Electrodeposited bimetallic nanoparticles Au/Cu on semiconductor metal oxide substrates

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Abstract

Bimetallic nanoparticles have gained attention as a new class of advanced materials, since they are attractive because of their bifunctionality in contrast with their individual components. Therefore, bimetallic nanoparticles have potential applications in diverse fields, such as catalysis, electrocatalysis, magnetic storage, and photovoltaic cells [1,2]. Nowadays, it has been shown that noble metal nanostructures, deposited on semiconductors metal oxide substrates improve the process of photoexcited electron transfer due to the formation of the Schottky barrier in the semiconductor-metal interface. ZnO is a *n*-type semiconductor with a band gap value of 3.37 eV. However, when ZnO is in contact with noble metals nanoparticles such as Au and Pt, its band gap increases to 5.1 eV and 5.65 respectively [3]. This inhibits the electron-hole pair recombination. On the other hand, the use of bimetallic nanoparticles such as Au/Cu, not only allows the formation of the Schottky barrier, it also offers a new approach to effectively capture energy in the visible and infrared regions of the solar spectrum when used in photoelectrochemical cells [4]. In this work, we electrodeposited Au/Cu nanoparticles by multipulse chronoamperometry on ZnO nanorods surface, which were previously electrodepositated on a glass-indium tin oxide (ITO) substrate. The system was characterized by UV-Vis spectroscopy, which showed a surface plasmon resonance (SPR) at λ_{max}= 580 nm, when the Au is typically observed at λ= 520 nm and Cu at λ= 580 nm (Figure 1). X ray diffraction (XRD) showed the phases corresponding to ZnO, Au and Cu. The presence of Au and Cu in the system was also confirmed by performing a cyclic voltammetry in the potential range of -1 V to 1.8 V vs saturated calomel electrode (SCE) in a 1 M $HClO_4$ aqueous solution, as supporting electrolyte. Au oxidation was observed at E = 1.2 V vs. SCE, while for Cu, it was observed at E_1 = -0.22 V vs SCE and E_2=-0.37 V vs SCE.

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References

[1] Hai, Z. Kolli, N. Bahena, D. Beaunier, P., J. Mater. Chem. A, Vol. 1 (2013)10829-10835.
[2] Chen, S. Jenkins, S. Tao, J., J. Phys. Chem. C, 117 (2013) 8924-8932
[3] Zhang, K.; Ronda, R.; Y Holloway, T., Vol. 7646 76461 p-1-76461 p-7
[4] Rusen, E.; Mocanu, A.; Somoghi, R., Colloid Polym Sci, Vol. 290 (2012) 1937-1942

Figure 1. UV-Vis absorption spectra of the systems ITO/ZnO_{film}, ITO/$ZnO_{nanorods}$ and ITO/ZnO/AuCu.