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ALUMINUM ANODIZING PROCESS

Heinrich Neunzig, Grevenbroich (Lower Rhine), and Veit Roehrig, Duisdorf, Germany, assignors to Vereinigte Aluminum-Werke Aktiengesellschaft, Bonn, Germany

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ABSTRACT OF THE DISCLOSURE

An aluminum or aluminum alloy surface is provided with a colored oxide layer by subjecting such surface to anodic oxidation in an aqueous electrolyte containing effective amounts of oxalic acid, sulfate ions and maleic acid.

The present invention relates to an anodizing process for aluminum and aluminum alloys, and, more particularly, the present invention is concerned with producing a colored oxide layer on an aluminum-containing metal body surface, as well as with an electrolyte composition suitable for use in the formation of such colored oxide layer.

It is frequently desired to use as building elements, or as sheathing for the outer walls of the buildings, aluminum or aluminum alloy sheets or profiles which should not reflect a substantial amount of light and which preferably should have a color which may range from light brown to dark brown and also from grey to black. The color of such aluminum or aluminum alloy building elements which are used in modern architecture should be light-fast and capable of withstanding atmospheric influences and, furthermore, should possess a sufficiently high corrosion resistance in order to withstand the chemical and physical attacks to which, for instance, the outer walls of buildings and the like are exposed.

Conventionally, such anodized aluminum or aluminum alloy elements were produced by anodic oxidation in a sulfuric acid electrolyte, followed by immersion in inorganic or organic dye solution.

It is an object of the present invention to provide a particularly simple and effective method for producing on aluminum and aluminum alloy bodies anodic oxide layers of light to dark brown or grey to black color, which oxide layers will possess a high degree of light-fastness and resistance to corrosion and atmospheric influences.

It is a further object of the present invention to provide an electrolyte solution which, upon anodic oxidation of aluminum and aluminum alloy body surfaces in contact therewith, will produce oxide layers of the above-described colors and quality.

Other objects and advantages of the present invention will become apparent from a further reading of the description and of the appended claims.

With the above and other objects in view, the present invention contemplates a method of forming a colored oxide layer on a surface of a body consisting of a material selected from the group consisting of aluminum and aluminum alloys, comprising the step of subjecting the surface to anodic oxidation in an aqueous electrolyte containing oxalic acid, sulfate ions and maleic acid.

The present invention also comprises an aqueous solution of sulfate ions in an amount equivalent to between 0.1 and 1% by weight of sulfuric acid, between 0.5 and 5% by weight of oxalic acid and between 3 and 40% by weight of maleic acid.

Thus, according to the present invention, highly light-fast, colored, very hard oxide layers which possess excellent resistance against corrosion and atmospheric attack

are produced in color tones which may range from light brown to dark, by anodic oxidation of aluminum or aluminum alloys is an aqueous electrolyte solution containing maleic acid, oxalic acid, and sulfate ions, whereby the sulfate ions may be supplied either by the incorporation in the solution of sulfuric acid or of sufficiently soluble metal sulfate such as manganese sulfate, potassium sulfates and the like.

Preferably, the aqueous electrolyte solution will contain between 0.5 and 5% by weight of oxalic acid, and most preferably between 1 and 3% by weight, as well as between 3 and 40% by weight and most preferably between 10 and 30% by weight of maleic acid: in addition thereto, an amount of sulfate ions which is the equivalent or corresponds to between 0.1% and 1% of sulfuric acid and most preferably to about 0.3% sulfuric acid.

Good results are obtained by carrying out the anodic oxidation at a current density of between 1 and 5 amperes per 100 cm.^{2}, and most preferably at a current density of between 1.5 and 3 amperes per 100 cm.^{2}, whereby a bath temperature of between 10 and 30° C. and preferably between 15 and 25° C. should be maintained. The anodization may be carried out with direct current as well as with alternating current and, depending on the alloy composition and current density, a potential of between 30 and 80 volts will be required.

The following examples are given as illustrative only, without limiting the invention to the specific details described therein.

Examples

Aluminum alloys of the composition described below were subjected to anodic oxidation in an electrolyte consisting of an aqueous solution of 20% by weight of maleic acid, 1.5% by weight of oxalic acid, and 0.3% by weight of sulfuric acid.

The temperature of the electrolyte was 20° C. and a current density of 2.5 amperes per 100 cm.^{2} was maintained.

The results obtained with various aluminum and aluminum alloy compositions are summarized in the following table:

Composition (DIN 1725, page 1)	Thickness of oxide layer, millimicrons	Color
Sheets:		
Al 99,5	20	Light brown.
Al 99,5	30	Dark brown.
Al 98,5	20	Medium grey.
Al 98,5	30	Dark grey.
$AlMg_1$	20	Medium brown.
$AlMg_1$	30	Dark brown-reddish.
$AlMg_3$	30	Dark brown-yellowish.
AlMn	20	Black.
Profiles:		
$AlMgSi_{0,5}$	20	Light brown.
$AlMgSi_{0,5}$	25	Middle brown-yellowish.
$AlMgSi_{0,5}$	30	Dark brown-yellowish.
$AlMgSi_1$	20	Dark grey.
$AlZnMg_1$	30	Black.

The thus obtained oxide layers are of considerably greater hardness than those which can be obtained by anodic oxidation in aqueous sulfuric acid. Thus, in accordance with the present invention, it is possible to obtain a great variety of color shades within the brown-grey-black range with thicknesses of anodic oxide layers which are within the range which is particularly suitable when the thus anodized aluminum or aluminum alloy body is to be used for architectural or building purposes.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this in-

vention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A method of forming a colored oxide layer on a surface consisting of a material selected from the group consisting of aluminum and aluminum alloys, comprising the step of subjecting said surface to anodic oxidation in an electrolyte consisting essentially of between 0.5 and 5% by weight of oxalic acid, between 10 and 30% by weight of maleic acid and an amount of sulfate ions corresponding to between 0.1 and 1% by weight of sulfuric acid, the balance being water.

2. A method of forming a colored oxide layer on a surface consisting of a material selected from the group consisting of aluminum and aluminum alloys, comprising the step of subjecting said surface to anodic oxidation in an electrolyte consisting essentially of between 1 and 3% by weight of oxalic acid, between 10 and 30% by weight of maleic acid and an amount of sulfate ions corresponding to about 0.3% by weight of sulfuric acid, the balance being water.

3. A method of forming a colored oxide layer on a surface consisting of a material selected from the group consisting of aluminum and aluminum alloys, comprising the step of subjecting said surface to anodic oxidation at a current density of between about 1 and 5 amperes per square centimeter, at a potential of between 30 and 80 volts, and at a temperature of between 10 and 30° C., in an electrolyte consisting essentially of between 0.5 and 5% by weight of oxalic acid, between 10 and 30% by weight of maleic acid and an amount of sulfate ions corresponding to between 0.1 and 1% by weight of sulfuric acid, the balance being water.

4. An aqueous solution of at least one substance selected from the group consisting of sulfuric acid and water-soluble metal sulfates, said substance being present in an amount equivalent to between 0.1 and 1% by weight of sulfuric acid, between 0.5 and 5% by weight of oxalic acid and between 10 and 30% by weight of maleic acid.

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JOHN H. MACK, *Primary Examiner.*

G. KAPLAN, *Assistant Examiner.*