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3,020,156

METHOD OF COATING METAL ON DIELECTRIC MATERIAL

Original Filed May 10, 1957

FIG. 1.

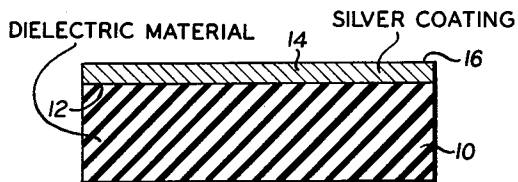


FIG. 2.

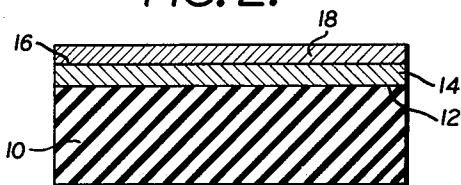


FIG. 3.

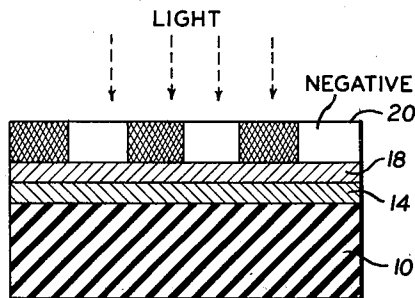


FIG. 4.

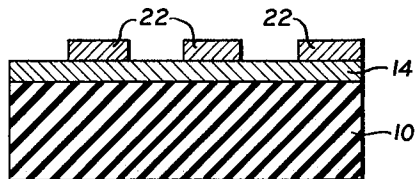


FIG. 7.

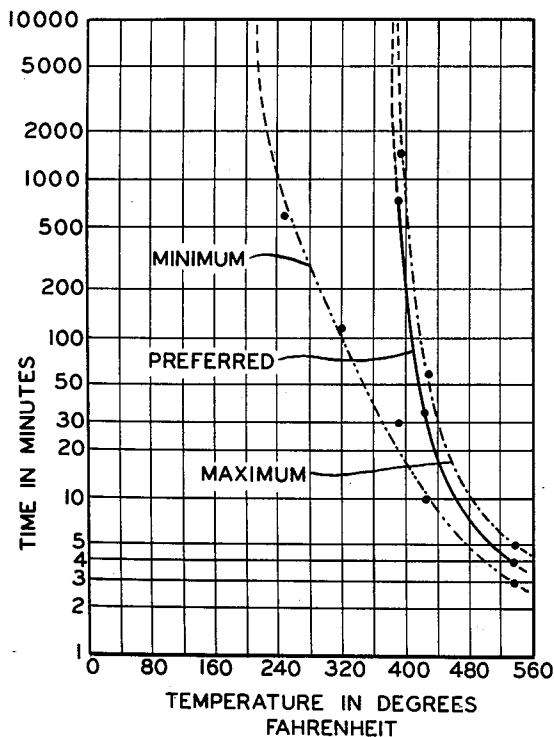


FIG. 5.

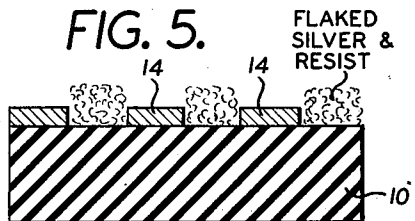
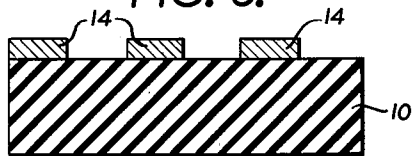


FIG. 6.



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METHOD OF COATING METAL ON
DIELECTRIC MATERIAL

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poration of New York
Continuation of application Ser. No. 658,390, May 10,
1957. This application Apr. 4, 1960, Ser. No. 19,595
4 Claims. (Cl. 96—35)

This invention relates to a method of coating metal
on dielectric material and particularly to a method for
coating metal on preselected portions of a piece of di-
electric material.

This application is a continuation of my earlier appli-
cation Serial Number 658,390, filed by me on May 10,
1957, and assigned to the assignee hereof, now aban-
doned.

