PROCEEDINGS OF THE INTERNATIONAL CONFERENCE
NANOMATERIALS: APPLICATIONS AND PROPERTIES
Vol. 4 No 2, 02NNSA04(2pp) (2015)

AFM Investigation of Epoxy Fracture Surfaces Indicating Nanoplasticity

Khadijeh Eskandaria[1], Hedayatollah Ghourchian[2]

[1] *Nanobiotechnology Research Center, Baqiyatallah University of Medical Science Tehran, Iran*
[2] *Laboratory of Microanalysis, Institute of Biochemistry & Biophysics, University of Tehran, P.O. Box 13145-1384, Tehran, Iran*

(Received 13 May 2015; published online 22 August 2015)

Noble metal nanoparticles have a great potential for biological study, especially the use of gold nanoparticles is very popular. In this work gold nanoparticles (GNPs), silver nanoparticles (SNPs) and gold-silver hybrid nanoparticles (HNPs) synthesized and used as a carrier for electrochemical investigation of redox protein. Optical characterization of these nanoparticles was performed by UV-Vis spectroscopy. The maximum of the plasmon band for GNPs, SNPs and HNPs (ratio of 1:1) are 524, 392 and 455 nm respectively. The optical absorption spectra of HNPs solution shows only one plasmon absorption, it is concluded that mixing of gold and silver leads to a homogeneous formation of alloy nanoparticles. LCR meter study shows the HNPs is best conductance in compare of GNPs and SNPs. Therefore, the electron transfer of the homogenous GO_x, HRP and Hb was investigates by electrochemical method in presence of HNPs. They demonstrated quasi-reversible cyclic voltammograms with a formal potential of -479, -178 and -168 mV in 50 mM phosphate buffer solution at pH 7.4 respectively.

Keywords: Gold nanoparticles (GNPs), Silver nanoparticles (SNPs) and Gold-silver hybrid nanoparticles (HNPs).

PACS numbers: 62.25.g, 68.37.Ps

1. INTRODUCTION

The intense research in the field of nanoparticles by chemists, physicists, and materials scientists is motivated by the search for new materials in order to further miniaturize electronic devices as well as by the fundamental question of how molecular electronic properties evolve with increasing size in this intermediate region between molecular and solid-state physics. Also metal nanostructures attract much interest because of their unique properties, including large optical field enhancements resulting in the strong scattering and absorption of light. Alloy nanoparticles, on the other hand, have mainly been studied because of their catalytic effects [1].

2. RESULTS AND DISCUSSION

2.1 Nanoparticles characterization

Gold and silver nanoparticles have strong surface plasmon giving an absorption peak in the visible region of the electromagnetic spectrum. As shown in Fig.1 the maximum absorption peak of GNPs and SNPs are 524 and 392 nm. Also HNPs with the ratio of at 1:1, 1:2 and 2:1 gold to silver exhibit maximum absorption band at 465, 431 and 496 nm respectively. The optical absorption spectra HNPs show only one Plasmon absorption it is demonstrate that mixing of gold and silver leads to a homogeneous formation of alloy nanoparticles. So the absorption peak became broad and shifted to longer wavelength, with increasing molar ratio of $HAuCl_4$.

2.2 Conductivity measurements of nanoparticles

The conductivity change of GNPs, SNPs and HNPs in different days was shown in Fig. 3. These results demonstrated that the SNPs have a significant conductivity change, because silver is prone to oxidation. In

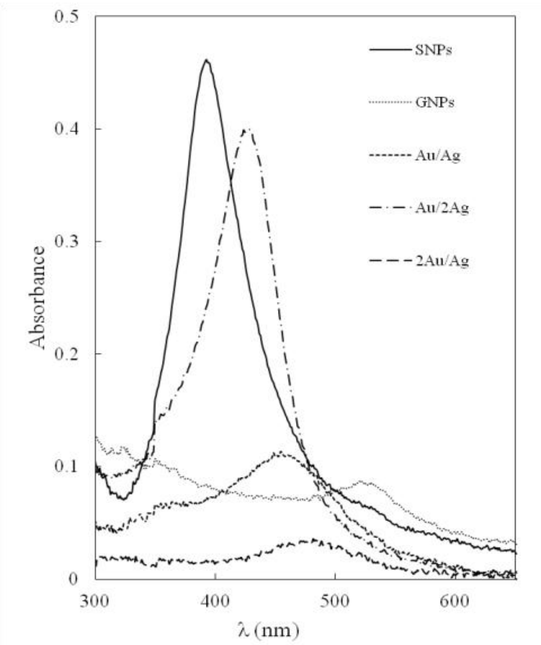

Fig. 1 – UV–Vis absorption spectra of GNPs, SNPs and HNPs (with ratio of 1:1, 1:2 and 2:1 gold to silver).

fact the equilibrium electrode potential of silver is +0.799 V. This value is only 0.01 V more negative than the equilibrium potential of an oxygen electrode in natural environments, so silver is susceptible to giving electrons to oxygen. Silver can still be thermodynamically oxidized by atmospheric oxygen at normal temperatures. At standard temperatures and pressures (STP), this thermodynamically equilibrium was occurred:

$$2Ag + O_2 \longrightarrow 2AgO \quad (1)$$

Moreover, although the conductivity of GNPs is 1.8

time less than of SNPs, but it is almost constant with time. This results show the HNPs with the ratio of 1:1 has a less conductivity change and in finally has a highest conductivity, so it selected for next test.

