

Local Tip Raman Enhancement from SWNT using cantilevers coated with Ag nanoparticles embedded in polymer matrix.

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Introduction

Tip Enhanced Raman Spectroscopy (TERS) propose new opportunities to combining of spectral and microscopic techniques that is most popular and attractive field of state of art science.

A first impressive result in the field of tip enhancement Raman was demonstrated by Lucas Novotny group in 2003 [1, 2]. This group used Au etched tips as enhancement system and Single Walled Carbon Nanotubes (SWNT) was used as a sample.

In this work we offer new approach for development of TERS probes based on using of usual commerce Si cantilevers modified with particles of Ag hydrosol (most effective SERS-active system today). Silver particles are protected by silane matrix from degradation and pollution.

Experimental section

Cantilever preparation.

Standard Si cantilevers activated in Ar^+ plasma was coated with Ag nanoparticles embedded in polymer matrix using the Langmuir-Blodgett technique. SEM image of the processed cantilevers is shown at Fig.1.

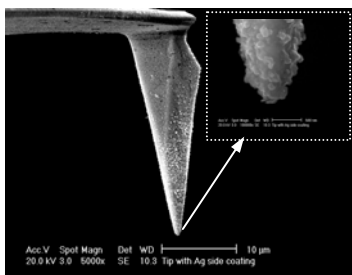


Fig.1
SEM image of the cantilever tip coated with Ag nanoparticles embedded in polymer matrix

Experimental setup.

We used Ntegra-Spectra system (NT-MDT Co.) to test our tips in TERS experiment. SWNT (SiC) was used as a sample to demonstrate Raman signal enhancement.

System contains Scanning confocal laser microscope, Cherny-Turner spectrometer, ANDOR CCD detector, SMENA AFM head, OLYMPUS inverted optical microscope, He-Ne laser, XY scanning stage.

SWNT preparation.

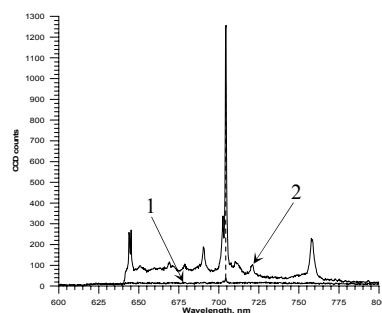
Ethanol solution of single walled SiC nanotubes was supplied by Dr. J. Loos from Eindhoven

University (TU/e). Sample was prepared by drop coating to cover glass with ethanol solution of SWNT. AFM image was acquired to control of nanotubes arrangement at the glass surface after water drying.

Raman signal measurements.

Fast laser confocal imaging of the cantilever tip was used to adjust tip/laser spot positioning.

Raman spectrum from SWNT was obtained in two modes. First mode “Tip out” – tip is moved out from sample surface at 4 μm , Raman spectrum was collected with integration time 5 s (Fig. 3.1). Second mode “Tip In” – tip is in semicontact position with the sample surface, Raman signal was collected with integration time 5s (Fig. 3.2).



Tip-enhanced Raman signal (TERS) of SWNT
1. “Tip out” mode, 2. “Tip in” mode
 $\lambda_{\text{ex}} = 632.8 \text{ nm}$, $P_{\text{ex}} = 100 \mu\text{W}$, $t_{\text{int}} = 5 \text{ s}$.

Result and discussion

New type of tip enhanced Raman probes based on standard Si cantilevers coated with Ag nanoparticles embedded in polymer matrix was developed. Tip enhancement near 1000 times on SWNT was demonstrated using our cantilever tips. In spite of presence Ag nanoparticles at tip of cantilever, such probes give possibility to obtain AFM image. Moreover our tip will have a good performance quite long time.

References

- [1] A.Hartschuh, N.Anderson & L.Novotny. *J. of Microscopy*, **Vol.210**, Pt 3 June 2003,
- [2] A.Hartschuh, E.J.Sa’nchez, X.S.Xie, & L. Novotny. *Phys.Rev.Letters.*, **Vol.90**, N9, 2003.