Journal of University of Anbar for Pure Science (JUAPS)   Open Access

Studying of Surface Enhanced Raman Scattering (SERS) spectrum of Ag nano thinfilm with Rhodamine6G and Graphen oxide.

Nasrin N. Jmail*   **Qassim M.J. AbdulAziz***   **J.H Rice****

* University of Anbar - College of science
** UCD - College of science- School of physics- Ireland.

A R T I C L E   I N F O

A B S T R A C T

Ag nano thinfilm with thickness 10 nm prepared on the clean coverslips glass, was done by using deposition vacuum system and the surface morphology done by atomic force microscopy (AFM). Nd-YAG (532 nm) green laser and a 50x objective was used as a excitation source. Composites of Rh6G, GO and silver nano thinfilm showed a good substrate for SERS signals. Strong SERS signals indicating match the energy levels of materials interacting with each other and increase the free electrons in external shells, depending on the quantum mechanics.

Introduction

Surface Enhanced Raman Spectroscopy (SERS) is a Raman Spectroscopic (RS) technique that provides greatly enhanced Raman signal from Raman-active analyte molecules that have been adsorbed onto certain specially prepared metal surfaces. Increases in the intensity of Raman signal have been regularly observed on the order of 10^4-10^6, and can be as high as 10^8 and 10^{14} for some systems. The importance of SERS is that it is both surface selective and highly sensitive whereas RS is neither. RS is ineffective for surface studies because the photons of the incident laser light simply propagate through the bulk and the signal from the bulk overwhelms any Raman signal from the analytes at the surface. SERS selectivity of surface signal results from the presence of surface enhancement (SE) mechanisms only at the surface. Thus, the surface signal overwhelms the bulk signal, making bulk subtraction unnecessary[1,2,3].

The optical and electronic properties of metal in nano scale have made them ideal for applications in many fields such as bioscience, nanophotonics, and nanoelectronics[4]. Silver NPs have attracted large research efforts as their properties strongly depend on the particles, size, shape, surrounding medium, and aggregation state2.

Silver nanoparticles are widely used in surface enhanced Raman scattering (SERS) spectroscopy because of high local field enhancement factor. For this purpose, silver nanoparticles can be dispersed in solution or formed on the substrates[5,6,7,8,9].

The goal of this work is to find a formula based on silver nano thinfilm , Rhodamine6G(Rh6G) and Graphen Oxide (GO) particles with high absorbance within visible–near infrared of spectrum to build a high efficient solar cell .The origin of these phenomena is largely due to an enhanced electromagnetic (EM) field at the metal substrate surface due to surface plasmon .

Material and methods

Rh6G with low concentration 10-5 M was done, 0.040g from Rh 6G, bronze/red powder, from ACROS ORGANICS Co., fig(1 a), was dissolved in 100mL of methanol to obtain a pink color solution as with water. Rhodamine 6G chloride, bronze/red powder with the chemical formula $C_{27}H_{29}ClN_2O_3$ properties as in table(1).

* Corresponding author at: University of Anbar - College of science

.E-mail address:

Table(1) Rhodamine 6G chloride properties.

Rh6G chloride properties	
Chemical formula	$C_{27}H_{29}CIN_2O_3$
Molar mass	479.02 g/mol
Appearance	bronze/red powder
Density	1.26 g/cm^3
Solubility in water	20 g/l (25 °C)
Solubility in methanol	400 g/l

Graphen oxide (GO) with concentration 2mg/ml dispersion in water from AL- DRICH, Co. GO appearance is brown to very dark brown and black. Physical state for GO is liquid.Silver nanolayer with thickness 10nm on the clean coverslips glass, was done by using deposition vacuum system.

Sample Deposition

To show the effect of chemical interaction of chemical materials that are used in this work , we tried to deposit materials in different procedures as showed in next section.

Results and discussion

The SERS enhancement of Rh6G on Ag nanoparticles was studied. GO as a good material for SERS when combined with metal nanoparticles. Ag nano thinfilm as a substrate and Rh6G as a probe molecule. Since Rh6G is fluorescent dyes that can be detected easily, its concentration had to be reduced in order to enhance Raman signals as much as possible. All experiments were carried out at room temperature in the same conditions. Ag nanoparticles show unique properties due to localized surface plasmon oscillation in the Vis-UV region . The effect of the surface plasmon oscillation of Ag nanoparticles on excitation of Rh6G molecules bound at the Ag surface is quite interesting.

