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Effect of Sulfur-Containing Amino Acid Stabilizers on the Surface Morphology of Eco Friendly Electroless Nano Copper Deposition

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Abstract

The impact of sulfur-containing amino alkanoic stabilizers like methionine and cysteine on the ecofriendly electroless nano copper testimony was contemplated. Naturally unsafe complexing specialists, diminishing operators, and pH modifiers were supplanted by sheltered and biodegradable choices like xylitol, glyoxylic corrosive, and KOH individually. Copper methanesulphonate was utilized as opposed to copper sulfate to improve the solvency of the copper salts. The electroless copper bath was streamlined by the expansion of 1 ppm convergence of stabilizers, at 45°C and pH of 13.25 ± 0.25. Both the amino alkanoic corrosive stabilizers were found to quicken the copper testimony rate at advanced conditions, however, restrain when their focuses were expanded. The physical parameters were determined by weight gain and gravimetric techniques. Surface morphology and basic property of nano copper deposits were contemplated by checking microscopy, power microscopy, and X-beam diffraction strategies. Electrochemical and erosion dynamic property of ecofriendly electroless bath was broke down by the Tafel plot. Methionine managed better and more conservative nano copper deposits than cysteine as a stabilizer

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I. INTRODUCTION

Electroless plating is the sort of wet procedure and late strategies utilized in the affidavit of honorable metal [1]-[5]. Since the covering is accomplished through metal particle trade utilizing substance decrease in the arrangement, and there is no covering development on corners and projections [6]-[8]. Copper is the present and future interconnect material and Emerging applications in zones, for example, manufacture of electromagnetic obstruction protecting materials, artistic or polymeric nanoparticles, vitality change, aviation, biomedical and car ventures, and so forth [9]-[11].

Added substances are assuming an imperative job to avert unconstrained deterioration of the bath. The convergence of numerous stabilizer added substances in the electroless copper bath may modify the physical and mechanical properties of the plate during the testimony [12].

In this work, we have utilized sulfur-containing amino corrosive stabilizers, for example, methionine and cysteine in electroless methanesulphonate bath [13]. These stabilizers assume an essential job in cell digestion other than the surface morphology. Both methionine and cysteine have improved physical and electrochemical properties and fundamentally impact the Surface morphology and basic property of nano copper deposits on ecofriendly electroless copper methanesulphonate bath [14]-[16].

II. METHODOLOGY

Table.1. Bath composition of copper methanesulphonate xylitol plain bath with stabilizers

Bath Composition	Plain bath	Stabilizers used bath
CuMS (II) ion contacting salt	3 g/L	3 g/L
Xylitol	20 g/L	20 g/L
Glyoxylic acid	10 g/L	10 g/L

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KOH (*p*H)	13.25± 0.25	13.25± 0.25
Temperature	45 ºC	45 ºC
Stabilizers (Cysteine & Methionine)	0 ppm	1 ppm & 10 ppm

III. RESULTS AND DISCUSSION

The expansion of 1ppm focus methionine and cysteine stabilizers has changed the physical highlights, for example, shading, shape and crystallite size of the nano copper deposits. The statement rate and thickness of the nano copper deposit were determined by utilizing straightforward and standard weight gain and gravimetric techniques. When all is said in done, the quickening and restraining properties of the stabilizers were affirmed and contrasted and the consequence of the testimony pace of xylitol plain bath. The outcomes show that 1 ppm centralization of cysteine and methionine has given higher qualities than the plain bath. Consequently, both went about as the quickening agent at the state of 1 ppm focus. Be that as it may, on account of 10 ppm fixation stabilizers utilized baths shows that the aftereffect of affidavit rate and thickness has a lower an incentive than the plain bath. So that, in this condition the two stabilizers went about as the inhibitor.

The actuation vitality is contrarily corresponding to the pace of copper statement. It might be proposed that expanding the communications on the metal surface outcomes in a decrease of statement rate because of a decrease in synergist locales on the metal surface.

SEM and AFM systems were utilized to analyze and examination of nano copper deposits on the epoxy sheet. Table-2.,table-3, Fig.1. What's more, fig.2 shows that intriguing pictures, for example, rocks, needles, grains, pyramid, bloom shapes saw on 2000 and 5000 amplification on the surfaces. Harshness esteems diminished for methionine as stabilizer due to steric factors however slowly expanded when fixation was expanded to 10 ppm. The nano copper deposits were a dull darker shading for cysteine and brilliant and sparkling for methionine.

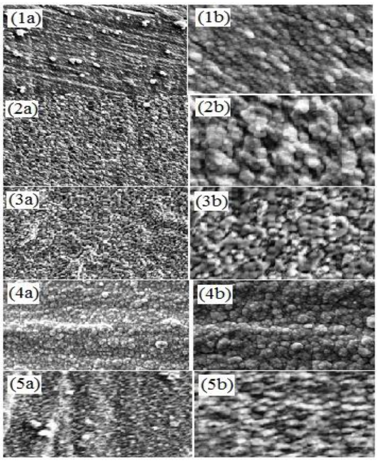

Fig. 1; SEM images of copper deposits on methanesulphonate bath with (a) 2000 and (b) 5000 magnification, (1) xylitol plain bath, (2) Cys (1 ppm), (3) Cys (10ppm) (4) Met 1 ppm), and (5) Met (10 ppm)

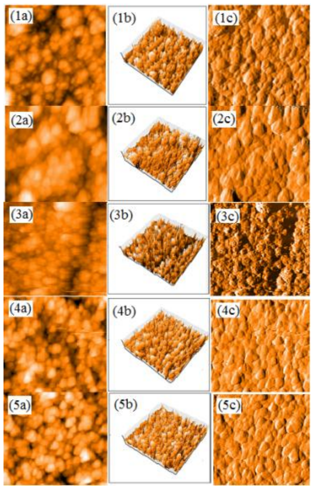

Fig. II:. AFM images of copper deposits on methanesulphonate bath (a) topography of copper deposits (b) 3-D image and (c) surface area; (1a, 1b, 1c) xylitol PB, (2a, 2b, 2c), Cys (1ppm), (3a, 3b, 3c) Cys (10ppm), (4a, 4b, 4c) Met (1ppm), and (5a, 5b, 5c), Met (10 ppm).

