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FROM THE EDITOR-IN-CHIEF

Nanoanalytics

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Two different directions can be distinguished in nanoanalytics.

The first one refers to methods and means for studying nanoobjects in themselves. It includes the use of up-to-date methods of scanning probe microscopy (scanning tunnel, atomic force), raster and transmission electron microscopy, X-ray photoelectric and Auger electron spectroscopy, optical spectroscopy in the visible and ultraviolet region, low-energy and reflection high-energy electron diffraction, and X-ray spectrometry and diffraction. Studies in this field aim to characterize nanoobjects, observe them, and sometimes manipulate them. It is often said that the evolution of nanoscience and nanotechnology in themselves to a substantial degree is due to the development of the corresponding methods. Analysts seldom work in this direction; nanoobjects are more often investigated by inorganic chemists, material scientists, nanobiotechnologists, and physicists. A trend has appeared in the application of the above-mentioned methods for the quantitative analysis of nanoobjects and recognition of individual atoms on their surfaces, which is due to the high resolution of some methods. Another trend is to combine three or four functions in one instrument; this allows one to study the chemical composition of surfaces and also their morphology.

The second direction, more familiar to the readers of our journal, is the use of nanoobjects as a *tool* to solve more or less routine analytical problems. A huge number of works has already been completed in this direction using various analytical methods, more often spectroscopic and electrochemical, and quite different nanoobjects. Let me list some areas of research and development.

Gold and silver nanoparticles, and also quantum dots (CdS, ZnSe, etc.) as bases of sensing elements in spectrochemical (surface plasmon resonance) and luminescence analysis, nanosensors, and especially bioanalysis (nanobiosensors for DNA, etc.).

Functionalized (for example, with enzymes) silicon dioxide nanoparticles for the determination of biomolecules.

Carbon nanotubes as adsorbents (and not only these).

Nanostructured electrodes and nanotubes in electrochemical methods of analysis.

Molecularly imprinted nanostructured polymers and silica materials as selective adsorbents, membranes, and sensing elements.

Micelles and similar nanostructures as chemical reactors in photometric and luminescence analysis.

Micellar electrokinetic chromatography and micellar extraction without the use of organic solvents.

Thus, gold and silver nanoparticles are used for the optical (absorption, fluorescence, light scattering) and also electrochemical detection of biomolecules, including DNA. Quantum dots (CdS, CdSe, CdTe, ZnS, PbSe, etc.) form conjugates with bioanalytes, by which these bioanalytes can be detected and determined, especially using luminescence spectrometry. This method is characterized by the very high quantum yield of luminescence at relatively narrow spectral bands. Micellar and microemulsion electrokinetic chromatography are also well-developed methods.

A workshop on nanoanalytics was organized in Saratov in 2007. It covered mainly the second direction, i.e., purely analytical applications of nanoobjects. Let me point to a short manual on the use of nanotechnologies in chemical sensors [1]; numerous surveys by Shtykov, for example, [2]; the paper by Valcarcel with coauthors on “Analytical nanoscience and nanotechnology today and tomorrow” [3]; and the paper about the use of nanoparticles in separation methods [4]. Bochenkov and Sergeev published a review about nanoparticles for chemical sensors [5].

As recent specific examples, let me indicate the use of silica nanoparticles with immobilized enzymes for fabricating biosensors [6] or a sensor for nitrogen oxide based on carbon nanotubes [7]. This sensor allows the detection of NO in biological objects in the real-time mode and with good spatial resolution. One-wall nanotubes were modified by grafting dextrane, which in turn was functionalized with 3,4-diaminophenol. Upon near infrared irradiation, the sensor fluoresces, but in the presence of nitrogen oxide its fluorescence is very selectively quenched. As near infrared radiation also penetrates into living tissues, there appears to be a possibility of detecting NO directly at certain places of a living organism.

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