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TREATING ALUMINUM SURFACES

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This invention relates to the production of oxide-coated aluminum articles having improved surface characteristics, and more particularly to the production of oxide-coated aluminum articles or parts for use in refrigerators and having improved properties.

In the manufacture of various articles of aluminum it is the practice in some cases to form artificially on the surface thereof a protective coating which is composed substantially of aluminum oxide and generally known in the art as an oxide coating. While aluminum having its surface thus coated has been quite successful commercially, as evidenced by its use in the various arts, for certain applications the inherent properties of the oxide coatings are such that the oxide-coated articles are not wholly satisfactory. For instance, oxide coatings on aluminum surfaces have been found to possess a slight odor, sometimes referred to as a "chalky" or "earthy" odor, which is generally not objectionable and is, in fact, usually unnoticed, but which is sometimes considered undesirable, especially in oxide-coated aluminum articles which in use are normally confined within a relatively small air space, such as articles or parts used in refrigerators.

Another peculiarity of oxide-coated aluminum surfaces is noted when they are used in contact with freezing water, such as the ice-cube trays used in mechanical household refrigerators and the aluminum grids or separators used in them. Considerable difficulty and annoyance have been experienced in removing the ice from oxide-coated aluminum ice-cube trays because of the tendency of the ice formed in contact with an oxide coating to stick or adhere to the surface. This difficulty is overcome to some extent by the provision of levers or other mechanical devices attached to the containers which, in use, do not reduce the adherence of the ice to the container surface but merely afford increased mechanical advantage to permit application of more force in removing the ice. Attempts have also been made to overcome this difficulty by reducing the adherence of the ice to the oxide-coated surface by applying molten wax to the surface of the oxide coating. This solution of the problem is not entirely satisfactory, however, because the covering of the oxide coating with wax, and the removal of excess wax, is an operation which adds materially to the cost of production of the article.

It is an object of this invention to provide an article having an oxide-coated aluminum surface

which is substantially free of odor. It is another object of this invention to provide an article having an oxide-coated aluminum surface which has a relatively low adherence to ice formed in contact therewith.

It is a primary object of this invention to provide a simple and economical process for the production of oxide-coated aluminum articles to be used as refrigerator parts, such as ice-cube trays and the like, which may be substantially free of odor and which present a relatively low adherence to ice formed in contact therewith.

Further objects and advantages of this invention will be apparent from the following description.

My invention is based on the discovery that by a simple process of treating an oxide coating, after its formation on an aluminum surface, with an aqueous solution of certain organic compounds, an oxide-coated aluminum article may be produced which is substantially odor-free and which presents a relatively low adherence to ice formed in contact therewith. The compounds which I have found to produce this desirable combination of properties, when present in and on an oxide-coated aluminum surface, are the water-soluble inorganic and organic salts of the reaction products produced by the action of sulfuric acid or its equivalent on the aliphatic alcohols of high molecular weights, such as the fatty alcohols.

In the practice of the method of my invention the aluminum surface is first provided with an adherent and adsorbent oxide coating. The term "oxide coating" is used herein and in the appended claims to describe a coating consisting substantially of aluminum oxide artificially formed on an aluminum surface by chemical treatment, with or without the use of externally-applied electrical energy, but does not include the thin film of aluminum oxide which is naturally formed on an aluminum surface upon exposure to air. For the purpose of my invention the oxide coating may be formed on the aluminum surface by any one of several methods, for example, by treating the aluminum article electrolytically as the anode in a solution of sulfuric acid, chromic acid, or oxalic acid, or by treating it, by simple immersion or otherwise, in a hot solution of an alkali carbonate containing a dichromate.

In forming the oxide coating on aluminum refrigerator parts, I prefer to treat the aluminum surface electrolytically as anode in an aqueous solution of sulfuric acid. The concentration of

the acid may range from about 1 to 70 per cent, but I prefer a concentration between about 15 and 25 per cent. When a solution containing 15 to 18 per cent of sulfuric acid is used at a temperature of about 68 to 74° F., a current density of from about 12 to 13 amperes per square foot is impressed upon the anode, and the action of the electrolyte on the aluminum is allowed to continue for about 10 to 30 minutes.

When using a solution of sodium carbonate and potassium dichromate to produce an oxide coating on an aluminum article, the piece to be coated is preferably immersed in a solution containing about 0.1 to 1.0 per cent of potassium dichromate and 0.5 to 6.0 per cent of sodium carbonate. I prefer to use a solution containing about 2.0 per cent sodium carbonate and 0.5 per cent potassium dichromate at or near the boiling temperature.