In this work the solid state Nd-YAG (532 nm) green laser and a 50x objective was   used . The laser source used as a source of excitation. It is made from features of ultra compact long lifetime, low cost and easy to operate. The laser power supply model no. LD-WL206, input : 85~264V , AC , 47~ 63HZ , 0.4A with 200mW and it is counties wave(CW)   from DPSSL DRIVER, MGL-III, 12097360. The system setup of Surface Enhance Raman Scattering, fig.(1).
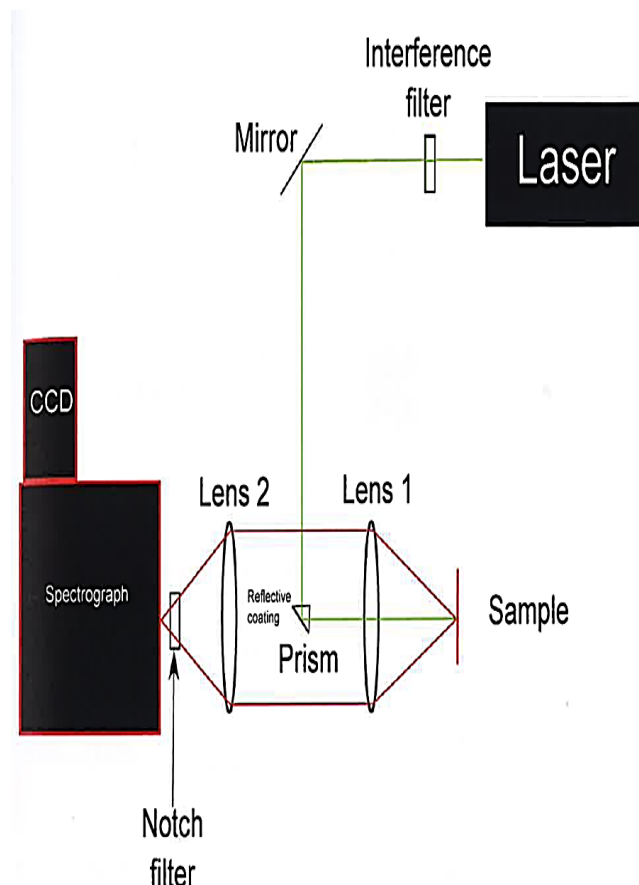

Fig(1) Schematic of SERS system.

SERS spectra for Ag nanolayer centered in Rh6G solution with concentration 10^{-5}M ,dissolved in methanol all over the night,(sample 1),   shows several strong peaks that indicate the role of surface plasmon for Ag nano thin film when combined with Rh6G. The molecule of the Rh6G binds to the metal surface of Ag nano thinfilm, Rh6G, probe and a highly fluorescent dye that is used for investigating surface-enhanced Raman spectroscopy (SERS) enhancement activity on Ag substrates.
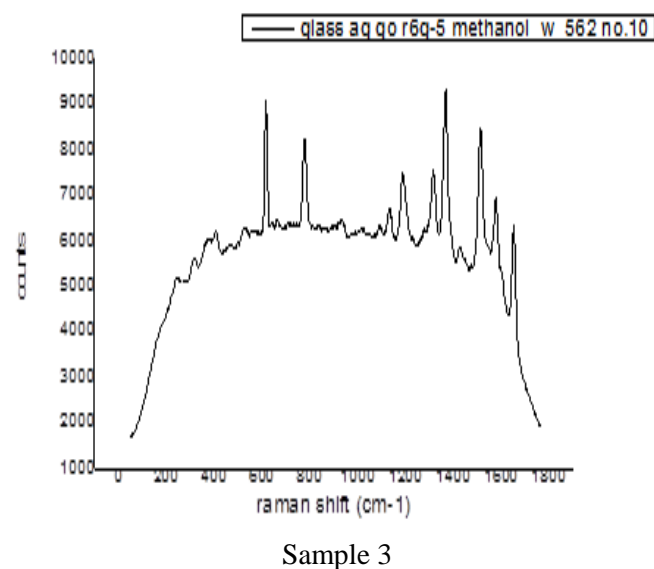
Sample 1
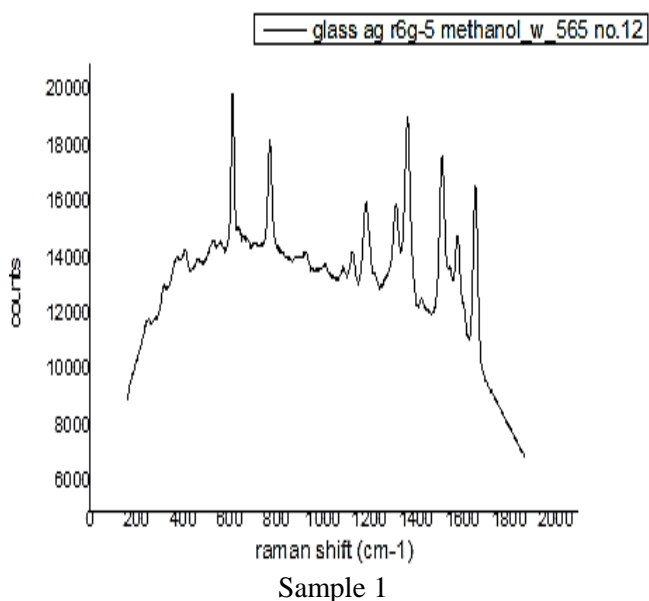
In general , the combine Ag nano thinfilm with Rh6G, dissolved in methanol, can be used as a very good substrate for applications that need a strong SERS spectra.

