

UNITED STATES PATENT OFFICE

2,482,354

COPPER PLATING SOLUTION

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1 Claim. (Cl. 204—52)

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This application is related to co-pending application of Abraham M. Max, Serial No. 613,215, filed August 28, 1945, now Patent No. 2,475,974.

This invention relates to electrodeposition of copper from acid plating baths and more particularly to addition agents which improve the quality of copper plated from these baths.

For many industrial applications requiring electrodeposition of copper, the quality of the deposit obtained from an ordinary acid plating bath is sufficiently good so that the use of special addition agents is unnecessary. Acid plating baths are desirable to use because of their advantages such as wide limits of operation, ease of control, smooth, heavy deposits of copper produced, and ability to plate on very thin conductive films. On the other hand, acid copper plating baths have some inherent disadvantages which make them unsuitable for certain other types of industrial applications. Among these disadvantages are the softness of the deposited copper and the tendency of the copper to tree or build up at projecting points.

One of the uses requiring improved copper plating baths is that of making metal replicas of surfaces having many fine variations in contour. This condition exists in the record making art where master matrices and molds are made from wax originals. Here, it is desired that the electroformed deposit follow the original surface contours exactly and that the deposit be relatively hard.

It is an object of the present invention to provide an improved acid copper plating bath which will produce smoother and harder electroformed deposits of copper.

Another object is to provide a new addition agent which will improve the performance of acid copper plating baths.

Still another object is to provide an improved acid copper plating bath permitting strong deposits of metal when the plating is done at high temperatures.

Electroformed copper deposits from an acid copper plating solution consist of columnar crystals perpendicular to the starting surface, or surface on which the copper is being plated, the crystals becoming larger, by lateral growth, as the deposits become heavier. If the surface being plated has an impression or depression therein, there results in the columnar, crystal structure a weakness perpendicular to the impression where the columnar crystals come together. Most commonly used addition agents retard the lateral growth of crystals, but due to

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the retained columnar structure, the weaknesses in irregular surfaces remain. Thus, many addition agents result in a brittle electroformed structure which splits under the stresses to which matrices are subjected.

It is apparent that a desirable structure for electroformed deposits is one in which the columnar growth is completely suppressed. It has now been found that if tri-isopropanolamine is added to a standard acid copper plating solution, the resulting solution will produce fine-grain deposits both laterally and perpendicularly to the surface which is plated, the columnar growth being largely retarded. Tensile tests made with specimens of such copper deposits show a tensile strength equal to that of a strong copper alloy.

In accordance with the present invention, there is added to a more or less standard, acid copper plating solution tri-isopropanolamine in the amount of approximately 0.1 to 0.5 ounce per gallon of plating solution. This plating solution may consist of about 25 to 32 ounces of copper sulfate and about 3 to 10 ounces of concentrated sulfuric acid per gallon of plating solution. The copper may be plated out in known manner at suitable current densities and suitable plating solution temperatures. However, it has been found that, surprisingly enough, plating may be done with the bath at temperatures as high as 125° F. with good, strong deposits of copper being formed.

It has been found that a copper deposit plated out from solutions prepared according to the present invention has an extremely fine and uniform grain structure which gives the copper considerable strength. Copper deposits resulting from the improved plating solution have a tensile strength of from about 65,000 pounds per square inch to about 90,000 pounds per square inch with an elongation of approximately 8 per cent to 12 per cent. This is about 80 per cent stronger than known samples of electroformed copper obtained from standard, conventional, plating solutions employing various addition agents proposed heretofore.

It will be obvious to those skilled in the art that the various proportions of the addition agent indicated above are not necessarily limiting but that they represent the preferred form of the invention. The proportions of the other ingredients in the standard plating bath may also be varied widely without departing from the scope of the invention.

As stated previously, this invention has par-

tical utility in electrodepositing copper in the making of phonograph record master matrices and molds but the improved bath may be used to provide a strong, even, fine-grained deposit of copper wherever it is desirable to deposit this metal electrolytically.

We claim as our invention:

An acid copper plating solution consisting essentially of the following ingredients per gallon of solution: approximately 25 ounces to 32 ounces of copper sulfate, approximately 3 ounces to 10 ounces of sulfuric acid, and an addition agent consisting essentially of 0.1 ounce to 0.5 ounce of tri-isopropanolamine.

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