

Potential Modulated Electrochemical Synthesis of Monodispersed Metal Nanoparticles on HOPG Surface

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Metal nanoparticles have attracted extensive attention due to their potential utility in optical electro devices, catalysis, and chemical sensor.

In this study, the size-similar metal silver, Nickel and Copper nanoparticles were prepared by potential modulated electrodeposition. First a potential step was used to nucleate metal particles on HOPG electrode surface, where nuclei with a supercritical size were formed. Secondly, a strip peak potential was applied to partially dissolve some of the nucleated metal particles. And then, a growth potential was applied to grow the metal particles slowly so that the diffusion zones of adjacent growth centers did not overlap because of slow growth rate.

The particle density can be determined by the nucleation parameter, overpotential and nucleation time. The effect of deposition parameters on size of metal particle was also studied. The current - time transients may be analyzed according to the theoretical models proposed by Hills and Scharifker model. The electrocrystallization of silver and Nickel on HOPG electrode occurred via "Volmer-Weber" or progressive nucleation and three dimension diffusion controlled growth mode, however, copper electrocrystallization on HOPG electrode occurred via instantaneous nucleation and three dimension diffusion controlled growth mode.

References

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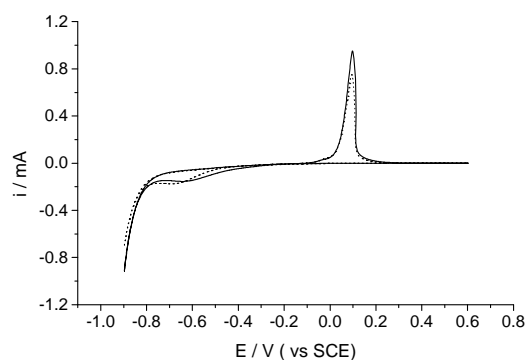


Fig. 1 Cyclic Voltammograms for Cu deposition and dissolution from aqueous 1.0 mM CuSO₄ and 1.0M H₂SO₄, scan rate 100mV/s.

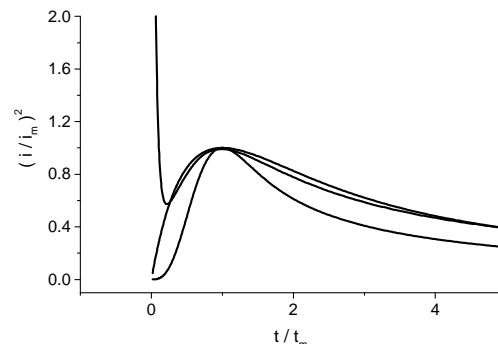


Fig. 2 Non-dimensional $\frac{i^2}{i_m^2}$ vs $\frac{t}{t_m}$ curve

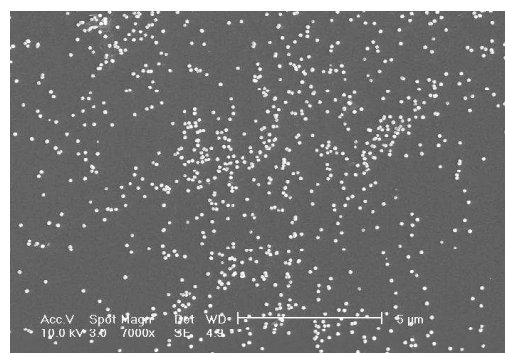


Fig. 3 SEM of Cu particles

E₁=-0.8V, t₁=26ms; E_s=0.082 V, t_s=20 ms ; E₂=-0.31V, t₂=70 s