We tried to change the way of adding Rh6G to show if there is any effect of adding way. Instead of dropping Rh6G on Ag nano thin film we immersed the glass substrate in Rh6G all over the night, to give a long time for chemical interaction between Ag nano thinfilm and Rh6G, and after that let it to be completely dried to measure the SERS signal in this case, sample 2.
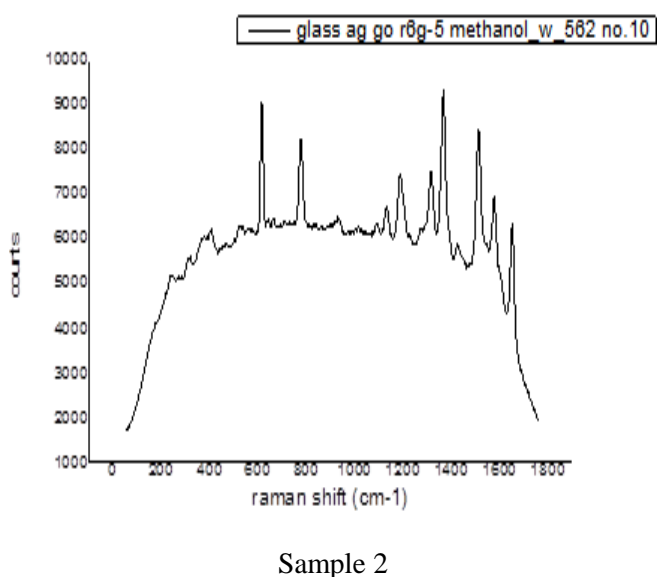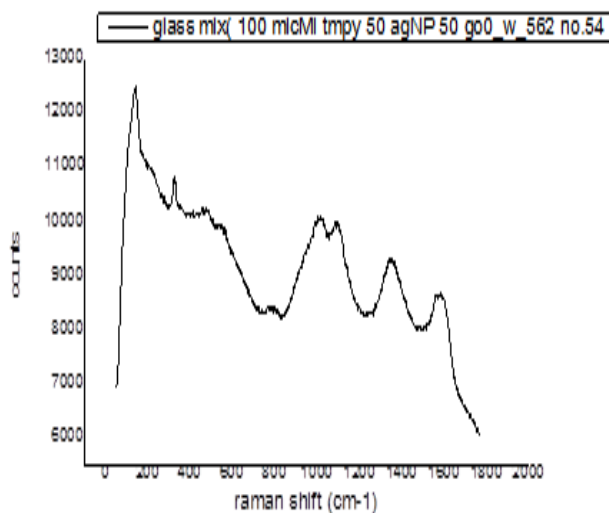

Sample 2

A very strong SERS spectra, as in previous sample, but with low intensity and long shifting . This mean that is the long chemical interaction's time less chemical enhancement for the surface plasmon that created by combine Ag nano thinfilm and Rh6G.

In this work, we wanted to show the role of combined silver nano thinfilm , graphen oxide and Rh6G. So, 20 μ mole from graphen oxide dropped on Ag nanolayer and then left it to be completely dried and after that dropped 20 μmole   Rh6G with concentration 10^{-5}M , dissolved in methanol, and also let it to take some hours to be dried, sample 3.

Sample 3

This sample shows schematically the location of different plasmon on the substrate of Ag nano thin film-GO-Rh6g. The effect of GO and Rh6G gives the enhancement of SERS signal. Many strong and high peaks appeared in addition to small and low peaks.

For the above sample, we wanted to show the effect of drying time on SERS signal, so we let the sample all over the night to be dried, sample 4.

