1

3,444,022

METHOD OF ALUMINUM-PLASTIC LAMINATE FORMING

Heinz F. Bichsel, Neuhausen am Rheinfall, Switzerland, assignor to Swiss Aluminium Ltd., Chippis, Switzerland, a corporation of Switzerland

No Drawing. Filed Sept. 27, 1965, Ser. No. 490,646
Claims priority, application Switzerland, Sept. 29, 1964, 12,665/64
Int. Cl. C09j 5/00
U.S. Cl. 156—281 8 Claims

ABSTRACT OF THE DISCLOSURE

Preparation for forming of a plastic coated aluminum alloy sheet, which latter includes 2–8% zinc and .3–5% magnesium and that can be hardened by solution annealing, quenching or aging, has the steps of coating the metal sheet with a thermoplastic layer, and immediately before the forming heating at least the metal sheet for a short time to a temperature of at least 180° C.

The invention relates to the preparation of an aluminum-plastic laminate for a subsequent forming, for instance into food receptacles, and to the subsequent forming of such receptacles.

It is known to produce food receptacles, such as tins and rigid foil containers, by deep-drawing, or stretch-forming, or similar forming of an aluminum-plastic laminate, the plastic component being thermoplastic synthetic material, such as, for instance polyethylene. The metal used in these prior art devices is commercial grade aluminum of a purity of about 98.75 percent, or of aluminum alloys which are non-hardenable. This metal has the disadvantage that it is soft.

Although aluminum alloys are known which are hardenable by heat treatment and hence have greater strength, they have, however, not been used for the instant purpose. The reason for this may be found therein that these alloys, after hardening, are difficult to deform, and heat treatment will not achieve maximum strength, if performed solely after the forming of the material into receptacles, such as containers or tins.

It is accordingly among the principal objects of the invention to provide for an aluminum-plastic laminate, of which the aluminum layer is composed of an aluminum alloy, and in which a short heat treatment precedes the forming.

It is another object of the invention to provide for the heat treatment to be at a temperature of not less than 180° C.

It is a further object of the invention to provide that the aluminum alloy is hardenable, and is subjected to hardening prior to the heat treatment.

It is still another object of the invention to provide for the aforesaid first heat treatment prior to the forming, and for a subsequent heat treatment after the forming.

It is still a further object of the invention to provide that the heat treatment may either precede or succeed the laminating step.

Further objects and advantages of the invention will be set forth in part in the following specification and in part will be obvious therefrom without being specifically referred to, the same being realized and attained as pointed out in the claims hereof.

2

In accordance with the invention, an aluminum alloy sheet metal that has of from 2 to 8 percent by weight of zinc (with a preferred range of from 2 to 3 percent of zinc) and of from .3 to 5 percent by weight of magnesium (with a preferred range of .3 to 1 percent of magnesium) is hardened by means of solution, annealing, quenching and aging. To the aluminum sheet there is laminated a layer of thremoplastic synthetic sheet. The heat treatment takes place at a temprerature of at least 180° C. and lasts from a few seconds to about five minutes, and takes place before the forming into receptacles.

In connection with the forming into receptacles, reference is had to the co-pending application of Joseph Ecken, Ser. No. 464,523, filed June 16, 1965, now abandoned, and to the applications listed therein.

In accordance with the instant method, it is as stated, possible to use a hardenable aluminum alloy, which has a much greater strength than the aluminum sheet heretofore used for the instant purpose. The use of hardened aluminum increases the stability of the tin cans and containers or alternatively, permits the use of thinner walls. (The term "tin can" as used herein refers only to the colloquial terminology, and does not imply that "tin" is being used in connection with the instant receptacles.)

The aforesaid aluminum alloy of 2 to 8 percent by weight of zinc and .3 to 5 percent by weight of magnesium reaches a maximum strength after a hardening treatment, as follows: Solution annealing at a temperature between 350° C. and 500° C. of from one-half hour to one hour, quenching in water or air, and either natural aging at room temperature, or artificial aging at an elevated temperature up to 150° C.