The coating of metals on dielectric materials has re-
cently become an extremely important art in view of the
growth of and interest in printed circuits and other items.
Among the methods which have been used to coat met-
al on dielectric material has been a photoetching process
well known in the art. However, no method heretofore
produced has yielded a precise sharp image in metal.
The sharpness of the image is often of extreme impor-
tance.

The main object of the present invention is to provide
a new and improved method of coating metal on dielec-
tric materials.

Another object of the present invention is to provide
a new and improved method for photoetching metallic
coatings on dielectric materials whereby to yield very
sharp delineations along the edges of the coating.

The above and other objects, characteristics and fea-
tures of the present invention will be more fully under-
stood from the following description taken in connec-
tion with the accompanying illustrative drawing.

In the drawing:

FIG. 1 is a diagrammatic sectional view showing a
dielectric material coated metal which forms one step
in my novel method;

FIG. 2 is a view similar to FIG. 1 showing a resist
overlying the metallic coating on the dielectric material,
which condition illustrates another step in the present
invention;

FIG. 3 is a view similar to FIGS. 1 and 2 showing
the exposure of the resist to light, which represents an-
other step in the present method;

FIG. 4 is a diagrammatic view similar to FIGS. 1 to
3 showing the condition of the exposed resist after de-
veloping thereof, which illustrates another step in my
novel method;

FIG. 5 is a diagrammatic view similar to FIGS. 1 to
4 illustrating the actual removal of metal whereby to
leave a metallic coating of desired configuration; and

FIG. 6 is a diagrammatic view similar to FIGS. 1 to
5 showing the final product;

FIG. 7 is a graph showing the time temperature re-
lationship for baking the metallic coating and for baking
the resist.

Referring now to the drawings in detail, any suitable
dielectric material may be employed in my novel meth-
od. For instance, the dielectric material may be a vitre-
micaceous material such as glass-bonded mica and
ceramoplastic. In the alternative, the dielectric mate-
rial may be made of glass, ceramic or some organic ma-
terial. The requirements of the dielectric material will
be more fully explained as my novel method is explained
in detail. The dielectric material is designated generally
by the reference numeral 10.

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The first step in the present method is to coat a sur-
face of dielectric material 10 with a metal. Preferably,
this coating may be applied in the form of "liquid met-
al" which is a suspension of metal in a suitable suspend-
ing liquid. Preferably, the metal is a good conductor
such as silver although other metals may be employed.
The step of coating the liquid metal on the dielectric ma-
terial forms no novel part of my method and is fully
described and claimed in U.S. Patent No. 2,752,237,
granted to Oliver A. Short on July 26, 1956, for Silver
Powder and Method for Producing Same. Accordingly,
the application of the silver coating and its composition
will not be described in detail as these details can be ob-
tained from a perusal of the aforementioned Short pat-
ent. Suffice it to say the liquid silver comprises pow-
dered silver suspended in a liquid such as a soda ash
solution. The suspension is applied to the entire surface
12 of the dielectric material 10 and after it is so applied
the coated dielectric material is placed in an oven for
baking. The temperature and time of the baking of the
silver suspension in order to drive off the suspending liq-
uid and to leave a coating of silver is dependent upon a
time-temperature relation. The table below sets forth
the time-temperature relationship which will yield a good
silver coating on the dielectric material. FIG. 7 graphi-
cally depicts the time-temperature relation for baking
"liquid silver" of the type described in the aforemen-
tioned Short patent. If other types of metallic coatings
are used, other time-temperature relationships may exist.
The preferred time for any of the given temperatures is
roughly half-way between the minimum and maximum
times stated in said table.

Temperature	Minimum Time	Maximum Time
248° F.-----	10 hrs.----	
320° F.-----	2 hrs.-----	
392° F.-----	½ hr.-----	24 hrs.
428° F.-----	10 min.----	1 hr.
536° F.-----	3 min.-----	5 min.

The preferred time and temperature for baking the given
"liquid silver" is about 400° F. for thirty minutes.

