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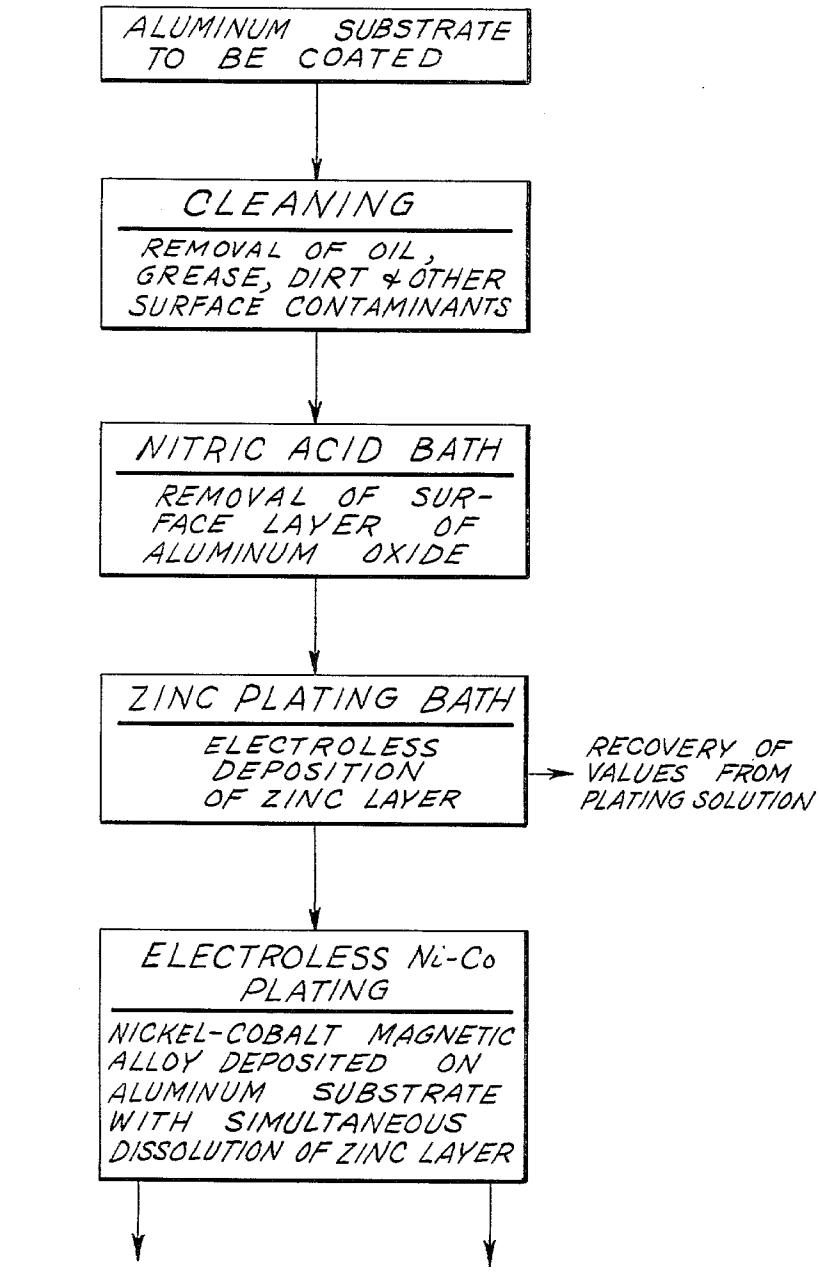

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DISPOSITION OF NICKEL-COBALT ALLOY ON ALUMINUM SUBSTRATES

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This invention relates to the deposition of nickel-cobalt alloy on aluminum substrates. More particularly, this invention relates to the plating or coating of aluminum articles with a nickel-cobalt magnetic alloy film. As used herein aluminum includes pure aluminum, commercial aluminum containing the usual impurities, aluminum base alloys and aluminum alloys wherein aluminum is the major and characterizing alloy component.

Aluminum storage devices or memory units comprising aluminum discs, drums and the like having deposited on the surface thereof a magnetic metal film are useful. The manufacture of such memory or storage devices from aluminum is attractive since aluminum is relatively cheap, easily machined, readily available and is lightweight. Aluminum, however, is a reactive metal and it is difficult to plate another metal onto aluminum using conventional plating techniques. Heretofore it has been extremely difficult to deposit a magnetic film or coating, such as a film of magnetic nickel-cobalt alloy, onto an aluminum substrate.

It is an object of this invention to provide a method for depositing a magnetic metal alloy film onto an aluminum substrate.

It is another object of this invention to provide a method of depositing a magnetic metal alloy film onto an aluminum substrate by electroless deposition.

It is another object of this invention to provide a method of depositing a film of nickel-cobalt magnetic alloy directly onto an aluminum substrate by electroless deposition from an aqueous nickel-cobalt-containing solution.