Solution annealing and quenching, in accordance with the invention, may take place at the end of the sheet metal production (the term sheet metal herein including also thin bands, sheets and foil). During the ensuing stcring prior to the subsequent forming, the sheet metal begins to harden with attendant deterioration in deformability. It is however, possible to regain the deformability of the material by applying a short term heat treatment; this heat treatment, however, should preferably be applied immediately before the subsequent forming, as otherwise during continued storing the material would again become hardened. This short term heat treatment is termed hereafter from time to time as recovery.

Between the solution annealing and quenching on one hand and the forming on the other, the aluminum alloy sheet is laminated with a layer of the aforesaid thermoplastic sheet connected to the aluminum alloy sheet; this lamination may be done in a conventional manner. The aluminum alloy sheet may, for instance, be coated with a solution or dispersion of the synthetic material, and thereafter the solvent or dispersion medium be vaporated; alternatively, the plastic material may be applied in sheet form, either by pressure under heat, or emerging out of the melt.

The aluminum-plastic laminate assembly may then be stored prior to the heat treatment that precedes the forming.

In accordance with a modification, however, the laminating without solvent or dispersion medium may, however, be combined with the aforesaid recovery as follows: The aluminum alloy sheet may be heated to the temperature needed for the recovery and, while it is still warm, may receive the synthetic plastic sheet layer. The forming of the aluminum-plastic laminate assembly of this modified method should, however, follow immediately after the aforesaid laminating step, that means within only a few hours, as otherwise the aluminum alloy will become hard, rendering forming difficult if not impossible; otherwise, another recovery heating must take place immediately prior to the forming.

During the recovery step sufficient heat must be supplied, so that the plastic layer will at least partially fuse on to the aluminum sheet. Experience has shown that better adhesion between the two laminates, namely the aluminum and the plastic, may thus be achieved.

The aforesaid aluminum alloy may, however, receive additional ingredients, as for instance from .1 to .6 percent by weight of manganese, .05 to .2 percent by weight of chromium, and the usual impurities of silicium, iron and copper. As previously mentioned, a preferred amount of zinc and magnesium in the alloy is 2 to 3 percent by weight of zinc and .3 to 1 percent by weight of magnesium; these are preferably used in connection with the aforesaid additions and impurities. Such an alloy is better formable than a higher alloyed aluminum.

For the thermoplastic sheet there is preferred polyolefines, such as polyethylene and polyisobutylene. The recovery temperature should be at least 180° C., so as to achieve a stretch gain that is sufficient for the deforming. The upper temperature limit is set on one hand by the disintegrating temperature of the plastic used, and on the other hand should not surpass 280° C., so that subsequently an after-hardening will take place during storing; lastly, it also depends on the duration of the recovery treatment: The shorter the recovery treatment, the higher the temperature that may be used without, however, reaching into the zone where hardening constituents go into solution. The recovery temperature of an aluminum-plastic assembly in which the plastic is polyethylene preferably is 230° C. The duration of the recovery is short, from a few seconds to about five minutes, preferably from one-half to one minute. If the duration is too long, there will either occur warm hardening which influences the deformability adversely, or the ageability during the subsequent storing will be adversely affected.

EXAMPLE

A sheet of an aluminum alloy .13 mm. thick, had the following alloy ingredients:

2.8% zinc, .9% magnesium, .08% silicium and .2% iron. This metal sheet was solution annealed for two minutes at a temperature of 450° C., and thereafter quickly quenched in air. The laminating was done by applying to said sheet metal a polyethylene sheet of 70 μm. thickness; it was applied under pressure and heat. During the subsequent cold storing, the hardening commenced at once, so that already after a few days the deformability had deteriorated to such an extent that no tear-free receptacles could be formed. After annealing the yield strength was 4.4 kg. per sq. mm., but after the completed cold hardening four weeks later, the yield strength was 10.9 kg. per sq. mm.

The laminated and hardened aluminum-plastic laminate assembly was subjected to a recovery treatment that lasted 30 seconds, at a temperature of 230° C.; this resulted in a reduction of the yield strength to 5.5 kg. per sq. mm. In this state injury free receptacles could be built during a few hours after the recovery treatment. During the recovery, the polyethylene layer melted without, however, being detached from the aluminum sheet; on the contrary, the adhesion of the two layers was better after the subsequent cooling-off than before.

