252-39 CROSS REFERENCE EXAMINER

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PROCESS FOR ETCHING ALUMINUM

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3 Claims. (Cl. 41—42)

This invention relates to the etching of aluminum and aluminum-rich alloys. More particularly it relates to a new and improved etching bath suitable for use in the chemical milling of aluminum to produce thereon machined surfaces of any desired configuration.

The chemical milling or machining of aluminum and aluminum-rich alloys has been practiced heretofore. Such processes are particularly valuable for chemically dissolving or etching from the surface of aluminum stock such areas as are required to be removed but would entail great difficulty in removing by mechanical machining methods. Chemical milling may be done simultaneously on different sides or surfaces without limitation as to shapes, sizes, or thicknesses of the aluminum stock.

By the term "aluminum-rich alloys" as used throughout the specification and claims is meant alloys having a great predominance of aluminum, e.g., 85% or more of aluminum, and which therefore will be chemically etched to substantially the same effect as aluminum.

Such chemical milling or etching has heretofore been accomplished by contacting the desired aluminum areas to be etched to a suitable caustic etching bath. The caustic bath functions to dissolve the exposed aluminum areas and the degree of dissolution or depth of etching may be controlled by regulating the strength and temperature of the caustic bath and the time of exposure thereto. Alkali metal, sodium or potassium, hydroxides are conventionally used as the caustic in the caustic bath. The chemical milling is usually carried out by immersing the stock to be etched in an aqueous caustic solution heated to the desired temperature. Areas on the aluminum stock which are not to be etched by the caustic bath are usually masked with materials which are not attacked by the caustic. This may be done by masking with masking tape, by painting or printing with an inert plastic film, for example, polyvinyl acetate or polyvinyl chloride, or other vinyl-type films. Alternatively, the surface may be protected against etching by gelatin, electroplate with a relatively inert metal, or in any other desired manner.

The aluminum stock may be immersed and allowed to remain motionless in the caustic bath for the required period or it may be continuously moved back and forth into and out of the bath to produce a tapered etching or milling in the aluminum stock, for example, as disclosed in U.S. Patent No. 2,739,047, issued to M. C. Sanz.

Etching or chemical milling solutions used heretofore have been subject to objectionable pitting of the aluminum stock. Especially where the etching was carried out at high rates, such prior caustic solutions did not etch with completely satisfactory uniformity. Moreover, where it was desirable to provide the etched surface with a bright finish, it could not be accomplished satisfactorily by chemical polishing by reason of the non-uniformly etched surfaces.

It is an object of this invention to provide a new and improved caustic etching solution for the uniform etching of aluminum and aluminum-rich alloys.

It is another object of this invention to provide a caustic etching solution for the chemical milling of aluminum and aluminum-rich alloys that will etch uniformly without objectionable pitting.

It is still another object of this invention to provide a new and improved method for the chemical milling of aluminum and aluminum-rich alloys.

Other objects of this invention will appear hereinafter.

The objects of this invention may be accomplished by providing an aqueous caustic etching solution containing an alkali metal monoperphosphate salt and etching the desired areas of aluminum or aluminum-rich alloy stock with said solution.

The aqueous caustic solution may be sodium or potassium hydroxide. Since both function about equally well, sodium hydroxide is generally preferred on the basis of cost.

The sodium or potassium hydroxide solution may have a strength of between 3% and 15% by weight in water. The temperature of the solution is preferably maintained at a temperature of 25° C. to 90° C., preferably 30° C. to 80° C. The alkali metal monoperphosphate salt may be sodium or potassium monoperphosphate and, in view of the presence of the sodium and potassium hydroxide in concentration between 3% and 15%, the alkali metal monoperphosphate will be trisodium- or tripotassium-monoperphosphate. The monoperphosphate may be added as mono-perphosphoric acid or mono- or di-sodium or -potassium monoperphosphate, and the trisodium or -potassium salt formed at the expense of the caustic solution.

The aqueous caustic etching solution of this invention is preferably prepared by adding completely neutralized solution of monoperphosphoric acid to a hot sodium or potassium hydroxide bath. The monoperphosphate concentration may be between 0.2% and 8% to 10% by weight of the solution. The upper limit of monoperphosphate is dependent upon the solubility of the phosphate in the solution. Less than about 0.2% of the monoperphosphate in the caustic solution will fail to promote the desired uniformity of etching of the aluminum stock.

