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PROCESS OF PRODUCING PERMANENTLY COLORED ALUMINUM

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ABSTRACT OF THE DISCLOSURE

A process for permanently coloring aluminum comprising cleaning the aluminum by dipping the aluminum in a non-silicate cleaner water bath at a temperature of approximately 165° F. for a period of for example three minutes, rinsing the cleaned aluminum, anodizing the rinsed aluminum in a sulphuric acid-water bath at approximately 80° F., applying a potential between the aluminum as an anode and a cathode positioned in the sulphuric water bath to produce a current density of approximately twenty-four amperes per square foot for approximately fifteen minutes to form an oxide film on the aluminum having a thickness greater than .6 of a mil, rinsing the anodized aluminum and placing it in a ferric ammonium oxalate-water bath at approximately 165° F. for from three to ten minutes, rinsing the dyed aluminum and sealing it by dipping it in a boiling water bath.

The aluminum may be etched prior to anodizing to provide a wood-like texture thereon. Etching, if accomplished, may be by immersion in a sodium hydroxide-water bath at approximately 140° F. for between five and ten minutes. After being anodized, dyed and sealed the aluminum may be baked at a temperature of between 300° F. and 400° F. for between one and two hours to change the gold color to a permanent reddish brown wood-like color.

The invention relates to permanently coloring aluminum and refers more specifically to a process for producing aluminum extrusions having a permanent wood-like appearance in both color and texture.

Approximately fifty percent of the windows and doors manufactured and sold in the United States each year are aluminum. Another forty percent of the windows and doors are wood, while steel and other materials make up the remaining ten percent. Aluminum has many advantages in window and door construction including, for example, the relative ease of maintenance of aluminum structures and the relative ease of operation of aluminum doors and windows due to the low expansion and contraction thereof caused by changes in humidity in contrast to wood doors and windows. Wood, however, presents a particularly warm and friendly appearance which to many people outweighs the disadvantages in maintenance and operation of windows constructed therewith. Thus, aluminum windows and doors are not as widely used, particularly in home construction, as they might be if they presented the same warm friendly appearance natural wood windows and doors do.

Several attempts have been made in the past to color aluminum with a view to making the material more appealing to the general public by providing a range of colors in which aluminum might be obtained. The prior coloring processes have, however, been generally unacceptable since the color provided on the aluminum has usually not been permanent, particularly when exposed to sunlight so that rapid fading of the color has occurred with exterior use of the aluminum. Where permanent color for the aluminum has been accomplished in the past the expense involved in the coloring process has been prohibitive and the color range has been severely limited.

It is therefore one of the objects of the present invention to provide an improved metal coloring process.

Another object is to provide an improved process for permanently coloring aluminum.

Another object is to provide a process for permanently coloring aluminum a wood-like color ranging from a golden cedar tone to a deep reddish brown.

Another object is to provide a process for permanently coloring aluminum including anodizing the aluminum to provide a predetermined minimum thickness of aluminum oxide thereon, dyeing the aluminum with a solution of ferric ammonium oxalate of predetermined minimum concentration at a minimum temperature for a predetermined time to produce aluminum having a deep gold color.

Another object is to provide a process as set forth above and further including baking the dyed aluminum to change the deep gold color thereof to a deep reddish brown wood-like color.

Another object is to provide a process as set forth above and further including etching the aluminum to be colored to provide a wood-like texture thereon.

Another object is to provide a process as set forth above and further including providing a pattern on the aluminum to be colored to improve the wood-like appearance thereof.

Another object is to provide a process for producing aluminum having a permanent wood-like color which is simple, economical and efficient.

Other objects and features of the invention will become apparent as the description proceeds.

One embodiment of the process of the invention will now be considered in detail.

Generally the process of the invention comprises anodizing an aluminum extrustion or the like in a sulphuric acid bath to produce a minimum thickness of aluminum oxide thereon after which the extrusion is placed in a ferric ammonium oxalate bath of predetermined concentration at a predetermined temperature to produce a deep gold color on the extrusions. The extrusions may then be baked to change the deep gold color to a reddish brown wood-like color. Providing a more wood-like aluminum extrusion is desired, the extrusion may be patterned and/or etched with a caustic soda solution prior to the anodizing thereof.

More specificially, in practicing the process of the invention for permanently coloring aluminum an aluminum extrusion or the like is first cleaned with a nonsilicated cleaner to remove oxides, grease, dirt and the like from the aluminum to be colored. The aluminum is cleaned to prevent subsequent spotting during the coloring process. The cleaner may be a bath of five or six ounces of cleaner per gallon of water at a temperature of approximately 165° F. In effecting the cleaning the aluminum may be dipped in the bath for approximately three minutes. After the dipping of the aluminum in the cleaner bath the aluminum is rinsed in a water bath.

