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METHOD FOR MANUFACTURING HIGHLY POLISHABLE SHEETS OF ALUMINUM

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For many purposes, for example for the manufacture of hub caps, bumpers or ornamental strips for motorcars, sheets of aluminum are required which have a high mechanical strength and hardness and get a high luster through a chemical or electrolytical polishing treatment followed by anodic oxidation. Only such aluminum sheets could compete with chromium-plated steel in the manufacture of hub caps and bumpers.

The usual aluminum alloys which are hardenable by a heat treatment (solution annealing, quenching and aging either at room temperature or at elevated temperature), for example the aluminum-copper-magnesium-alloys (2024 or 2117 according to the classification of the Aluminum Association (AA)), the aluminum-zinc-magnesium-alloys (7075, 7076 AA) and the aluminum-magnesium-silicon-alloys (6061, 6151 AA), have a high mechanical strength, but their luster after chemical or electrolytic polishing and anodizing does not meet the requirements.

Many manufacturers require highly polishable sheets which have not only high mechanical strength and high hardness but are moreover so easily workable in the hardened state obtained by heat treatment that it is possible to obtain therefrom for instance hub caps and bumpers by pressing without a new annealing. The alloys mentioned hereabove are not sufficiently workable in the hardened state for this purpose. In the case of the aluminum alloys which are hardenable only by cold working, for example the binary aluminum-magnesium alloys (5052 AA), the increasing of the mechanical strength is obtained by an increased content of the alloying constituent and that at the expense of the workability and of the luster.

There is known an aluminum-magnesium-silicon-alloy on the base of high purity aluminum (for instance 99.99 percent) which reaches a high mechanical strength and shows a high luster after chemical or electrolytical polishing and anodizing. But this alloy has the disadvantage of becoming coarse-grained during the solution heat treatment, which is undesirable for a subsequent forming operation. It is therefore unsuitable for the manufacture of hub caps and bumpers for motorcars.

Our present invention relates to a method for manufacturing aluminum-alloy sheets which show a high luster after chemical or electrolytical polishing and anodizing and have at the same time a high mechanical strength after hardening by heat treatment and are nevertheless easily workable and fine-grained after the said heat treatment without new annealing. According to our invention a rolling slab made from an alloy of aluminum of commercial grade (2S—having a purity of 99.0 percent to 99.49 percent) with 0.3 to 0.7 percent magnesium and 0.3 to 0.7 percent silicon is hot rolled together with a plate made from an alloy of aluminum of a purity of over 99.85 percent with 0.3 to 0.7 percent magnesium and 0.3 to 0.7 percent silicon, the metal of the slab and the metal of the plate becoming welded together during the hot rolling, whereafter the compound body is cold rolled to the final thickness, for example to a thickness of 1 mm., and finally hardened by heat treatment (solution annealing at a temperature of from approximately 900° F. to approximately 1000° F., quenching, and aging either at room temperature or at elevated temperature).

Both the basic alloy (the alloy of the rolling slab) and the plating alloy used for carrying out our invention are aluminum-magnesium-silicon alloys with a lower content of magnesium and of silicon as in usual aluminum-magnesium-silicon alloys, which contain up to 1.4 percent magnesium, up to 1.2 percent silicon and up to 1.0 percent manganese.

An aluminum-magnesium-silicon alloy having a low content of alloying constituents and made from aluminum of a purity of over 99.85 percent becomes coarse-grained by annealing just as an aluminum-magnesium-silicon alloy made from high-purity aluminum and having the usual content of alloying constituents. However we found surprisingly that both the plating alloy with low content of alloying constituents and the basic alloy with low content of alloying constituents become uniformly fine-grained by recrystallization during the solution annealing after the hot and cold-rolling operations; it seems that a nucleus effect is originated by the welded zone formed between the plating and the basic metal.

The thickness of the plating after rolling to final thickness may amount up to about 20 percent of the whole thickness of the sheet.

It is of course possible to make both faces of the aluminum sheet highly polishable; for this purpose both faces of the rolling slab are covered with a plate made from an alloy of aluminum of a purity of over 99.85 percent with a low content of magnesium and silicon.