After the baking is completed there is a silver coating
14 which overlies surface 12 of dielectric material 10 and
which adheres thereto with considerable strength. It is
not my present aim to coat one entire surface of a dielec-
tric material with metal. It is my aim to only coat por-
tions of surface 12 with coating 14. Accordingly, hav-
ing first coated the entire surface 12 with coating 14,
it becomes necessary to remove undesired portions of
the silver coating 14, while permitting the desired por-
tions to remain in overlying relationship with dielectric
material 10. To accomplish this aim, a light sensitive
solution is coated over the upper surface 16 of silver
coating 14. The resist formed by the light sensitive solu-
tion must be of a type that when heated forms a stronger
bond with the upper surface 16 of the metal coating 14
than the metal coating 14 forms with the upper surface
12 of dielectric material 10. Moreover, and equally im-
portant, the resist must be shrinkable when heated. The
following formulations yield resists which are suitable for
use in my method.

Formulation I:	
Commercial fish glue-----oz---	16
Ammonium dichromate (20% solution) .oz---	3
Water -----gal---	1
Concentrated ammonia -----drops---	10

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Formulation II:

Gum arabic (14° Baumé)-----cc--	1,000
Ammonium dichromate (20% solution) .cc--	340
Ammonia (28% solution)-----cc--	50
Water—sufficient to make solution with 14° Baumé specific gravity.	

Both of the formulations described above will give satisfactory results when employed in the method being described and both work with a water developer as will be described hereinafter. The preferred formulation for the resist may be tabulated as—

Formulation III:

Fish glue-----oz--	10½
Egg white-----oz--	2
or	
Dried albumin-----oz--	2½
Ammonium dichromate (20% solution) .oz--	4
Concentrated ammonia-----drops--	10
Water -----oz--	16
With the preferred resist, the developer preferably comprises—	
Calcium chloride (solution of 40° Baumé specific gravity)-----cc--	1,000
Lactic acid (85% solution)-----cc--	53

After the light sensitive material is sprayed onto the silver coating the light sensitive solution is subjected to heat of about 100° F. for a sufficient time to cause it to dry. Preferably, the heat is that emanated from an infrared lamp whereby to prevent exposure of the ammonium dichromate which is light sensitive.

Once the light sensitive coating has been dried, a negative is placed in overlying relationship therewith. The negative may be in the form of a cutout pattern but preferably it is in the form of a photographic plate having opaque and transparent portions to prevent and permit the transmission of light therethrough, respectively. The negative is designated by the reference numeral 20. Once the negative is placed over the light sensitive material, a bright light is directed onto the negative and a portion of this light passes through the negative to expose the light sensitive material 18 and another portion is prevented from passing through due to the opaque parts of the negative. Accordingly, only those portions of the light sensitive material 18 underlying the transparent part of the negative 20 will be exposed.

After exposure the negative is removed and the light sensitive material is subjected to a developer. The composition of the developer will depend upon the type of light sensitive coating employed and the particular developers usable with the light sensitive formulations disclosed hereinbefore have already been described. The developer washes away the unexposed portions of the light sensitive material and leaves unaffected the exposed portions thereof. This condition is shown in FIG. 4. The developed but unremoved portions of the light sensitive material are commonly called a resist and are herein designated by the reference numeral 22.

After the formulation of the resist the entire resulting piece comprising the dielectric member 10, the silver coating 14 and the resist 22 is placed in an oven and is baked. It has been discovered that the time-temperature relationship used for baking the liquid silver is also suitable for baking the resists resulting from the light sensitive solution formulations disclosed hereinbefore. As was pointed out, any resist formed as a result of the use of the formulations described hereinbefore will shrink when heated. Moreover, and as is necessary to the working of my invention, the resist must bond to the silver with a stronger bond than the silver bonds to the dielectric. When these conditions are met and the resist is baked in accordance with the relationship described hereinbefore and preferably at about 400° F. for thirty minutes, the resist 22 will shrink and tend to flake off. In shrinking, however, the resist will remain firmly bonded to

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the silver underlying it and will pull the silver off of the underlying dielectric material. At the completion of the baking the flaked off resist and silver may merely be brushed away or washed away or blown away and the result will yield a silver coating of desired pattern overlying the dielectric material 10 as is shown in FIG. 6.