Yet another object of this invention is to provide aluminum articles coated with a film of magnetic nickel-cobalt alloy.

How these and other objects of this invention are achieved will become apparent in the light of the accompanying disclosure made with reference to the accompanying drawing wherein there is schematically presented a flow diagram illustrative of one embodiment of the practice of this invention.

In accordance with this invention, it has now been discovered a nickel-cobalt film is effectively deposited on an aluminum substrate by first providing the aluminum substrate with a protective coating of zinc and then placing the zinc coated aluminum substrate into contact with an aqueous nickel-cobalt-containing solution, said nickel-cobalt-containing solution having a composition effective for the deposition of nickel-cobalt alloy directly onto said aluminum substrate with the simultaneous dissolution of the zinc coating from said aluminum substrate into said solution, to effect deposition of said nickel-cobalt alloy directly upon said aluminum substrate.

Referring now to the accompanying drawing, there is indicated therein in block diagram various operations carried out in the practice of this invention. An aluminum substrate or an aluminum article to be coated is cleaned for the removal of oil, grease, dirt and other surface contaminants. The cleaned aluminum article is then treated for the removal of the adherent surface aluminum oxide film which rapidly forms upon aluminum in contact with an oxygen atmosphere. As indicated, the removal of the adherent surface film of aluminum oxide can be effected by immersing the aluminum article in a nitric acid bath.

Following the treatment for the removal of the surface layer of aluminum oxide, the aluminum substrate or aluminum article is immersed in a zinc plating bath, such as an aqueous solution of an alkali metal zincate, to effect electroless deposition of a protective layer of zinc onto the aluminum. The purpose of the zinc layer is to protect the aluminum substrate against oxidation prior to the deposition of the nickel-cobalt film thereon. If desired, the spent zinc plating bath is recovered for regeneration or for the recovery of values, such as zinc values, therefrom.

Following the zinc plating operation the aluminum article, now coated with a protective layer of zinc, is immersed in an aqueous nickel-cobalt-containing plating bath having a composition such that the protective layer of zinc is removed from the aluminum substrate and dissolves within the bath and substantially simultaneously a film or coating of nickel-cobalt alloy is deposited on the aluminum substrate. Following this electroless plating operation the aluminum substrate, now coated with a film of nickel-cobalt magnetic alloy, is recovered. If desired, the nickel-cobalt plating bath can be recovered for regeneration or the recovery of the metal values therefrom.

In the practice of this invention the aluminum article to be coated is carefully cleaned to remove from the surface thereof any oil, grease, dirt, and extraneous matter. Cleaning may be effected by washing in a water bath and/or by applying a jet of wet steam to the aluminum article. Grease and oil and like contaminants are removed by solvent washing. Desirably, the methods of removing surface contaminants from the aluminum article should not chemically attack the aluminum article itself.

Following the cleaning operation the adherent surface film or layer of aluminum oxide is removed by known methods, such as dipping in an acid bath, such as a bath of nitric acid, preferably followed by a water rinse. Following the removal of the aluminum oxide layer the aluminum article is immersed in an aqueous zinc plating bath. This operation usually involves immersing the aluminum article for about 0.25–3 minutes at room temperature in an aqueous solution of alkali metal zincate which may be made up with about 100 grams of zinc oxide and about 400 grams of caustic soda per liter of bath, the balance being substantially water. The alkali metal zincate bath may vary widely in the proportions and concentrations of its components. The amount of zinc oxide may be less than 100 grams per liter of bath but the ratio of caustic soda to zinc oxide is usually in the range from about 3:1 to 8:1. The alkali metal zincate bath may also be prepared from equivalent amounts of zinc salts and other caustic alkalis. Desirably, there

may be incorporated in the alkali metal zincate bath a minor amount of at least one of the hydrous oxides of iron, cobalt and nickel. The presence of these added compounds promotes the deposition of a uniform, dense and adherent zinc coating on the surface of the aluminum article. The presence of added copper salts to the alkali metal zincate solution also is useful.

An alkali metal zincate bath having the following composition in grams per liter may be employed:

ZnO	100
$NaOH$	400
$FeCl_3.6H_2O$	1
$C_4H_4O_6$	5

An alkali metal zincate bath also suitable in the practice of this invention has the composition:

Water	liter	1
Caustic soda	grams	400
Zinc oxide	do	80
Copper, in the form of potassium copper cyanide	do	2
Sodium sulfite	do	25

The alkali metal zincate bath is also effective to remove any remaining adherent aluminum oxide film from the aluminum article.