Example

A 110 mm. thick rolling slab made from an alloy of aluminum of commercial grade with 0.4 percent magnesium and 0.6 percent silicon is covered with a 25 mm. thick plate made from an alloy of aluminum of a purity of 99.99 percent with 0.4 percent magnesium and 0.6 percent silicon. The slab covered with the plate is then heated during 8 hours at 420° C. and thereafter hot rolled down to a thickness of about 7 mm. During this last operation the basic alloy and the plate alloy become firmly united, so that it is possible to cold roll the compound body down to final thickness, for example to 1 mm. When the sheet has reached its final thickness, it is submitted to a solution annealing at 520° C. (968° F.) and quenched.

After aging during 3 days at room temperature the sheet has the following mechanical values:

Yield strength σ 0.2 (kg./mm.^{2})	Tensile strength σ B (kg./mm.^{2})	Elongation δ 10 (%)	Brinell hardness (kg./mm.^{2})
8-9	19-21	30-25	50-55

In this state the sheet is very easily workable and allows a deep drawing rate of more than 1.2. Its workability corresponds to that of pure aluminum 2S; of course, the necessary amount of deformation work is greater.

By annealing at 140° C. the sheet aged during 3 days at room temperature the following values can be attained:

Yield strength σ 0.2 (kg./mm.^{2})	Tensile strength σ B (kg./mm.^{2})	Elongation δ 10 (%)	Brinell hardness (kg./mm.^{2})
18-20	24-27	22-18	75-80

By annealing at 160° without previous aging at room temperature after quenching the following values are reached:

Yield strength σ 0.2 (kg./mm.^{2})	Tensile strength σ B (kg./mm.^{2})	Elongation δ 10 (%)	Brinell hardness (kg./mm.^{2})
28–32	32–36	20–15	90–100

In this latter state a deep drawing rate of 1:1.9 is possible; that is to say, the workability is very high in view of the obtained tensile strength. For instance, it is possible to manufacture motorcar hubs by spinning or deep-drawing such a material having a hardness of 90 to 100 kg./mm.^{2}, which caps can successfully compete with hub caps made from chromium-plated steel sheet.

According to the considered rate of forming the sheets made according to our invention are aged either at room temperature or at elevated temperature, possibly after an intermediate aging at room temperature.

The bodies formed from the hardened, substantially homogeneous material according to our invention can be chemically or electrolytically polished after the forming operation and thereafter subjected to anodic oxidation. The obtainable lustre depends on the purity of the metal used for the plating material (iron content for example) as well as on the employment of a temperature which will cause solution annealing.

What we claim is:

1. A process for manufacturing highly polishable aluminum alloy sheets having high mechanical strength and good workability, comprising covering at least one face of a rolling slab made from a first alloy consisting essentially of aluminum with 0.3 to 0.7 percent magnesium and 0.3 to 0.7 percent silicon, said first alloy being produced from a commercial grade aluminum with a purity of 99.0 percent to 99.49 percent, with a substantially thinner plate made from a second alloy consisting essentially of aluminum with 0.3 to 0.7 percent magnesium and 0.3 to 0.7 percent silicon, said second alloy being produced from aluminum of a purity of over 99.85 percent, hot rolling said slab together with said plate, the latter becoming pressure-welded to the slab during the hot rolling, then cold rolling the resultant compound plated sheet to final thickness, and then hardening said compound plated sheet by a treatment including solution annealing, then quenching, and then aging, whereby the second alloy has a fine-grained character.

2. A highly polishable sheet composed only of aluminum alloys and having a yield strength of 28 to 32 kg./mm.^{2}, a tensile strength of 32 to 36 kg./mm.^{2}, an elongation of 20 to 15 percent and a Brinell hardness of 90 to 100 kg./mm.^{2}, which sheet comprises a base of an alloy consisting essentially of aluminum with 0.3 to 0.7 percent magnesium and 0.3 to 0.7 percent silicon, said aluminum being a commercial grade aluminum with a purity of 99.0 percent to 99.49 percent, plated on at least one face with a substantially thinner layer of an alloy consisting essentially of aluminum with 0.3 to 0.7 percent magnesium and 0.3 to 0.7 percent silicon, the last mentioned aluminum being of a purity of over 99.85 percent and the last mentioned alloy being fine grained.

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