ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Red shift in the Surface Plasmon Resonance of the Gold nanoparticles by using Sodium Chloride and hydrogen chloride solutions

Zakariya Yahia[1]*, Raad M. S. Al-Haddad[1], Abdul Kareem Al-Kazaz[2]
[1]Department of Physics, College of Science, University of Baghdad, Baghdad, Iraq
[2]Department of Biotechnology, College of Science, University of Baghdad, Baghdad-Iraq
***Corresponding author: E-Mail: zak_bits_2008@yahoo.com**

ABSTRACT

The purpose of this study is to synthesis the gold nanoparticles (AuNPs) and shift in its surface plasmon resonance (SPR) to the near infrared (NIR) region of spectrum by using chemical methods. The AuNPs solution is prepared by citrate reduction method and a solution of Sodium Chloride is added to it, then two volumes of Hydrogen Chloride solutions are added individually. The results showed a red shift in the absorbance of SPR from 524nm to the 715nm, 721nm and 725nm.

KEY WORDS: Red shift, SPR, HCl, NaCl, NIR, AuNPs, chemical method.

1. INTRODUCTION

One of applications of gold nanotechnology was in medical fields and used with an external source of energy such as near infrared (NIR) laser where Gold nanoparticles (AuNPs) absorb the light as a heat source to heat up and ablate tumors. That means there is an a lethal amount of energy (lethal doses) applied in the cancer cells (Marsh, 2009). The surface plasmon resonance (SPR) is an optical property of gold nanoparticles. This unique phenomenon of noble metal leads to strong electromagnetic fields applied on the surface of the particle and enhance the optical properties such as absorption (Xiaohua Huang, 2010). Gold nanoparticles (AuNPs), among nanoparticles materials show special characterestic in this field due to the physical properties: the high ratio between surface area and volume (surface area to volume) and small size (Khan, 2014). The purpose of this work is to use a fast and simple method - in the same time (Wolfgang Haiss, 2007), to synthesize the gold nanoparticles and shift the absorption of surface plasmon resonance (SPR) to the near infrared region (NIR). There are many developed methods in synthesizing the AuNPs and one of these method is the chemical procedure (Monic Shah, 2014). Where the AuNPs shifted from visible region to unvisible one (red shift) which attributed to the oscillation of the surface plasmon of free electrons (Mohamed Anwar, 2012). However, the 800 nm (near infrared, NIR) is the optimal wavelength is used for the best penetration in the tissue by gold nanoparticles where the absorption of hemoglobin is decreasing predominantly and the absorption of water is increasing, forming a ‘‘tissue window’’ transmission by assistant of Sodium Chloride (NaCl) and hydrogen chloride (HCl) solutions (James, 2014). To study the effect of using chemical materials in the Surface Plasmon Resonance of the Gold nanoparticles is prepared by chemometric technique (Soheila Honary, 2013), where the gold particles and Sodium Chloride and hydrogen chloride are solutions (Tapan, 2001). The main target is to synthesize gold nanoparticles in aqueous solution by using chemical reduction methods (Zhao Jingyue, 2015), Chloroauric acid ($HAuCl_4$) the source of AuNPs and Trisodium citrate dihydrate ($Na_3C_6H_5O_7$) the reducing agent (Ahlam Jameel Abdulghani, 2014). The major step in synthesizing AuNPs is reducing the gold ions (Au^{1+} or Au^{3+}) to (Au^0) neutral atoms with a strong reducing agent (Ratul Kumar Das, 2012). In this chemical technique Trisodium citrate dihydrate (reducing agent) is used to stop the growth of the gold nanoparticle at the nano scale and Capping as well to prevent aggregation (Susie Eustis, 2006).

2. EXPERIMENTAL METHOD

Materials: Chloroauric acid ($HAuCl_4$), distilled water, Trisodium citrate dihydrate ($Na_3C_6H_5O_7$), Sodium Chloride (NaCl) and Hydrogen Chloride (HCl) of 0.1N.

Synthesis of AuNPs: Mix 1g of Chloroauric acid with 50ml and 1g of Trisodium citrate dehydrate with 100ml of distilled water. Add 150µL from Chloroauric acid solution to the 49.85ml of distilled water and heat it without stirring at 100°C, when the solution start evaporating add 500µL of Trisodium citrate dehydrate solution with stirring till the color of solution turned to red and then cool it.

