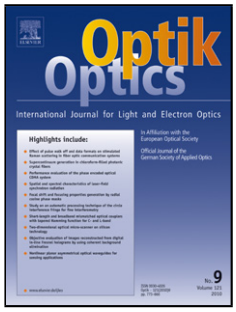

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PII: S0030-4026(17)31268-8
DOI: https://doi.org/10.1016/j.ijleo.2017.10.061
Reference: IJLEO 59797

To appear in:

Received date: 11-7-2017
Accepted date: 10-10-2017

Please cite this article as: Uday Muhsin Nayef, Intisar Mohammed Khudhair, Ullrich Pietsch, Synthesis of Gold Nanopartiles Chemically Doped with Porous Silicon for Organic Vapor Sensor by Using Photoluminescence, Optik - International Journal for Light and Electron Optics https://doi.org/10.1016/j.ijleo.2017.10.061

Synthesis of Gold Nanopartiles Chemically Doped with Porous Silicon for Organic Vapor Sensor by Using Photoluminescence

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Abstract

Gold nanoparticles (AuNPs) were formed by applying the seed-growth where use reducing and capping agent we found the size of nanoparticle depended on the amount of the seed that added to growth solution. AuNPs are incorporated into porous silicon (PS) that was prepared using the electrochemical etching technique. In this study, the influence of gold colloids on PS characteristics has been investigated. Different colloidal solution of gold colloid has been characterized by UV-Vis, then using the solution to dope PS by electrochemical etching. The influences of gold colloid with PS characteristics have been investigated. The morphology after noble metal modification was exhibited by atomic force microscopy (AFM) and the study of structural properties by using X-ray diffraction (XRD) was also carried out, while, Fourier Transform Infrared (FTIR) characterization techniques proved the oxidation of PS substrate. We also found that the PL intensity is depended on concentration of AuNPs and affected by organic vapor chemical. It has been found that the PL spectrums of PS doped with AuNPs improved the PL intensity.

***Keyword*:** gold nanoprticles; porous silicon; Photoluminescence; organic vapor sensor.

Introduction

Gold colloidal "nanogold" can be define as suspension (colloid) of nanometer sized particle of Au in aqueous environment [1-2]. There are two types of environment water and organic solvent [3]. Advantage water-AuNPs is single step, simple, good solvent for many metal ions. Shape control of NP is easy, and the interest advantage is bio-conjugation of AuNPs with enzymes and DNA is easily accomplished [2].

Gold nanoparticles (AuNPs) can be prepared by different methods such as physical irradiation method, laser ablation, electrochemical...etc, chemical method, chemical reduction, sol-gel,...etc, and biological method, microorganisms, plants [4-6]. Chemical reduction method is extensively used for many reasons such as easy to prepare nanoparticle (require simple equipment), accuracy, NPs-solution is stable and can prepare large quantities of NPS [7-9]. The basic mechanism of this method is metal salt ion which is reduced to colloidal metal (formed NP metal) by reducing agent and stabilizing agent to prevent the NPs from aggregate to large particle. Some of these type of reducing and stabilizing can use citrate ion, sodium borohydride, phosphorus, phosphonium chloride, ascorbic acid, cetyltrimethyl ammonium bromid-CTAB,...etc [10-11]. One method to produce colloidal AuNPswhich is Seed-Growth, S-G includes two steps to prepare the NPs,the first step is known as "seed solution". In this step metal salt ($HAuCl_4$) will be reduced by trisodium citrate($Na_3C6H_5O_7$), Sodium borohydride ($NaBH_4$) in water to create small spherical particle. The second step is known as "growth solution" containing more Au salt reduced with Ascorbic Acid (AA) and surfactant stabilizer (CTAB). Then seed is add to growth to serve as nucleation for further growth of NPs, the final size is determined by size of seed and amount of ion to be reduced on them [12-14]. We can produce different shape from this method by the change of the preparation parameter of some of these shapes is nanosphere, nanostare, nanorod, nanoprism, nanocube, nanotriangles and many other shapes [15]. AuNP possesses various properties dependent on shape and size [16]. The physical and chemical properties are strongly affected by the size, shape, local environment and aggregation state [17-18]. These properties are different from the bulk, because these unique properties make us use the gold nanoparticle in many fields such as using AuNPs in biological applications because is chemically stable leading to less side effect in body (low toxicity) [19,13]. Also AuNPs used to improve sensor that based on PS when it doped with the last material, where PS is most attractive host platform to produce sensor because it has large surface area to volume ratio, simple to fabricate and can control the pore size by controlling the parameter of fabrication [20-21]. PS can be formed by electrochemical etching of crystal silicon with fluoride solution [22]. We can dope AuNPs with PS for two reasons. Open structures allows to doping and large surface area allows easy penetration into the PS [23]. Doping changed the optical properties of PS where PL is achieved with higher intensity where AuNPs will fill up pores of PS that lead to enhanced PL [24].

In this study, effects of the organic vapors on PL spectra of AuNPs with PS were investigated. Possibility of optical organic vapor sensor based on PS covered with AuNPs was explored.