Following the immersion in the zincate bath the aluminum article is removed and subjected to a water rinse to remove any adhering zincate solution. The aluminum article is now coated with a protective layer of zinc. The zinc coated aluminum article is then immersed in an aqueous nickel-cobalt electroless plating solution to effect substantially simultaneously the dissolution of the protective zinc layer and the deposition of a film of nickel-cobalt magnetic alloy directly onto the surface of the aluminum article, the nickel-cobalt alloy being deposited onto the aluminum surface without any intervening zinc layer.

An electroless plating bath suitable for the deposition of a nickel-cobalt magnetic alloy film has the following composition:

	Gms./l.
$CoCl_2.6H_2O$	60–35
$NiCl_2.6H_2O$	2–25
Rochelle salt	200
NH_4Cl	50
$NaH_2PO_2.H_2O$	20

Desirably, the hypophosphite ion content in the nickel-cobalt plating bath is in the range from about 11 to about 13 grams per liter. When the nickel-cobalt plating bath contains about 60 grams per liter $CoCl_2.6H_2O$ and about 2 grams per liter $NiCl_2.6H_2O$, the amounts of the other components hereinabove identified remaining unchanged, there is deposited upon the aluminum article a nickel-cobalt magnetic alloy film having the approximate composition by weight 90% cobalt, 7% nickel and 3% phosphorus. When the nickel-cobalt plating bath contains about 35 grams per liter $CoCl_2.6H_2O$ and about 25 grams per liter $NiCl_2.6H_2O$ there is deposited on the aluminum article a nickel-cobalt magnetic alloy film having the composition by weight approximately 40% cobalt, 56% nickel and 4% phosphorus.

The compositions of nickel-cobalt plating baths particularly useful in the practice of this invention are disclosed in copending, coassigned patent application Serial No. 148,953 filed October 31, 1961 in the name of Ernest W. Jones, one of the co-inventors of the invention described herein, now abandoned. The disclosures of the above-identified patent application are herein incorporated and made part of this disclosure.

The electroless plating of the aluminum article for the deposition of the magnetic film of nickel-cobalt thereon may be carried out at any suitable temperature from about room temperature up to about 180° F. or higher, if desired, and for a period of time sufficient to deposit on the aluminum article a nickel-cobalt alloy coating of the desired thickness, usually from about 1–10 minutes, more or less.

Following immersion in the nickel-cobalt electroless plating bath the aluminum article is removed and washed and may be in the form ready for installation in an operating device. The spent nickel-cobalt plating bath is desirably recovered and treated for regeneration for the recovery of metal values therefrom, including nickel, cobalt and zinc.

As will be apparent to those skilled in the art in the light of the foregoing disclosure many modifications, alterations and substitutions are possible in the practice of this invention without departing from the spirit or scope thereof.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of depositing a nickel-cobalt alloy film directly onto an aluminum substrate which comprises depositing a layer of zinc on said aluminum substrate by contacting said aluminum substrate with an aqueous alkali metal zincate solution and placing the zinc coated aluminum substrate into the contact with an aqueous nickel-cobalt-containing solution, said nickel-cobalt-containing solution having the composition:

	Gms./l.
$CoCl_2.6H_2O$	60–35
$NiCl_2.6H_2O$	2–25
Rochelle salt	200
NH_4Cl	50
$NaH_2PO_2.H_2O$	20

and effective for the deposition of a nickel-cobalt alloy directly onto said aluminum substrate with the simultaneous dissolution of the zinc coating from said aluminum substrate into said solution to effect deposition of said nickel-cobalt alloy directly upon said aluminum substrate.

2. A method in accordance with claim 1 wherein said alkali metal zincate solution is prepared from zinc oxide and caustic soda, the weight ratio of caustic soda to zinc oxide being in the range from about 3:1 to about 8:1.

3. A method of depositing a nickel-cobalt magnetic alloy film directly upon the surface of an aluminum article which comprises, removing surface contaminants from said aluminum article, treating said aluminum article to remove any adherent film of aluminum oxide from the surface thereof, depositing a layer of zinc upon the surface of said aluminum article now substantially free of any adherent surface aluminum oxide film by contacting said aluminum article with an aqueous alkali metal zincate solution, contacting the resulting zinc coated aluminum article with an aqueous nickel-cobalt-containing plating solution, said nickel-cobalt-containing plating solution having the composition:

	Gms./l.
$CoCl_2.6H_2O$	60–35
$NiCl_2.6H_2O$	2–25
Rochelle salt	200
NH_4Cl	50
$NaH_2PO_2.H_2O$	20

and effective for the deposition of a nickel-cobalt alloy directly upon the aluminum surface of said article with the simultaneous dissolution of the zinc layer from said article, to effect deposition of said nickel-cobalt alloy directly upon the aluminum surface of said article.

4. A method in accordance with claim 3 wherein said alkali metal zincate solution is prepared from zinc oxide and caustic soda, the weight ratio of caustic soda to zinc oxide being in the range from about 3:1 to about 8:1.

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