Procedure: Add 0.5g of Sodium Chloride to 10ml of distilled water then add 750µL of this solution and 50µL of Hydrogen Chloride solution of 0.1N to 2ml of AuNPs solution, respectively. Repeat the procedure by adding 100µL of Hydrogen Chloride instead of 50µL.

3. RESULTS AND DISCUSSION

In this work an UV-visible spectrophotometer is used to show the effect of HCl and NaCl on the absorbance of surface plasmon resorance of gold nanoparticles, first the gold nanoparticles was synthesized chemically and it shows the SPR at λ = 524nm in the visible region see fig.1, then a Sodium Chloride solution (750µl) added to the AuNPs solution (2ml) and the result is a shift in red region in the surface plasmon resonance at λ= 715nm in near infrared region (closer to 800nm) (James, 2014), and the absorbance is decreased see fig.2.

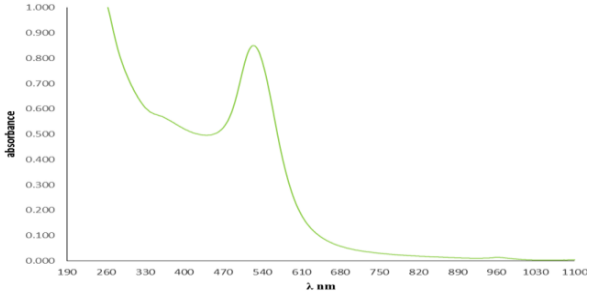

Fig.1. The SPR of AuNPs in visible region at λ= 524nm

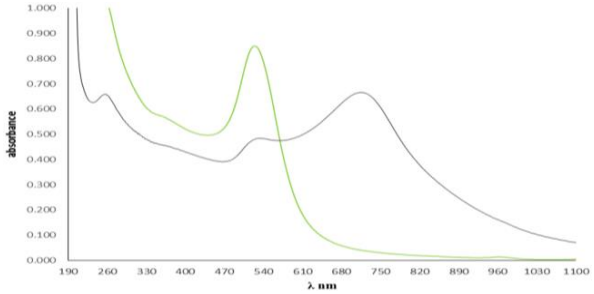

Fig.2. The SPR of AuNPs was shifted to the red region at λ= 715 nm

green curve is the AuNPs Solution while black curve represent the effect of NaCl solution on SPR of AuNPs

In this step a hydrogen chloride solution (100µl) is added to a previous solution of gold nanoparticles and Sodium Chloride solutions and repeat the same procedure with 50µl of hydrogen chloride solution (half the previous one), fig.3, shows the effect of hydrogen chloride solution, it reduce the absorbance and increase the red shift of surface plasmon resonance of gold nanoparticles towards near infrared region at λ = 721nm (HCL = 100µl) and at λ = 725nm (HCl = 50µl).

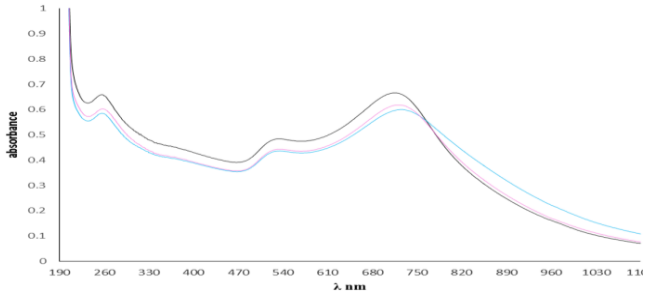

Fig.3. The effect of HCl volume on SPR of AuNPs, black curve represents NaCl (750µl)

Pink and blue curves represent 100µl and 50µl of HCl, respectively

Although the hydrogen chloride solution reduces more the absorbance of gold nanoparticles but The volume of hydrogen chloride solution directly proportional to the absorbance of AuNPs, when the volume increased the absorbance increased and inversely proportional to the red shifting. As a result, the Sodium Chloride solution has a good effect in increasing the shifting towards red region but reduce the absorbance of AuNPs comparing to hydrogen chloride solution. Fig.4, shows the red shifting under the effect of Sodium Chloride and hydrogen chloride solutions on absorbance and surface plasmon resonance of gold nanoparticles.