I have found that the above described method not only is easy to work and costs very little, but additionally it yields very sharp silver images heretofore not readily obtainable by previously disclosed photoetching methods. Extremely intricate patterns of metal may thus be coated on dielectric materials with great ease.

While I have herein shown and described the preferred form of my invention and have suggested various changes and modifications therein, other changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of this invention.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. The method of coating a metal on a predetermined portion of the surface of a dielectric material, comprising the steps of coating said surface with a liquid silver suspension, baking said suspension at about 400° F. for about thirty minutes to drive off the liquid from said suspension and to cause said silver to bond to said surface, coating said silver with a light sensitive heat shrinkable solution consisting essentially of 16 ounces of commercial fish glue, 3 ounces of a 20% solution of ammonium dichromate, 10 drops of concentrated ammonia and 1 gallon of water, baking said solution at about 100° F. until it dries, disposing a negative over said dried solution, illuminating said negative to expose a portion of said light sensitive material, developing said light sensitive material in water to wash away the exposed portion thereof, and baking the remaining portion of said light sensitive material at about 400° F. for about thirty minutes to cause said material to shrink and pull the underlying silver off said surface of said dielectric material.

2. The method of coating a metal on a predetermined portion of the surface of a dielectric material, comprising the steps of coating said surface with a liquid silver suspension, baking said suspension at about 400° F. for about thirty minutes to drive off the liquid from said suspension and to cause said silver to bond to said surface, coating said silver with a light sensitive heat shrinkable solution consisting essentially of 10½ ounces of fish glue, 2 ounces of egg white, 4 ounces of a 20% solution of ammonium dichromate, 10 drops of concentrated ammonia and 16 ounces of water, baking said solution at about 100° F. until it dries, disposing a negative over said dried solution, illuminating said negative to expose a portion of said light sensitive material, developing said light sensitive material in water to wash away the exposed portions thereof, and baking the remaining portions of said light sensitive material at about 400° F. for about thirty minutes to cause said material to shrink and pull the underlying silver off said surface of said dielectric material.

3. The method of coating a metal on a predetermined portion of the surface of a dielectric material, comprising the steps of coating said surface with a liquid silver suspension, baking said suspension at about 400° F. for about thirty minutes to drive off the liquid from said suspension and to cause said silver to bond to said surface, coating said silver with a light sensitive heat shrinkable solution consisting essentially of 10½ ounces of fish glue, 2½ ounces of dried albumin, 4 ounces of a 20% solution of ammonium dichromate, 10 drops of concentrated ammonia and 16 ounces of water, baking said solution at about 100° F. until it dries, disposing a negative over said dried solution, illuminating said negative to expose a portion of said light sensitive material, developing said light sensitive material in water to wash away the exposed portion thereof, and baking the remaining portion of said light sensitive material at about 400° F. for about thirty

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minutes to cause said material to shrink and pull the underlying silver off said surface of said dielectric material.

4. The method of coating a metal on a predetermined portion of the surface of a dielectric material, comprising the steps of coating said surface with a liquid silver suspension, baking said suspension at about 400° F. for about thirty minutes to drive off the liquid from said suspension and to cause said silver to bond to said surface, coating said silver with a light sensitive heat shrinkable solution consisting essentially of 1,000 cc. of gum arabic having a specific gravity of about 14° Baumé, 340 cc. of a 20% solution of ammonium dichromate, 50 cc. of a 28% solution of ammonia, and enough water to yield a solution having a specific gravity of 14° Baumé, baking said solution at about 100° F. until it dries, disposing a negative over said dried solution, illuminating said nega-

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tive to expose a portion of said light sensitive material, developing said light sensitive material in a solution consisting essentially of 1,000 cc. of a calcium chloride solution having a specific gravity of 40° Baumé and 53 cc. of an 85% solution of lactic acid to wash away the exposed portion thereof, and baking the remaining portion of said light sensitive material at about 400° F. for about thirty minutes to cause said material to shrink and pull the underlying silver off said surface of said dielectric material.

References Cited in the file of this patent

UNITED STATES PATENTS

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