

CLAIMS

1. An electrolyte for electrodeposition of copper on a substrate, said electrolyte comprising, in aqueous solution, copper ions, a combination of at least two aromatic amines, and an electrochemically inert cation selected from the group consisting of cesium (Cs^{2+}), alkylammonium and mixtures thereof, characterized in that

- the two aromatic amines are 2,2'-bipyridine and imidazole,
- the concentration of copper ions is between 0.4 and 40 mM, the sum of the concentrations of the aromatic amines is between 1.6 and 160 mM, and the concentration of the cation is between 0.4 and 100 mM, and
- the pH of the electrolyte is above 6.7.

2. The electrolyte as claimed in claim 1, characterized in that the copper ions are derived from a compound selected from the group consisting of copper sulfate, copper chloride, copper nitrate and copper acetate.

3. The electrolyte as claimed in one of the preceding claims, characterized in that the concentration of copper ions is between 2 and 6 mM, the sum of the concentrations of the aromatic amines is between 4 and 24 mM, and the concentration of the cation is between 2 and 20 mM.

4. The electrolyte as claimed in one of the preceding claims, characterized in that the combination consisting of the two aromatic amines and the electrochemically inert cation is a suppressor of the electrodeposition of copper.

5. The electrolyte as claimed in one of the preceding claims, characterized in that the alkylammoniums are compounds of formula $(\text{N-R}_1\text{R}_2\text{R}_3\text{R}_4)^+$ in which R_1 , R_2 , R_3 and R_4 represent, independently of one another, a hydrogen or a C_1 - C_4 alkyl, provided that R_1 , R_2 , R_3 and R_4 do not simultaneously represent a hydrogen.

6. The electrolyte as claimed in one of the preceding claims, characterized in that it contains hydrogen carbonate ions (HCO_3^-).

7. An electrochemical process for depositing copper on patterns hollowed-out in a dielectric substrate, the patterns having an opening dimension less than 40 nm, the process being characterized in that it comprises the steps of:

- bringing the surface of the patterns into contact with an electrolyte as claimed in one of claims 1 to 6,
- polarizing the surface of the patterns to an anodic or cathodic electric potential allowing the electrodeposition of copper, so as to form a continuous deposit of copper.

8. The electrochemical process as claimed in claim 7, characterized in that the surface of the patterns is covered with a layer forming a barrier to diffusion of copper, and in that the continuous deposit of copper fills the entire volume of the patterns and comes into contact with the barrier layer.

9. The electrochemical process as claimed in claim 7, characterized in that the surface of the patterns is covered with a layer forming a barrier to diffusion of copper, and in that the continuous deposit of copper is a conformal seed layer that comes into contact with the barrier layer.

10. The electrochemical process as claimed in claim 7, characterized in that

- the dielectric substrate is covered with a layer forming a barrier to diffusion of copper, itself covered at least partially with a copper seed layer with a thickness between 0.5 and 10 nm, and
- the continuous deposit of copper comes into contact with the seed layer and fills the entire volume of the patterns.

11. The electrochemical process as claimed in one of claims 8 to 10, characterized in that the layer forming the barrier to diffusion of copper comprises at least one material selected from the group consisting of cobalt (Co), ruthenium (Ru), tantalum (Ta), titanium (Ti), tantalum nitride (TaN), titanium nitride (TiN), tungsten (W), tungsten titanate (TiW) and tungsten nitride or carbide (WCN), manganese (Mn) and manganese nitride (Mn_3N_2).

12. The electrochemical process as claimed in claim 11, characterized in that the layer forming the barrier to diffusion of copper comprises a stack of

several layers of different materials, including a material forming a barrier to diffusion of copper and a material promoting adhesion of copper.

13. The electrochemical process as claimed in claim 7, characterized in that the patterns have a form factor greater than 2/1, preferably greater than 3/1.

14. The electrochemical process as claimed in claim 7, characterized in that the patterns are trenches or interconnection vias.

15. The electrochemical process as claimed in claim 7, characterized in that it is carried out on a dielectric substrate covered successively - at least in the patterns - with 1) a layer of tantalum nitride with a thickness between 0.5 and 3 nm, 2) a layer of cobalt with a thickness between 0.5 and 3 nm, and 3) a layer of copper with a thickness between 0.5 and 5 nm.

16. The electrochemical process as claimed in claim 7, characterized in that the dielectric substrate is covered successively - at least in the patterns - with 1) a layer of tantalum nitride with a thickness between 0.5 and 3 nm, and 2) a layer of ruthenium with a thickness between 0.5 and 5 nm.