ABSTRACT

Synthesis of Au-Ag and Au-Pt bimetallic NPs with different Ag: Au and Pt: Au compositions in an aqueous medium and their attachment on glassy carbon electrode (GCE) via 1,6-hexadiamine (HDA) linker for the reduction of hydrogen peroxide (HP), nitrobenzene (NB), dioxygen and oxidation of methanol were described. The Au-Ag NPs and Au-Pt NPs were prepared by the galvanic displacement of Ag(0) and Pt(0) by AuCl₄⁻ ions. The Au-Ag NPs modified electrode showed the limit of detection of 0.12 and 0.23 µM (S/N=3) for HP and NB, respectively.

Direct attachment of Au@Ag and Au@Pt core@shell NPs on GCE and their electrocatalytic activity were studied. Au-Ag NPs was fabricated by catalytic deposition of Ag NPs followed by galvanic displacement of Au NPs. The difference in the thermodynamic reduction potential between Ag(0) and Au³⁺ leads to the reduction of Au³⁺ ions by Ag(0) to deposit Au-Ag NPs. The Au@Pt NPs were fabricated on electrode surface by substrate catalyzed electroless deposition. The composition dependent electrocatalytic activity was realized at Au-Ag NPs and Au-Pt NPs modified electrodes towards the reduction of HP. The sensitivity of the electrode towards HP was found to be 865 and 1306 µA mM⁻¹ cm⁻² for Au-Ag NPs and Au-Pt NPs modified electrodes, respectively. The Au-Pt NPs modified electrode was also exploited for the reduction of dioxygen and oxidation of hydrazine. Simultaneous determination of isoniazid (INH) and theophylline (TP) was achieved at the Au@Pt NPs modified electrode. The Au-Pt NPs modified electrode exhibited higher
electrocatalytic activity towards dioxygen, HP, INH, TP and hydrazine than the bare and AuNPs modified electrodes.

A simple, facile and fast method for the growth of anisotropic Au nanostructures (AuNS) and CuNS on ITO substrate was demonstrated. The growth of AuNS including bipyramidal and wires on solid and solution phases using in-situ electrochemical reduction of Au\(^+\) ions from the growth solution was achieved. It was found that the spherical, bipyramidal and nanowires were grown on ITO substrate after 1, 3 and 6 h, respectively. The greater SERS enhancement was observed at the Au-nanowires grown substrate when compared to spherical and bipyramidal NS due to higher surface coverage. Besides, fabrication of surfactant-free cubic, spherical, dendritic and prickly CuNS on ITO surface by electrodeposition was described and investigated the role of applied potential, deposition time and pH on the morphology of dendritic CuNS. SEM images confirmed that cubic, spherical, dendritic and prickly CuNS were formed at the applied potentials of +0.10, -0.10, -0.30 and -0.50 V for 400 s, respectively in the presence of 10 mM CuSO\(_4\) containing 0.1 M H\(_2\)SO\(_4\). The dendritic CuNS modified electrode effectively catalyzed the oxidation of glucose and hydrazine when compared other NS.

Further, the Au-Pt bimetallic NPs were fabricated on both SWCNTs and FMWCNTs by electroless deposition and studied their electrocatalytic activity towards the oxidation of glucose and methanol and the reduction of HP. Initially, a jungle-gym structured film of SWCNTs was synthesized on the gold wire substrate by catalytic chemical vapor deposition and the fabrication of Au-
PtNPs on SWCNTs was achieved by electroless deposition method. Functionalized-MWCNTs (FMWCNTs) were fabricated on GCE by chemical attachment using 1,8-octadiamine (OD) and N, N’-Dicyclohexylcarbodiimide (DCC). The Au-PtNPs were then attached on the FMWCNTs by substrate catalyzed electroless deposition. The homogeneously deposited thin layer of PtNPs over the SWCNTs/AuNPs (Au-20 and Pt-20 nm) electrode effectively catalyzed the glucose oxidation whereas a thick layer of Au-PtNPs (Au-20 and Pt-30 nm) on SWCNTs effectively catalyzed hydrogen peroxide reduction when compared to SWCNTs and SWCNTs/AuNPs electrodes. The FMWCNTs/Au-PtNPs showed excellent long-term stability and superior electrocatalytic activity towards methanol oxidation than FMWCNTs and Au-PtNPs modified electrodes.

The preparation of nitrogen-doped graphene oxide (N-GO) by intercalating melamine into GO and attach them on GCE via Michael’s reaction followed by its electrochemical reduction and electroless deposition of Au-PtNPs were studied. The modified electrode was utilized for the oxidation of rutin (RT) and quercetin (QR). The NG/Au-PtNPs modified electrode showed better electrocatalytic activity when compared to bare and NG electrode. Further, the comparison of the different bimetallic nanoparticles and their composites towards the reduction of HP was discussed. It was found that the electrocatalytic activity is not only depending on the composition of the bimetallic NPs but also the nature of the substrate in which they were immobilized.