If it is desired to provide a soft wood appearance on the finished aluminum the aluminum is then etched in a bath of sodium hydroxide. The sodium hydroxide bath may have a concentration of eight to ten ounces of sodium hydroxide per gallon of water and should be at approximately 140° F. The etching is continued for from five to ten minutes. Etching is not necessary to the coloring process. Again the aluminum should be rinsed in a water bath after the etching step.

The aluminum is then rinsed in a nitric acid bath following the caustic soda bath and second water rinse to remove the residue left on the aluminum by the caustic soda from the aluminum. The nitric acid bath may be a

concentration of five ounces of nitric acid per gallon of water. The pores of the aluminum are thus flushed and the aluminum is ready for anodizing after a subsequent water rinse which may be accomplished by dipping the aluminum in a water bath.

The aluminum is then anodized by placing the aluminum in a sulphuric acid bath of approximately fifteen ounces of sulphuric acid per gallon of water or approximately a fifteen percent concentration of sulphuric acid at approximately 80° F. or between 78° F. and 82° F. and applying an electric potential between the aluminum as an anode and a cathode placed in the sulphuric acid bath to provide a current density of approximately twenty-four amperes per square foot of aluminum for a period of time sufficient to produce a minimum aluminum oxide coating of approximately .8 of a mil in thickness. The anodizing may be carried out at 70° F. with a current density of twelve amperes per square foot, however more uniform results in the finished colored aluminum are obtained when the anodizing is carried out at the higher temperature and current density. Also, while the desired colored aluminum can be obtained with aluminum oxide coatings of approximately .6 of a mil in thickness, uniformity of color is better if the oxide thickness is maintained at, at least .8 of a mil. The anodizing may thus be carried on in the usual manner with the standard anodizing equipment.

It will be noted, however, that the thickness of the oxide coat in the process of the invention is considerably less than that required in other known permanent aluminum coloring processes which may require an oxide thickness on the aluminum to be colored of as much as 1½ mils in thickness. The higher oxide thickness raises the cost of coloring the aluminum to the point where in the past permanent coloring of aluminum has been accomplished only in installations wherein cost was of little or no importance. After the anodizing process the aluminum is again dipped in a water bath to rinse the aluminum.

The aluminum is then colored by immersion in a bath of approximately three percent ferric ammonium oxalate or three ounces of ferric ammonium oxalate per gallon of water at a temperature of between 160° F.–170° F. for a period of from three to ten minutes. It is particularly noted that a two percent ferric ammonium oxalate solution will not provide the deep color desired nor will a temperature of 120° F. provide the desired deep gold color.

After dyeing the aluminum in the ferric ammonium oxalate solution the aluminum is rinsed by dipping in a water rinse. The dyed aluminum is then sealed by dipping in a boiling water bath so that the aluminum will not stain on subsequent baking and so that the color will be permanent.

If a deep reddish brown wood-like color is desired, the deep gold aluminum workpieces may then be baked at elevated temperatures. The gold colored aluminum turns to deep red or reddish brown colored aluminum as a permanent color in approximately one and one-half hours on being baked at 350° F. and will turn to the reddish brown color in approximately ninety seconds on being baked at 900° F. Baking the deep gold aluminum workpieces for forty-five minutes at 350° F. will produce a wood color which is medium or not as deep as continued baking would produce.

In general, the longer the deep gold workpieces are baked at any given elevated temperature, the darker they will become. The higher the temperature at which the workpieces are baked, the less time it takes to obtain any given degree of darkening of the workpieces. The most effective control range of temperature is from 300° F. to 450° F. A baking temperature of less than 300° F. increases the time required for baking to a point where it is impractical. A baking temperature of more than 450° F. shortens the time required for baking to a point where it is difficult to obtain uniform coloring.

Thus it is particularly desirable to bake the workpieces at approximately 350° F. to insure a practical baking time and a reasonable degree of uniformity of color. Further, baking the workpieces at approximately 350° F. allows the workpieces to be packaged prior to baking since the usual packaging material will not burn at this temperature whereby considerable economy in the production of colored workpieces is accomplished and the mechanical properties of the aluminum are not adversely affected as they might be by baking at temperatures higher than 350° F. for any substantial time.

As indicated above if a more wood-like appearance is desired in the finished permanently colored aluminum, the aluminum may be patterned to resemble wood so that the shades and shadows produced by the patterns will aid the etched aluminum surface in presenting a wood-like appearance in all respects including pattern, texture and color. The color of aluminum formed by the above indicated process, all of the parameters of which are not intended to be exactly fixed at the present time is permanent in accordance with accelerated testing procedures and as indicated above varies from a golden cedar tone to a deep reddish brown in accordance with variations in the thickness of the oxide film, the time in the dye bath and the time and temperature of baking.

While one embodiment of the present invention has been considered in detail, it will be understood that other embodiments and modifications thereof are contemplated. It is the intention to include all embodiments and modifications as are defined by the appended claims within the scope of the invention.

