMPLE IV

The present example illustrates the effect of hydrogen in aluminum on bright dipping.

The alloys in Example II were painted (pattern on one side) with the untritiated ink of Example I and heated for 30 minutes at 930° F. The samples were bright dipped at 200° F for 3 minutes in a bath containing approximately 5% HNO<sub>3</sub>, 85% H<sub>3</sub>PO<sub>4</sub> and 10 percent water.

Substantially no pitting and grain boundary attack was found to have occurred in the area covered by the ink.

#### EXAMPLE V

The present example shows the effect of hydrogen in aluminum upon the uniformity of etching.

The alloys of Example II were painted (pattern on one side) with tri-butyl phosphate and heated for 30 minutes at 930° F. They were then immersed in a caustic etch from 1 minute to a time required to almost completely dissolve the sample as in Example III. The pattern of the original application was visible from both sides as evidenced by a more uniform and glossy appearance of the metal in the pattern area as contrasted with the uncoated area.

#### EXAMPLE VI

The present example shows the effect of hydrogen in aluminum on bright dipping.

Example V was repeated except that the alloy samples were bright dipped at 200° F for 3 minutes in a bath containing approximately 5% HNO<sub>3</sub>, 85% H<sub>3</sub>PO<sub>4</sub> and 10 percent water, as in Example IV.

Substantially no pitting and grain boundary attack was found to have occurred in the area covered by the coating.

#### EXAMPLE VII

The present example shows the effect of hydrogen in aluminum upon the uniformity of etching.

Example V was repeated employing butyl stearate as the coating and again a more uniform and glossy appearance was produced in the pattern area as contrasted with the uncoated area.

#### EXAMPLE VIII

Examples III and IV were repeated but before etching or brightening, the panels were buffed. Again the ink pattern was clearly visible after the first minute of etching or brightening, even though the original surface had been removed in the buffing operation.

The present example thus shows that the effect of hydrogen in aluminum is not caused by an initial surface oxide.

#### EXAMPLE IX

In the present example mechanical working was employed following coating and heating.

An alloy 5252 panel was treated as in Example II, then cold rolled 50 percent. It was then etched as in Example III. The ink pattern originally placed in a square grid pattern was visible as an elongated grid after etching.

It is thus seen that mechanical working following coating and heating does not effect subsequent chemical treatment.

This invention may be embodied in other forms or carried out in other ways without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered as in all respects illustrative and not restrictive, the scope of the invention being indicated by the appended claims, and all changes which come within the meaning and range of equivalency are intended to be embraced therein.

What is claimed is:

1. A method of producing an improved surface on non-heat treatable aluminum or aluminum alloy strip comprising:

A. providing a material in strip form selected from the group consisting of non-heat treatable aluminum and aluminum alloys;

B. coating said material with an organic compound chosen from the group consisting of long chain hydrocarbon containing at least 14 carbon atoms, higher fatty acids and esters, long chain polymers, acrylate esters, and phosphate esters, which decomposes at a temperature of at least 400° F and which liberates atomic hydrogen upon decomposition;

C. heating said coated material to a metal temperature of between 850° and 1,050° F for at least 1 minute to decompose said compound and generate atomic hydrogen, whereby said hydrogen is adsorbed and absorbed by said material and enters the lattice thereof;

D. cooling said material; and

E. physically altering the surface of said material by applying at least one chemical compound thereto which reacts with said material.

2. A method according to claim 1 wherein said physical altering comprises treating the surface of said material in a manner selected from the group consisting of chemical etching and bright dipping.

3. A method according to claim 2 wherein said physical altering is by chemical etching in a caustic bath.

4. A method according to claim 2 wherein said physical altering is by bright dipping in an acid bath.

5. A method according to claim 2 wherein said organic compound contains at least 14 carbon atoms.

6. A method according to claim 2 wherein said coating is selected from the group consisting of hexadecane, butyl stearate, stearic acid, tri-butyl phosphate and butyl acrylate.

7. A method according to claim 2 wherein said coating is applied to selected areas of said surface to form a pattern.

8. A method according to claim 2 further including the step of anodizing said material following said physically altering.

9. A method according to claim 2 wherein said coating is applied in a uniform layer to the surface of said material.

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