ECS Journal of Solid State Science and Technology 2020 vol.9 N6

Two-Step Mediated Electrosynthesis and Catalytic Activity of Au/Cu2O@poly(N-vinylpyrrolidone) Nanocomposite

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Abstract

© 2020 The Author(s). Published on behalf of The Electrochemical Society by IOP Publishing Limited. Efficient two-step methylviologen (MV2+) - mediated electrosynthesis of a nanocomposite of gold nanoparticles with copper(I) oxide stabilized by a shell of poly(N-vinylpyrrolidone) (Au/Cu2O@PVP) was performed in DMF at room temperature at the potentials of MV.+ radical cation generation. At the first step, the mediated reduction of Cu2+ ions, generated in situ by dissolution of the copper anode, in the presence of dissolved oxygen or with subsequent oxidation with oxygen, leads to Cu2O@PVP composite containing Cu(0) and Cu2O in a different ratio. In the latter case, the resulting composite is in the form of stable nanoroses. When AuCl is added into the resulting solutions of Cu2O@PVP, the partial chemical reduction of AuCl by Cu(0) occurs to form Au(0) and CuCl. At the second step, the electrochemical reduction of AuCl leads to Au/Cu2O@PVP nanocomposite not containing Cu(0), but nanoroses are preserved. Cu2O@PVP nanoparticles are catalytically inactive in the reduction reaction of p-nitrophenol with sodium borohydride in water, and Au/Cu2O@PVP nanocomposites exhibit catalytic activity. In the presence of cetyltrimethylammonium chloride, the catalytic activity of both types of particles sharply increases; in the case of Cu2O@PVP, the increase is so high that the catalytic activity becomes the same as for Au/Cu2O@PVP.

http://dx.doi.org/10.1149/2162-8777/aba1fc

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