Chemical Method for the Preparation of Silver Surfaces for Efficient SERS

O.F. Kolomys, **V.V. Strelchuk, S.A. Kravchenko, Iu.M. Nasieka, B.O. Golichenko, M.I. Boyko**

V.E. Lashkaryov Institute of Semiconductor Physics, NAS of Ukraine, 41, Pr. Nauki, Kyiv, Ukraine, E-mail: kolomys@isp.kiev.ua

Silver colloidal surfaces are ideal for surface plasmon generation, since the behavior of the dielectric constant near the Froehlich frequency gives rise to an intense absorption in the visible region of the spectrum. An ideal silver surface is a stable and well packed film of metal particles in which the size and shape of the silver particles can be readily controlled. Vacuum evaporation is widely used to form metal surfaces, but the metal islands that are produced by this method are small (of the order tens of nanometers in diameter), even if a high evaporation rate is used. It has been shown that larger islands of the order 100 nm in diameter produce the best surface plasmon absorption at visible wavelengths. Sputtering is also a popular method of forming silver surfaces, but this confines grain sizes to a rather small ranges usually <50 nm[1] Pulse laser ablation method is difficult, expensive and gives unstable results.

The best convenient method for forming thin silver film on glass and silicon surface is a process known as the mirror reaction (Tollens' reaction) [2]. In this reaction Ag ion is reduced by glucose to elemental silver that strongly adheres to the glass surface of substrate to form thin silver film. $Ag^+ + RCHO$ (glucose)$\rightarrow$ $Ag^0 + RCOO^-$. Advantage of this method is ability to control properties of silver thing film by change of starting material concentration.

Micro-Raman spectra were measured using the triple spectrometer Horiba Jobin Yvon T64000 equipped with confocal optical microscope. As an optical excitation source the Ar-Kr laser line with λ_{ex} = 488.0 nm was used.

SERS spectra of Rhodamine 6G 10^{-6} M obtained on SERS silver colloidal substrates. Enhance factor was obtained for the 612 cm^{-1} and 1649 cm^{-1} peaks, which are the highest SERS peaks in low and high frequency regions of the R6G. For silver colloidal surfaces deposited on the glass and silicon substrate enhance factor was about 3.1×10^3 and 5×10^3, respectively.

[1] *M. S. Anderson* Locally enhanced Raman spectroscopy with an atomic force microscope, *Appl. Phys. Lett. – 2000. – 76. –P. 3130-3132*.
[2] *Oshitna, K., and Tollens, B.,* Ueber Spectral-reactionen des Methylfurfurols // Ber. Dtsch. Chem. Ges. –1901.–34. –P. 1425.