Table.2. Surface morphologies of xylitol plain bath with stabilizers (1ppm) concentration

Surface morphologies	**Xylitol plain bath**	**Xylitol plain bath with stabilizer (1 ppm)**	
		Cysteine	**Methionine**
Deposition rate(µm/h)	3.02	3.16	3.36
Thickness (µm)	181.2	191.4	201.6
Roughness value (nm)	216	92	86
Crystallite size (nm)	121	110	98
Shape	Rocks	grains	flowers
Specific surface area(m^2/g)	5.534	6.088	6.833

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Activation energy (kJ/mol)	70.4	76.8	76.1

Table.3. Surface morphologies of xylitol plain bath with stabilizers (10 ppm) concentration

Surface morphologies	Xylitol plain bath	Xylitol plain bath with stabilizer(10 ppm)	
		Cysteine	Methionine
Deposition rate(μm/h)	3.02	2.68	2.86
Thickness (μm)	181.2	160.8	171
Roughness value (nm)	216	118	104
Crystallite size (nm)	121	143	126
Shape	Rocks	needles	pyramids
Specific surface area(m^2/g)	5.534	4.683	5.315
Activation energy (kJ/mol)	70.4	63.6	62.8

Tafel plots used to comprehend the property of consumption current and testimony rate precision on electroless baths. Table.4. furthermore, fig. III shows that the outcomes demonstrate the higher consumption current and testimony rates in 1 ppm grouping of the quickened electroless bath. Yet, the centralization of stabilizers increments to 10 ppm, the erosion current, and statement rates was diminished than the xylitol plain bath. The exploratory aftereffects of testimony rates from the Tafel plots are like a determined physical parameter, for example, the weight gain strategy.

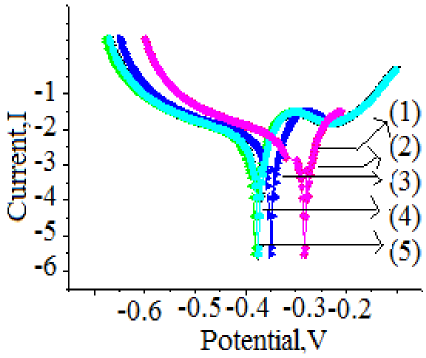

Fig. III: Tafel polarization curve for copper deposits with electroless copper methanesulphonate xylitol bath at pH 13.25 ± 0.25; (1) xylitol plain bath, (2) Cys (1 ppm); (3) Cys (10 ppm), (4) Met (1 ppm), (5) Met (10 ppm)

Table.4. Electrochemical proppeties of xylitol plain bath with stabilizers (1ppm and 10 ppm) concentration

Xylitol plain bathwith stabilizer	β_a mV/ decade	β_c mV/ decade	E_{corr} (mV)	I_{corr} (mA)	Deposition rate (μm/h)
Plain bath	**51.3**	**247.7**	**-441.8**	**41.0**	**0.543**
Cysteine (10 ppm)	133.7	377.5	-432.6	21.1	0.279
Methionine (10 ppm)	93.9	554.5	-489.7	27.8	0.367
Cysteine (1 ppm)	87.2	205.5	-486.8	50.7	0.670
Methionine (1 ppm)	115.0	308.7	-502.1	53.8	0.713

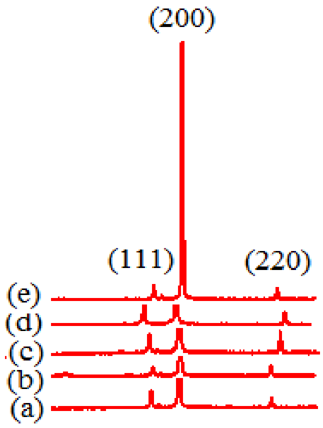

Fig.IV: XRD pattern for copper deposits (a) xyliotol PB;(*b*) Cys (1 ppm); (c) Cys (10 ppm), (d) Met (1 ppm), (e) Met (10 ppm).

The XRD design used to explore crystallite size and explicit surface territory esteems from the Scherrer condition. Table-2, table-3, and fig. IV show that the particular surface territory esteem is relative to line width (FWHM) values and conversely corresponding to the crystallite size. Crystallite sizes are corresponding to hindering effectiveness. Genuine nano copper deposits need to expect in the (111) lower plane. Be that as it may, the nearness of following the amount of methanesulphonic corrosive in the ecofriendly electroless bath has trademark properties of modifying the conductivity and dissolvability, which is some help to move to a higher plane (200).

IV. CONCLUSION

The impact of 1 ppm and 10 ppm convergences of cysteine and methionine stabilizers on xylitol based methanesulphonate bath were examined. The nearness of methanesulphonate, pure nano copper deposits was seen at the higher plane (200) direction. Physical and electrochemical trial methods were

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utilized to describe the surface of saved copper and morphological information bolstered the stabilizers went about as the quickening agents at 1 ppm and inhibitors at 10 ppm. At improved conditions, crystallite size and harshness were found to less than 100 nm. Also, splendid, uniform, fine and pure nano copper deposits were gotten on the extension of methionine (1 ppm) to xylitol baths.

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