The following examples are given to illustrate in detail the preferred embodiments of this invention.

Example 1

Caustic etching solutions having concentrations of 3%, 7%, 10% and 15%, by weight of sodium hydroxide, were prepared by dissolving the required amount of sodium hydroxide in water. To these solutions was added 3% by weight of trisodium monoperphosphate. The rates of etching, in mils per minute of aluminum alloy 1100, containing Mn 0.05%, Cu 0.2%, Si 0.5%, Fe 0.5%, and Zn 0.1%, at different etching bath temperatures, were as follows:

Conc. of NaOH	Bath Temperature		
	30° C., mils	50° C., mils	80° C., mils
3%		0.2	0.5
7%	0.1	0.5	0.75
10%	0.2	0.8	1.0
15%	0.4	1.1	1.4

In all eleven of the above trials the aluminum alloys was etched or milled to a substantially uniform depth even when etched for a period of two to three hours. The etched surface had a satin finish and showed no objectionable pitting. The etched surface was readily given

a bright finish by subjecting the etched aluminum alloy to chemical polishing by immersing for thirty seconds in a solution containing 80% ortho-phosphoric acid, 3% monoperphosphoric acid, and 17% water.

Aluminum alloy 1100 etched for one hour in a caustic soda solution of like strength at a temperature of 50° C. in the absence of an alkali metal monoperphosphate was badly pitted and could not be polished by the above-mentioned chemical polishing solution.

Example II

A series of trials were run in accordance with the details of Example I with the exception that the alkali metal hydroxide was potassium hydroxide. The results were indistinguishable from those of Example I.

Example III

Example I was again repeated using potassium hydroxide in place of sodium hydroxide, and using tripotassium monoperphosphate in place of the trisodium monoperphosphate of Example I. Again the results were highly satisfactory as in the series of trials of Example I.

Example IV

Example I was repeated using the following aluminum alloys in place of alloy 1100:

Aluminum alloy 52S containing Mn 0.1%, Mg 2.5%, Cu 0.1%, Zn 0.1%, and Cr 0.25%.

Aluminum alloy 61S containing Mn 0.15%, Mg 1.0%, Cu 0.3%, Si 0.6%, Fe 0.7%, Zn 0.2%, Cr 0.25%, and Ti 0.15%.

Aluminum alloy 3S containing Mn 1.25%, Cu 0.2%, Si 0.6%, Fe 0.7%, and Zn 0.1%.

In all cases the results were highly satisfactory to produce an etched surface of satin finish that could be readily polished to a bright finish by chemical polishing as described in Example I.

The process of the present invention may be practiced for the controlled etching or so-called "chemical milling" of aluminum and aluminum-rich alloys to close tolerances and to depths of over one-quarter inch. The etched surfaces were smooth and sufficiently free of pits to permit chemical polishing to glass-bright finish.

Throughout the specification and claims, any reference to parts, proportions and percentages refers to parts, proportions and percentages by weight unless otherwise specified.

Since it is obvious that many changes and modifications can be made in the above-described details without departing from the nature and spirit of the invention, it is to be understood that the invention is not to be limited to said details except as set forth in the appended claims.

I claim:

1. The method of chemical milling of aluminum and aluminum-rich alloy stock which comprises immersing said stock into an aqueous alkali metal hydroxide etching solution having a temperature between 25° C. and 90° C. and containing between 0.2% and the limit of its solubility in said solution of an alkali metal monoperphosphate.

2. The method of chemical milling of aluminum and aluminum-rich alloy stock which comprises immersing said stock into an aqueous alkali metal hydroxide etching solution having a temperature between 25° C. and 90° C. and containing between 0.2% and the limit of its solubility in said solution of trisodium monoperphosphate.

3. The method of chemical milling of aluminum and aluminum-rich alloy stock which comprises immersing said stock into an aqueous alkali metal hydroxide etching solution having a temperature between 25° C. and 90° C. and containing between 0.2% and the limit of its solubility in said solution of tripotassium monoperphosphate.

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