Sample 4

we saw that there were some strong peaks but with low intensity and numbers compared with above sample that means that the long drying time did not give a good enhancement for surface plasmon and there was weak chemical enhancement for SERS in this case.

Finally, Rh6G can be dissolved in methanol and water, so, to show the effect of solvent liquid , we repeated the same procedure as in third sample but with Rh6G dissolved in water, sample 5.
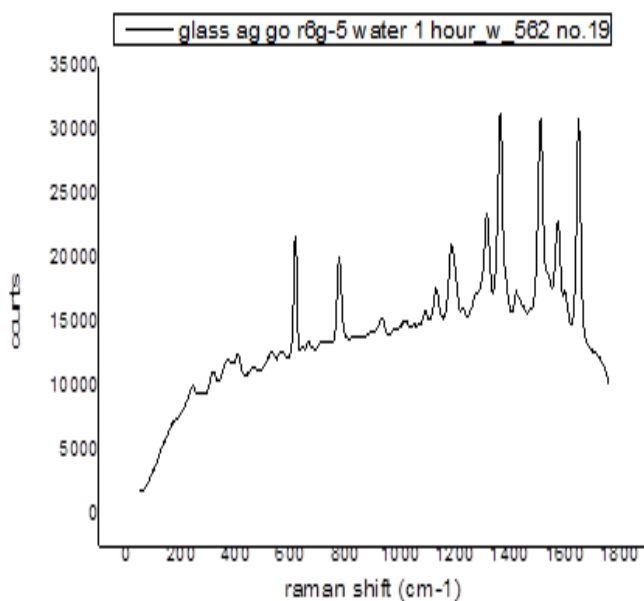
Sample 5

There were strong peaks but with less numbers and long shift compared with third sample. That means

that methanol gives chemical enhancement for SERS better than water.

Conclusions

SERS spectra for Ag nano thinfilm and Rh6G with concentration 10-5mol dissolved in methanol show several strong peaks that indicate the role of surface plasmon for Ag nano thin film when combined with Rh6G. The molecule of the Rh6G binds to the metal surface of Ag nano thinfilm, Rh6G, probe and a highly fluorescent dye that is used for investigating surface-enhanced Raman spectroscopy (SERS) enhancement activity on Ag substrates. In general , the combine Ag nano thinfilm with Rh6G, dissolved in methanol, can be used as a very good substrate for applications that need a strong SERS spectra. Rh6G is high fluorescent dye, has a remarkably high photostability, high fluorescence quantum yield. GO with Ag NP composites should be attractive for use as a SERS substrate. The effect of GO and Rh6G gives the enhancement of SERS signal.

References

[1] Christine J Hicks, SERS Surface Enhanced Raman Spectroscopy, MSU CEM. 924, 2014.

[2] P. ˇSim´akov´a, M. Proch´azka, and E. Koˇciˇsov´a, SERS Microspectroscopy of Biomolecules on Dried Ag Colloidal Drops, Institute of Physics, Faculty of Mathematics and Physics, Charles University, Spectroscopy: An International Journal, Volume 27 , Issue 5-6, Pages 449–453, 2012.

[3] Bhavya Sharma, Renee R. Frontiera, Anne-Isabelle Henry, Emilie Ringe, and Richard P. Van Duyne ,SERS: Materials ,applications, and the future,Department of Chemistry, Northwestern University, USA, materials today, Vol. 15 , No. 1-2, 2012.

Journal of University of Anbar for Pure Science (JUAPS)   Open Access

[4] Kneipp, K.; Kneipp, H.; Itzkan, I.; Dasar, R.R.; and Feld, M.S. Chem. Rev. 1999, 99, 2957-2975.

[5] Moskovits, M. Rev. Mod. Phys. 1985, 57, 783.

[6] TAMASA PANIGRAHI, SYNTHESIS AND CHARACTERIZATION OF SILVER NANOPARTICLES USING LEAF EXTRACT OF Azadirachta indica, master thesis, department of life science, NATIONAL INSTITUTE OF TECHNOLOGY, INDIA, 2013.

[7] Aoife Power, The Preparation and Characterisation of Silver Nanomaterials and their application in Sensing Techniques, PhD thesis, Dublin Institute of Technology (D.I.T),2011.

[8] Silver Nanoparticle Synthesis and Spectroscopy, National Nanotechnology infrastructure Network , www.nnin.org, 2007.

[9]] Alexander Pyatenko, Munehiro Yamaguchi, and Masaaki Suzuki, Synthesis of Spherical Silver Nanoparticles with Controllable Sizes in Aqueous Solutions, J. Phys. Chem. C, 111, 7910-7917, 2007.