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PROCESS OF ELECTRODEPOSITION OF ALUMINUM

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This invention relates to the electrodeposition of aluminum and relates particularly to a process involving the deposition of aluminum from aluminum compounds dissolved in anhydrous solvents.

We have found that aluminum may be plated on a suitable cathode by electrolyzing a metal-halide-ether complex, analogous to the magnesium-halide-ether complexes known as Grignard reagents.

By treating finely divided aluminum with ethyl iodide, with exclusion of moisture, a product is formed which is a mixture of monoethyldiiodoaluminum with diethylmonoiodoaluminum and this with anhydrous ether forms a complex which can be used as an electrolyte from which, under suitable conditions, aluminum can be deposited as a plate.

The preparation of a suitable aluminum compound and the plating of aluminum from an ethereal solution is illustrated by the following:

To 7 parts by weight of aluminum powder contained in a receptacle of glass, enamel or other resistant material, there is added 12 parts of redistilled ethyl iodide. The upper part of the receptacle, which is glass, is provided with a reflux condenser and with a tube for the purpose of passing dry nitrogen or other inert gas into the reaction chamber. The reflux condenser is equipped with two openings, one being an outlet for escaping gases and the other being employed as a means of introducing from an apparatus similar to a separatory funnel 38 parts of etnyl iodide.

Dry nitrogen is allowed to flow through the contents of the receptacle containing the aluminum and ethyl iodide, this flow of gas being continued for about 15 minutes until all air is displaced. The receptacle then is heated in an oil bath to about 100° C. until the reaction starts. When reaction between the ethyl iodide and aluminum begins the source of heat is removed and ethyl iodide is allowed to flow slowly from the separatory funnel or similar apparatus until no more action occurs in the receptacle. Heat is again applied, the temperature of the bath being raised to 125° C. and being maintained for a period of about one hour. The mixture now containing diethyl aluminum iodide and ethyl aluminum diiodide with some free aluminum is cooled in an ice bath and about 50 parts of absolute ether are added through the reflux condenser. Care, however, should be taken to make such additions gradually and cautiously on account of the large amount of heat liberated during the formation of the Grignard etherates. After all the ether has been added and a solution, apparently homogeneous, has been obtained, the mixture is ready for electrolysis.

For this purpose an anode of aluminum and a cathode of copper may be employed. These are immersed in the solution in the reaction chamber, the latter being equipped with a tight-fitting closure having an outlet for the liberation of nitrogen. The deposition of the aluminum is conducted at a current density of 0.02 amperes per sq. cm. About 40 volts are required to pass this current. Dry nitrogen is passed through the receptacle during the entire electrolysis.

At the beginning of the electrolysis a large amount of gas will be given off but as the operation progresses, evolution of gas will diminish. The solution will darken in color and at this point the plating is most efficient. The electrolysis will take about three hours. Only one side of an object is plated in this manner, the operation being conducted with the cathode reversed in position in order to apply plating to the opposite side. When the deposition is completed the article (cathode) is washed with alcohol and cleansed by rubbing with a rag.

The foregoing is set forth particularly for illustrative purposes, it being understood that the composition of the electrolyte and the precise procedure employed with respect to voltage, current density and other conditions may be varied according to circumstances.

The property which aluminum possesses of resisting ordinary atmospheric corrosion renders the process of prospective value in the coating of metals which normally are readily corroded and which by being plated with aluminum may be expected to acquire new properties of resistance. Furthermore, pure aluminum is very little attacked by certain concentrated acids, such as nitric and acetic. Also, it has been found that sulphur compounds in ordinary petroleum will not corrode aluminum tubes to any appreciable extent, even at high temperatures.

The low tensile strength and especially the low elastic limit of pure aluminum renders it rather unsatisfactory as a structural material for many purposes, even though it is not attacked by corrosive agents of various kinds. Therefore the possibility of electroplating aluminum on steel or other common metals promises a wider range of metallic substances in chemical construction work.

One of the possible uses of aluminum plate is for steel economizer tubes. These tubes contain water inside and hot flue gases on the out-

side. Flue gases frequently contain a high content of corrosive sulphur compounds due to the sulphur present in the coal employed as a fuel. Among the other applications of the present process we contemplate the electroplating of the outside of such tubes or other tubing employed in analogous operations. Other possible uses to prevent corrosion due to sulphur compounds are lining tubes and reaction chambers used in petroleum cracking stills and for the inside of locomotive smoke stacks.

Still another possibility is that of plating the inside of steel cylinders used to store compressed gases. It is very difficult, if not impossible, to store gas in iron cylinders and have this gas remain in a state of purity, as volatile products are formed by chemical action with the iron. Prevention of such action may be expected if the cylinder is lined with a plate of pure aluminum.

Aluminum-plated steel would furnish a material of high tensile strength, great elasticity and notable resistance to corrosion, hence should prove a material which would be useful in many chemical industries. We contemplate, through applying the process of the present invention, to secure various metals protected with a plate of aluminum which will find a wide variety of uses.

In the process of plating aluminum on dissimilar metals, such as copper, iron, steel and the like, by electro-deposition from an organic compound of aluminum soluble in an organic solvent vehicle such as is specifically illustrated in the foregoing, we obtain the most satisfactory deposits in the complete absence of moisture and preferably, therefore, conduct the plating step under anhydrous conditions. The employment of an electrolyte of this character forms a part of the present invention.

The invention is by no means limited to the particular illustrative embodiments set forth above, but embraces the employment of any metallo-organic compounds or electrolytes constituted in an equivalent or analogous way. Compounds containing bromine, for example, may be used in place of those containing iodine. Likewise departures in constitution of much greater latitude, within the confines of the invention, are contemplated herein.

What we claim is:

1. The process of plating aluminum on dissimilar metals by electrodeposition which comprises subjecting, as cathode, a metallic article to be plated, to the action of an electric current while immersed in a solution of an organic compound of aluminum dissolved in an organic solvent vehicle.

2. The process of plating aluminum on dissimilar metals by electrodeposition which comprises subjecting, as cathode, a metallic article to be plated, to the action of an electric current while immersed in an anhydrous solution of an organic compound of aluminum dissolved in an anhydrous organic solvent vehicle.

3. In the process of electroplating with aluminum the step which comprises subjecting a metallic article serving as cathode to an electric current passed through a metallo-alkyl-iodine complex with ether, said complex containing aluminum in combination, capable of being liberated as a metallic deposit on the cathode.

4. As a composition for use in the process of electroplating metals, an anhydrous electrolyte comprising a metallo-organo-halide-complex containing aluminum.

5. The method of electroplating which comprises subjecting a metal article as cathode to the action of an electric current while immersed in an electrolyte containing an aluminum complex of the Grignard type.

6. The method of electroplating which comprises subjecting a metal article as cathode to the action of an electric current while immersed in an electrolyte containing a metallo-organo-halide-complex containing aluminum.

7. An electrolyte comprising an ethereal solution of a metallo-organo-halide-complex containing aluminum.

8. An electrolyte comprising an ethereal solution of an aluminum complex of the Grignard type.

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