

UNITED STATES PATENT OFFICE

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METHOD OF FORMING COATINGS OF METAL AND PRODUCT THEREOF

No Drawing.

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This invention relates to a method of coating articles with metal by cathode sputtering, and the coated articles so produced.

The object of my invention is to provide on various articles of manufacture a durable, non-corrosive, firmly adherent protective surface, and particularly in those cases in which electroplating in a liquid electrolyte or the various methods of chemical plating have proved to be unsatisfactory. For example, metal coatings may be formed on glass by this method.

With the above and other objects in view, the invention consists in the construction, combination and arrangement of parts as will be hereinafter more fully described.

It is known that when an electric discharge takes place from a metal cathode in a suitably evacuated space that portions of the cathode are torn off and carried away therefrom. This takes place at a rate that is proportional to the square of the current, as contrasted with electrolysis in a liquid electrolyte where the removal of metal is proportional to the first power of the current. As the metal so removed is in atomic form it is in such a physical condition that permits the particles to approach a surface sufficiently close to come within the range of molecular attraction, and hence a tight, almost integral bond is formed with the surface.

The cathodic deposits of most substances are soft, but those formed by discharges from silicon or chromium cathodes are hard and dense. It is for this reason that I prefer to use one of these metals. It is further known that the rate of deposition is much greater in a space that contains an inert or a monatomic gas, such as mercury vapor, argon or helium, and it is therefore desirable that one or more of these gases be present in the tube in which the coatings are formed.

A method of practicing my invention that has proved satisfactory is to place the article to be coated in an air tight tube or chamber having suitable electrodes therein one at least of which is made of the metal it is desired to deposit as a coating. The surface to be covered is placed about two

inches from and facing the electrode made of the coating metal. A dish of mercury is placed in the chamber, and the air is pumped out until the chamber is practically devoid of any gas except the mercury vapor. Enough helium is then admitted to the chamber to raise the pressure to a value at which a good electrical discharge occurs when a potential of about five thousand volts is applied across the electrodes. Maintenance of this discharge for approximately eight hours, with the electrode that is made of the metal it is desired to deposit functioning as electrode for about one-half of that time, results in a smooth, fine grained, dense deposit on the surface of the article.

If alternating current is used each electrode is the cathode for one-half the time, as mentioned above, and it is then convenient to make both electrodes of material to be sputtered and place two plates back to back, whereby that side of each plate that faces an electrode is covered with the metal. The electrodes need not be of the same metal, as the character and purity of the deposit on a surface facing one electrode is negligibly affected by the material of the opposite electrode.

Direct current can be used for the sputtering and the coatings are produced just as successfully as, and more rapidly than, with alternating current. In this case the material of the anode is unimportant.

It was found that coatings of silicon and chromium so formed were entirely unaffected by the application of any common acids or other chemical substances and were conspicuously resistant to ordinary mechanical abrasion.

One use to which this invention has been applied is in coating the top plate electrodes for frequency control crystals in radio transmitters. There has been difficulty in finding a metal from which can be made the top plates of the desired weight and size not subject to warping, corrosion, or wearing down on the surface. Top plates of aluminum and of brass possess advantages as regards their relations of weight to size and freedom from warping, but ordinary brass plates suffer

from tarnishing under ordinary operating conditions while aluminum plates rub off onto the crystals and change their frequencies. Top plates made of either of the mentioned materials are very satisfactory when provided with a coating of silicon or chromium by the method herein disclosed.

While the application of my invention to a specific use has been set forth for purposes of illustration, it is to be understood that this is not to be interpreted as a limitation of the invention, as it finds many uses other than that mentioned.

It will be understood that the above description comprehends only the general and preferred embodiment of my invention and that various changes in construction, proportion and arrangement of parts may be made within the scope of the appended claims without sacrificing any of the advantages of my invention.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

Having thus described my invention, what I claim is:

1. A method of electrodepositing metal, comprising the steps of disposing an object between electrodes in an air tight chamber, one of which electrodes is made of the metal to be deposited, exposing in said chamber a body of mercury having a free surface evacuating said chamber until there is substantially no gas in said chamber except mercury

vapor, releasing one or more monatomic gases in said chamber to raise the pressure in said chamber to a magnitude at which the desired discharge will pass, and passing a discharge between said electrodes until the requisite thickness of metal has been deposited on said object.

2. A method of electrodepositing metal, comprising the steps of disposing an object between electrodes in an air-tight chamber, one of which electrodes is made of the metal to be deposited, exposing in said chamber a body of mercury having a free surface, evacuating said chamber until there is substantially no gas therein except mercury vapor, releasing helium gas in said chamber to raise the pressure in said chamber to a magnitude at which the desired discharge will pass and passing a discharge between said electrodes until the requisite thickness of metal has been deposited on said object.

3. A method of electrodepositing metal, comprising the steps of disposing an object between electrodes in an air-tight chamber, one of which electrodes is made of the metal to be deposited, exposing in said chamber a body of mercury having a free surface, evacuating said chamber until there is substantially no gas therein except mercury vapor, releasing helium gas in said chamber to raise the pressure in said chamber to a magnitude at which the desired discharge will pass and passing a discharge at a potential of substantially 5,000 volts for a period of about eight hours.

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