What we claim as our invention is:

1. A process for permanently coloring aluminum or the like comprising anodizing the aluminum to produce an oxide coating thereon, dyeing the anodized aluminum in a bath of more than two ounces per gallon ferric ammonium oxalate to water at a temperature above 160° F. and baking the dyed aluminum at a temperature sufficient to produce a change in color from gold to a reddish brown wood-like color.

2. The process as set forth in claim 1 wherein the ferric ammonium oxalate is approximately a three percent concentrate solution.

3. The process as set forth in claim 1 wherein the ferric ammonium oxalate bath is maintained at a temperature of between 160° F. and 170° F.

4. The process as set forth in claim 1 wherein the oxide thickness of the aluminum after anodizing is greater than .6 of a mil in thickness.

5. The process as set forth in claim 1 wherein the oxide thickness of the aluminum after anodizing is approximately .8 of a mil in thickness.

6. The process as set forth in claim 1 wherein the dyeing time is between three and ten minutes.

7. The process as set forth in claim 1 wherein the anodizing is carried out at a temperature of approximately 80° F.

8. The process as set forth in claim 7 wherein the anodizing temperature range is between 78° F. and 80° F.

9. The process as set forth in claim 1 wherein the aluminum is etched before being anodized to provide a wood texture on the aluminum.

10. The process as set forth in claim 9 wherein the etching is produced by dipping the aluminum in an eight ounce per gallon sodium hydroxide-water bath.

11. The process as set forth in claim 10 wherein the aluminum is flushed with a five ounce per gallon nitric acid-water bath after etching and before anodizing.

12. The process as set forth in claim 1 wherein the aluminum is first patterned before it is anodized and dyed to provide a more wood-like appearance.

13. The process as set forth in claim 1 wherein the anodized and dyed aluminum is sealed by dipping in a boiling water bath.

14. A process for permanently coloring aluminum or the like comprising producing an oxide coating on the aluminum, dyeing the oxide coated aluminum in a ferric oxalate bath and baking the dyed aluminum at an elevated temperature for a predetermined time which temperature and time are sufficient together to produce a change in color from gold to a reddish brown wood-like color.

15. A process for permanently coloring aluminum or the like comprising anodizing the aluminum to produce an oxide coating thereon, dyeing the anodized aluminum in a bath of more than two ounces per gallon ferric ammonium oxalate to water at a temperature above 160° F. and baking the dyed aluminum at a temperature of between 300° F. and 400° F. for a predetermined time to produce a change in color from gold to a reddish brown wood-like color.

16. A process for permanently coloring aluminum or the like comprising anodizing the aluminum to produce an oxide coating thereon, dyeing the anodized aluminum in a bath of more than two ounces per gallon ferric ammonium oxalate to water at a temperature above 160° F. and baking the dyed aluminum for approximately one and one-half hours at approximately 350° F. to produce a change in color from gold to a reddish brown wood-like color.

17. A process for permanently coloring aluminum or the like comprising anodizing the aluminum to produce an oxide coating thereon, dyeing the anodized aluminum in a bath of more than two ounces per gallon ferric ammonium oxalate to water at a temperature above 160° F. and baking the dyed aluminum for approximately ninety seconds at 900° F. to produce a change in color from gold to a reddish brown wood-like color.

18. A process for permanently coloring aluminum or the like comprising etching the aluminum before anodizing to provide a wood texture on the aluminum, anodizing the aluminum to produce an oxide coating thereon, dyeing the anodized aluminum in a bath of more than two ounces per gallon ferric ammonium oxalate to water at a temperature above 160° F., sealing the dyed aluminum and subsequently baking the aluminum at a temperature at between 300° F. to 400° F. for between one and two hours to change the gold color to a permanent reddish brown wood-like color.

19. A process for permanently coloring aluminum a gold color comprising cleaning the aluminum with a non-silicate cleaner by dipping the aluminum in a five ounces per gallon cleaner-water bath at approximately 165° F. for approximately three minutes, rinsing the cleaned aluminum in a water bath, anodizing the cleaned and rinsed aluminum in a fifteen ounces per gallon sulphuric acid-water bath at approximately 80° F., applying a potential between the aluminum as an anode and a cathode positioned in the bath to produce a current density of approximately twenty-four amperes per square foot of aluminum for approximately fifteen minutes to form an oxide film on the aluminum of approximately .8 of a mil, rinsing the anodized aluminum in a water bath, placing the rinsed anodized aluminum in a three ounces per gallon ferric ammonium oxalate-water bath at approximately 165° F. for from three to ten minutes, rinsing the dyed aluminum, subsequently sealing the dyed aluminum by dipping in a boiling water bath and subsequently baking the anodized, dyed and sealed aluminum at a temperature of between 300° F. to 400° F. for between one and two hours to change the gold color to a permanent reddish brown wood-like color.

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