According to my invention the oxide-coated aluminum is rendered substantially free from its characteristic odor, and at the same time given the property of relatively low adherence to ice formed in contact with it, by subjecting the oxide coating to the action of a solution of an organic compound produced by the action of sulfuric acid or its equivalent upon aliphatic alcohols of high molecular weight and neutralizing the resulting product with an organic or inorganic alkali. Compounds of this nature which I have found to produce satisfactory results, and which are therefore preferred for my invention, are the sulfuric reaction products of the fatty alcohols having 12 to 18 carbon atoms, such as lauric, oleic, myristic, cetyl, and stearic alcohols, etc., or mixtures thereof, substantially neutralized with an alkaline medium. These compounds may be formed by methods known in the art, generally by reaction of the fatty alcohol with sulfuric acid or such reagents as fuming sulfuric acid, sulfur trioxide and chlorosulfonic acid, followed by neutralization with an alkali, such as ammonium hydroxide, an alkali metal hydroxide or an organic base such as triethanolamine. According to the conditions of the reaction, either a sulfuric acid ester is obtained by reaction of the hydroxyl group of the alcohol with the sulfuric acid, or aliphatic sulfonic acids, or mixtures of both of these types of compounds may be obtained. My invention contemplates the use of the neutralized products of either or both of these types of compounds. I have found that water-soluble salts, such as the alkali metal salts, are particularly suited to the practice of my invention, the sodium salt of sulfated stearic alcohol being preferred. The term "sulfuric reaction product" as used in this specification and in the appended claims is intended to include, therefore, the water-soluble compounds formed by neutralizing the sulfated and sulfonated alcohols with organic or inorganic alkalis, and mixtures of these various compounds. Commercial products of this nature, known under the trade names "Gardinol," "Avitex," "Duponol," etc., produce satisfactory results when used in the practice of my invention.

In carrying out the method of my invention the oxide-coated aluminum article is preferably treated in an aqueous solution of the sulfuric reaction product. The most desirable manner of application is to dissolve the sulfuric reaction product in the water used for sealing the oxide coating, and to perform the sealing and impregnation of the oxide coating in a single operation. The sulfuric reaction product is effective

in amounts as small as about 0.1 gram per liter of solution and may be used in amounts up to the solubility limit of the compound in the solution. For most purposes it has been found desirable to use the sulfuric reaction product in concentrations of about 0.5 to 5 grams per liter. The treating solution may be used at any temperature desired, but it is preferred to use it at or near the boiling point. When lower temperatures are used, a substantially longer time of treatment is required to effect the removal of the characteristic odor of the oxide coating and the production of a coating which presents a relatively low adherence to ice formed in contact therewith.

In the following example there is set forth a comparison of two aluminum ice-cube trays, one of which was treated according to the method of the present invention, the other of which was provided with an aluminum oxide coating and subsequently sealed without the use of the compounds contemplated by my invention. In forming these two trays they were treated as anodes in a sulfuric acid electrolyte containing 15 per cent sulfuric acid at a current density of about 12 amperes per square foot for a period of 20 minutes at a temperature of about 70° F. One of these trays was then immersed in a boiling aqueous solution containing about 2 grams per liter of a sodium salt of sulfated stearic alcohol for a period of about 20 minutes. The other tray was treated for a like period in boiling water. The trays were then washed and dried and it was noted that the characteristic odor of the oxide coating was absent from the tray treated in the sulfated stearic alcohol solution. Both trays were then filled with water and ice was frozen in them. The trays were then tested by a standard test to determine the pull required to remove the ice from the trays. In this test it was found that the oxide-coated surface treated with the sulfated stearic alcohol compound required a pull of about 100 pounds to remove the ice therefrom, whereas removal of the ice from the tray having the oxide coating which had not been treated with the sulfated stearic alcohol compound required about 300 pounds pull.

This invention is not to be considered as limited to the coating of refrigerator parts, such as ice-cube trays, grids and the like, but is adaptable to use in connection with any oxide-coated aluminum article in which the properties of a substantially odor-free oxide coating and relatively low adherence to ice formed in contact therewith are desired singly or in combination.

The term "aluminum" as used herein and in the appended claims is intended to include both aluminum in its various grades of purity and the aluminum base alloys.

The term "odor-free" as used in this specification and in the appended claims means free from the characteristic odor of oxide coatings.

I claim:

1. An aluminum article provided on its surface with an adherent oxide coating, said coating having been impregnated with an aqueous solution of a material selected from the group consisting of the substantially alkali neutralized sulfonated and sulfated fatty alcohols and the substantially organic base neutralized sulfonated and sulfated fatty alcohols.

2. An oxide-coated aluminum ice-cube tray having a relatively low adherence to ice formed in contact with its surface, said surface compris-

ing an adherent oxide coating, said coating having been impregnated with an aqueous solution of a material selected from the group consisting of the substantially alkali neutralized sulfonated and sulfated fatty alcohols and the substantially organic base neutralized sulfonated and sulfated fatty alcohols.

3. A method of treating an oxide-coated aluminum surface comprising subjecting said surface to the action of an aqueous solution of a material selected from the group consisting of the substantially alkali neutralized sulfonated and sulfated fatty alcohols and the substantially organic base neutralized sulfonated and sulfated fatty alcohols.

4. A method of treating an oxide-coated aluminum surface comprising subjecting said sur-

face to the action of a hot solution of a material selected from the group consisting of the substantially alkali neutralized sulfonated and sulfated fatty alcohols and the substantially organic base neutralized sulfonated and sulfated fatty alcohols.

5. A method of treating an aluminum surface comprising forming on said surface an adherent, adsorbent coating consisting substantially of aluminum oxide, and subjecting said oxide-coated surface to the action of a hot aqueous solution of a material selected from the group consisting of the substantially alkali neutralized sulfonated and sulfated fatty alcohols and the substantially organic base neutralized sulfonated and sulfated fatty alcohols.

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