Silicon nanowires uniformly decorated with Au nanoparticles for SERS detection of viruses

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Rapid detection and identification of pathogenic viruses is one of the key tasks of modern biomedicine. PCR and ELISA methods widely used in medical practice today allow effective virus identification, but they have their own disadvantages: expensive equipment is required for such tests, and the time to obtain a result takes from several hours. Therefore, it is necessary to develop new fast and inexpensive methods of virus detection. Raman spectroscopy is one of the promising methods for the study of bioobjects [1], but this method has poor sensitivity, so for its effective application it is necessary to create structures that enhance this effect.

Silicon is a biocompatible material, it is safe and has no toxic effects on bioobjects. In the presence of noble metal nanoparticles (Au, Ag) due to the emergence of localized plasmon resonances, a significant increase in the intensity of the optical signal of Raman scattering (10^4-10^6 times) is observed - the effect of surface-enhanced Raman scattering (SERS) [2]. Thus, silicon structures decorated with noble metal nanoparticles will provide highly sensitive, fast and specific registration of the optical signal from surrounding molecules, including biomolecules [3].

In this work, arrays of silicon nanowires decorated with gold nanoparticles along their entire length (Au@SiNWs) were prepared (Fig. 1). The SiNWs were prepared by metal-assisted chemical etching (MACE) of silicon wafers (12 Ohm*cm). For uniform coating of the SiNWs along the entire length, the samples were immersed in $HAuCl_4 \cdot 3H_2O$ (0.005 M) aqueous solution for 30 min. Then, the nanowires were immersed for 10 seconds in HF (5 M) solution and finally were washed in MQ. This uniform coating of the Au@SiNWs provides higher SERS activity for virus detection.

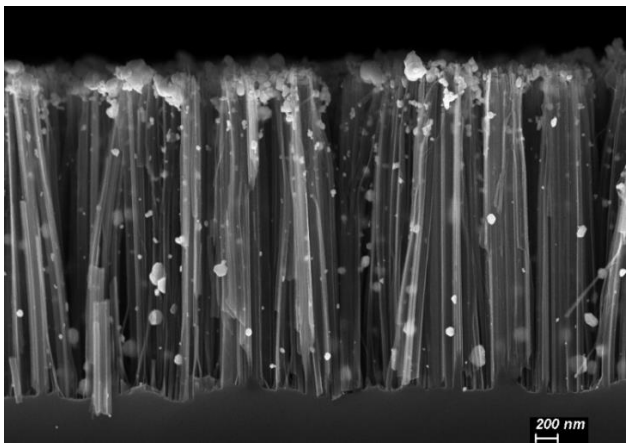

Fig. 1. Scanning electron microscopy micrograph of Au@SiNWs.

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[1] J.-Y. Lim, J.-S. Nam, S.-E. Yang, H. Shin, Y.-H. Jang, G.-U. Bae, T. Kang, K.-I. Lim, Y. Choi, Identification of Newly Emerging Influenza Viruses by Surface-Enhanced Raman Spectroscopy, Analytical Chemistry, Vol. 87, pp. 11652–11659, (2015).
[2] B. Sharma, R.R. Frontiera, A.I. Henry, E. Ringe, R.P. Van Duyne, SERS: Materials, applications, and the future, Materials Today, Vol. 15, pp. 16-25, (2012).
[3] Z. Movasaghi, S. Rehma, I. Rehman, Raman Spectroscopy of Biological Tissues, Applied Spectroscopy Reviews, Vol. 42, pp. 493-541, (2007).