2.3 Electrochemical investigation

The cyclic voltammograms (CVs) of homogenous, HNPs, SPNs + GO_x, GPNs+GO_x and HPNs + GO_x on CNT/GC electrode in 50 mM pH 7.4 PBS were shown in Fig. 2. It's obviously that the only GOx without nanoparticle and nanoparticle without GOx have no response and SPNs + GO_x is also. In fact a nanoparticle as an electron-transporting shuttle was caused to facilitate of electron passing between redox active site and electrode. Thus the GO_x have a direct electron transfer in presence of GNPs and HNPs. but as can be seen in Fig. 2, the redox response of HPNs + GO_x is stronger than of GPNs + GO_x, due to of high conductivity shown by LCR meter result. on the other hand Although silver is best conductor among the metals, but the ESR study of Ag nanoparticles indicates the existence of free radicals from Ag nanoparticles, thus it can be said that the oxidation pathway is associated with the production of radicals which are causing to protein oxidation. It can lead to hydroxylation of aromatic groups and aliphatic amino acid side chains, nitration of aromatic amino acid residues, nitrosylation of sulfhydryl groups, sulfoxidation of methionine residues, chlorination of aromatic groups and primary amino groups, and to conversion of some amino acid residues to carbonyl derivatives. Oxidation can lead also to cleavage of the polypeptide chain and to formation of cross-linked protein aggregates. Furthermore, functional groups of proteins can react with oxidation products of polyunsaturated fatty acids and with carbohydrate derivatives (glycation/glycoxidation) to produce inactive derivatives. Therefore the GO_x no have electrochemical response in presence of SPNs. However, it was reported that gold GNPs could adsorb redox proteins (proteins) without loss of their biological activities, but its weak conductive in compare of silver, that causing to low electrochemical response as shown in Fig. 2. according of LCR meter results, the HNPs has a highest conductivity, so HNPs has been used for study of the direct electron transfer of proteins, because in HNPs, gold sector with having a good biocompatibility and capability of protein absorption was caused to safety of proteins structure and its concentrates in nanoparticles surface and moreover the silver sector facilitate electron transfer and in result amplification of electrochemical response. The formal potential of GPNs + GO_x and HPNs + GO_x is -477 and -479 mV respectively. The formal potential (E^0) has been calculated by average of the cathodic and anodic peak potential [2]. It was obvious that GO_x in presence of HNPs is exhibited excellent redox properties for high conductivity of HNPs. Therefore, the HNPs with having of highest conductivity and electrochemical response are best substrate for electron transferring of redox proteins.

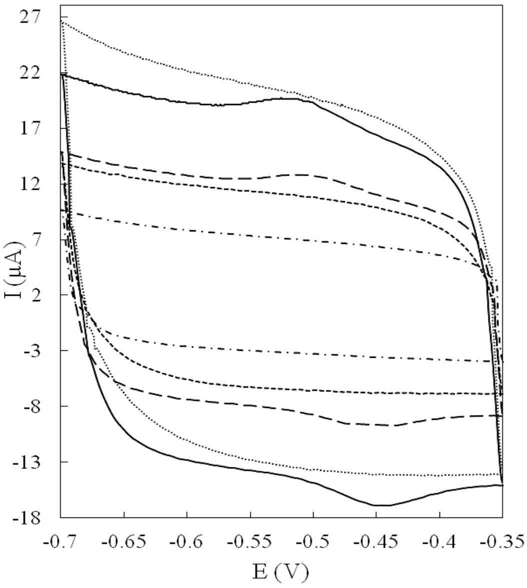

Fig. 2 – Cyclic voltammograms of homogenous GO_x (-⊙-⊙-), HNPs (···), SPNs + GO_x (---), GPNs + GO_x (– – –) and HPNs + GO_x (—) on CNT/GC electrode in 50 mM pH 7.4 PBS at 50 mV/s.

3. CONCLUSION

In this paper different noble metal nanoparticles synthesized and changes in protein structure and redox property was investigated in nanoparticles presence. it is clearly shows in hybrid nanoparticles we used advantage of multiple nanoparticles. Also it shows although the SNPs have a highest conductivity in first, but the process of decreasing of its conductivity is high too. Moreover unlike SNPs, the conductivity of GNPs is least but it has a minimal change in time.

REFERENCES

1. S. Link, Z.L. Wang, M.A. El-Sayed, *J. Phys. Chem. B.* **103** 3529 (1999).
2. P. Rahimi, H.A. RafieePour, H. Ghourchian, P. Norouzi, M.R. Ganjal, Biosens. *Bioelectron.* **25**, 1301 (2010).