After fourteen days of cold storing of the receptacles, the yield strength mounted to 13.2 kg. per sq. mm.: To the hardening by cold storage there had been added the hardening by the forming. In contrast thereto, commercial grade aluminum after the same forming has a yield strength of only about 6.4 kg. per sq. mm.

During the forming of the aluminum-plastic laminate assembly, the plastic layer is subjected to tensions which may yield to find tears in the plastic; such tears might during sterilization of the container lead to at least a partial detachment of the plastic layer from the metal. It has been found, however, that these defects may be avoided if after the forming of the container, the container is subjected to a heat treatment during which the plastic layer will fuse onto the metal layer. For polyethylene, such a heating step may be carried out for one minute at 140° C.

The instant invention is particularly suitable for the production of receptacles made from metal-plastic laminates of the instant type, for the reception of food stuffs. The forming of the receptacles may be done in a simple manner in a continuous operation, by unwinding the aforesaid metal-plastic laminate assembly off a roll, being placed in front of the recess of a die, and pressed thereinto by compresed air; reference is again had to the aforesaid application Ser. No. 464,523.

The receptacles are preferably produced in the food process plant immediately before the filling and closing. For this purpose, the laminates in accordance with the instant invention are delivered to the food processor, and are subjected to the recovery treatment immediately before the forming of the containers. Owing to the hardening during the normal storing thereafter, there are achieved stable packages which may be subjected to a sterilization operation.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent, is as follows:

1. In a method of preparing, for a subsequent forming operation, a formable laminated double layer assembly including an aluminum alloy sheet layer and a thermoplastic synthetic layer joined thereto, the steps comprising adding to an age hardened metal sheet which is composed of an aluminum alloy having of from about 2 to about 8 percent by weight of zinc and of from about .3 to about 5 percent by weight of magnesium hardened by solution annealing, quenching or aging, a layer of said plastic material and, immediately prior to the forming, subjecting at least the aluminum alloy sheet layer to a heat treatment lasting from about a few seconds to about five mintues at a temperature of at least 180° C., whereby there will take place a reduction in the yield strength of the metal as compared to its initial age hardened yield strength, and subsequently forming the laminate.

2. In a method, as claimed in claim **1**, the steps comprising first adding the layer of thermoplastic material to the aluminum alloy sheet and subsequently subjecting the laminated assembly to the heat treatment until the synthetic material commences to disintegrate.

3. In a method, as claimed in claim **1**, the steps comprising first adding the layer of thermoplastic material to the aluminum alloy sheet and subsequently heat treating the assembly until the plastic layer at least partially fuses to the aluminum alloy sheet.

4. In a method, as claimed in claim **1**, the steps comprising heat treating the aluminum alloy sheet and laminating onto the still warm aluminum alloy sheet the thermoplastic sheet as the thermoplastic sheet emerges from the melt.

5. In a method, as claimed in claim **1**, the steps comprising heat treating the aluminum alloy sheet, and pressing the thermoplastic layer as a sheet onto the still warm aluminum alloy sheet.

6. In a method, as claimed in claim 1, said aluminum alloy having of from about 2 to about 3 percent by weight of zinc and of from about .3 to about 1 percent by weight of magnesium.

7. In a method, as claimed in claim 1, subsequently forming said assembly, and thereafter subjecting the formed assembly to a short heat treatment while the plastic layer fuses to the aluminum alloy layer.

8. In a method, as claimed in claim 1, said thermoplastic sheet material being polyethylene.

References Cited

UNITED STATES PATENTS

1,578,979	3/1926	Fuller et al.	148—159 X
2,630,396	3/1953	Langer	156—272
2,728,703	12/1955	Kiernan et al.	
2,851,372	9/1958	Kaplan et al.	117—8
2,861,022	11/1958	Lundsager	161—214
3,047,934	8/1962	Magner	156—322
3,090,715	5/1963	Clarke et al.	161—217
3,206,848	9/1965	Rentmeester.	
3,323,965	6/1967	Hanle et al.	156—272 X

EARL M. BERGERT, *Primary Examiner.*

R. A. KILLWORTH, *Assistant Examiner.*

U.S. Cl. X.R.

72—46; 148—159; 156—322; 161—216