Polytetrafluorethylene as a substrate for surface enhanced Raman spectroscopy

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Surface-enhanced Raman scattering (SERS) has great potential as an analytical technique based on the surface enhancement of Raman signals of the molecule situated on the metal surface which is nowadays currently used for the detection of various analytes at low concentration [1]. In order to obtain optimal enhancement of Raman signals of the molecule it is necessary to use nanostructured surfaces or nanoparticles of noble metals with suitable physical parameters such as their size, shape and degree of aggregation [2].

In this work we have prepared suitable SERS active substrates from synthetic polymer foils of PTFE by deposition of Au layers on its surface inside of plasma discharge [3]. We tested electromagnetic mechanism enhancement on rude PTFE-Au surface and sandwich structures. Time of sputtering was investigated with respect to the surface properties. The ability of PTFE-Au substrates to enhance Raman signals was investigated by immobilization of biphenyl-4,4'-dithiol (BFD) from the solutions with various concentrations. BFD was also used for preparation of sandwich structures [4] with Au or Ag nanoparticles by two different procedures.

In the first procedure (Fig. 1a) the gold foils were modified by silver or gold nanoparticles previously covered by BFD. BFD was added drop-wise at intensive stirring to the 1 ml of nanoparticles. The obtained mixture was purified by double centrifugation in order to remove from the solution undissolved BFD. Next centrifugation led to separation of nanoparticles. Afterwards the supernatant was removed and modified nanoparticles were redispersed in water. PTFE foil with gold layer was placed to the solution of nanoparticles for 12 h. After that the foil was removed from the solution, washed by methanol and dried on the air. SERS measurements were performed on Raman NIR Advantage spectrograph.

In the second procedure (Fig. 1b) PTFE foil with gold layer modified by BFD was prepared. Then such modified foil was placed into the solution of 2 ml of nanoparticles for 12 h. After that the foil was removed from the solution, washed by methanol and dried on the air. SERS measurements were performed on Raman NIR Advantage spectrograph.

We have demonstrated the possibility preparation of SERS active substrate with suitable properties by sputtering deposition of gold layer on the PTFE foil. Such foil is cheap, easy to manipulate with it and offers the possibility to measure from both sides of PTFE foil. It was found out that optimum of sputtering time is for 30 s and the maximum of SERS signal intensity was achieved at 10^{-6} mol·L^{-1} for BFD. With use of sandwich structures of nanoparticles we were able to obtain signal even at 10^{-8} mol·L^{-1}.

Acknowledgements

The financial support from the Ministry of Education of the Czech Republic MŠMT 6046137307, the GACR Foundation No. 203/09/0675 and GAAV CR Foundation KAN200100801 is gratefully acknowledged.

References

[1] M. Moskovits, Rev. Mod. Phys., **57** (1985) 783.

[2] A. C. Sant'Ana, T. C. R. Rocha, P. S. Santos, D. Zanchet, M. L. A. Temperini, J. Raman Spectrosc., **40** (2009) 183.

[3] V. Švorčík, J. Siegel, P. Slepička, V. Kotál, J. Švorčíková, M. Špirková, Surf. Interf. Anal., **39** (2007) 79.

[4] W. Yuling, C. Hongjun, D. Shaojun, W. Erkang, J. Chem. Phys., **124** (2006) 074709.

Figures

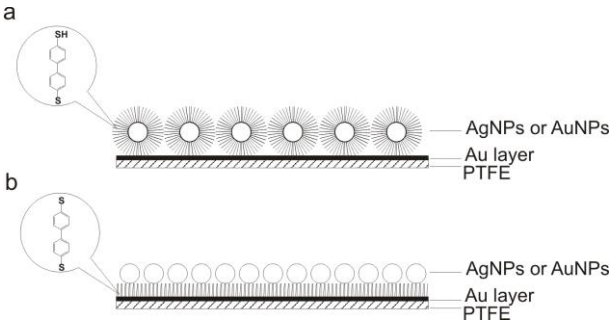

Figure 1. (a) Preparation of sandwich structures using modified nanoparticles. (b) Preparation of sandwiche structures using modified gold layer.