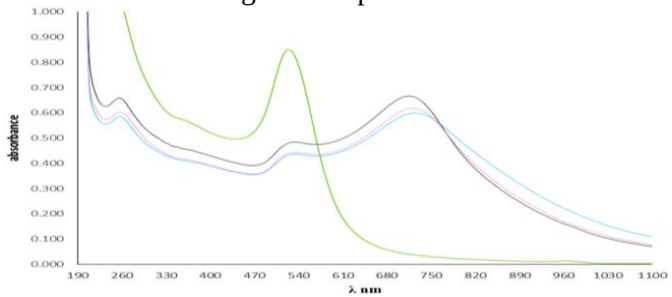

Fig.4. The effect of NaCl and HCl solutions on absorbance and SPR of AuNPs

4. CONCLUSION

A red shift in the surface plasmon resonance of gold nanoparticles can be achieved to the near infrared by adding Sodium Chloride solution and the absorbance has decreased. Hydrogen Chloride solution is used as an assistant factor to the Sodium Chloride to increase the shifting towards near infrared with more loss in absorbance, it can reduce this by increasing the volume of Hydrogen Chloride solution but the shifting will be less.

REFFERENCES

Ahlam Jameel Abdulghani, Rasha K. Hussain, Synthesis of Gold Nanoparticles Via Chemical Reduction of Au (III) Ions by Isatin in Aqueous solutions Ligand Concentrations and pH Effect, Baghdad Science Journal, 11 (3), 2014, 1201-1216.

James F. Hainfeld, Michael J. O'Connor, Ping Lin, Infrared-Transparent Gold Nanoparticles Converted by Tumors to Infrared Absorbers Cure Tumors in Mice by Photo thermal Therapy, PLOS ONE, 9 (2), 2014.

Khan AK, Rashid R, Murtaza G, Zahra A, Gold Nanoparticles Synthesis and Applications in Drug Delivery, Tropical Journal of Pharmaceutical Research, 13 (7), 2014, 1169-1177.

Marsh M, Schelew E, Wolf S, & Skippon T, Gold Nanoparticles for Cancer Treatment, PHYS 483 - Queen's University, Kingston, 2009.

Mohamed Anwar K Abdelhalim, Mohsen M. Mady, Magdy M. Ghannam, Physical-properties-of-different-gold-nanoparticles-ultraviolet-visible-and-fluorescence-measurements, J. Nanomed Nanotechol, 3 (3), 2012.

Monic Shah, Vivek Badwaik, Yogesh Kherde, Gold nanoparticles various methods of synthesis and antibacterial applications, Frontiers in Bioscience, 19, 2014, 1320-1344.

Ratul Kumar Das, Nayanmoni Gogoi, Punuri Jayasekhar Babu, The Synthesis of Gold Nanoparticles Using *Amaranthus spinosus* Leaf Extract and Study of Their Optical Properties, Advances in Materials Physics and Chemistry, 2, 2012, 275-281.

Soheila Honary, Pouneh Ebrahimi, Maedeh Ghasemitabar, Preparation of Gold Nanoparticles for Biomedical Applications Using Chemometric Technique, Tropical Journal of Pharmaceutical Research, 12 (3), 2013, 295-298.

Susie Eustis, Mostafa A. El-Sayed, Why gold nanoparticles are more precious than pretty gold Noble metal surface plasmon resonance and its enhancement of the radiative and nonradiative properties of nanocrystals of different shapes, Chem. Soc. Rev., 35, 2006, 209-217.

Tapan K. Sau, Anjali Pal, N.R. Jana, Z. L. Wang, Tarasankar Pal, Size controlled synthesis of gold nanoparticles using photochemically prepared seed particles, Journal of Nanoparticle Research, 3, 2001, 257–261.

Wolfgang Haiss, Nguyen T.K. Thanh, Jenny Aveyard, David G. Fernig, Determination of Size and Concentration of Gold Nanoparticles from UV-Vis Spectra, Analytical Chemistry, 79 (11), 2007, 4695-4700.

Xiaohua Huang, Mostafa A. El-Sayed, Gold nanoparticles Optical properties and implementations in cancer diagnosis and photothermal therapy, Journal of Advanced Research, 1, 2010, 13–28.

Zhao Jingyue, Friedrich Bernd, Synthesis of Gold Nanao particles via Chemical Reduction Methods, Nanocon, 2015.