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Problems and solutions of laser mass spectrometry

The report examines the various trends in laser mass spectrometry for elemental analysis. The potential possibilities of laser ablation, laser ionization, and ionization of gas-forming impurities are regarded. It analyzes the basic physical processes during the generation of ions by the laser irradiation and conditions of adequately display the composition of the sample using the laser plasma. The new concept of implementation standard less elemental analysis by using a laser time-of-flight mass spectrometer is offered. The key provisions of the concept are both a complete ionization of the vaporized sample by laser pulse of a local volume and without a discriminatory transmission and detection of the ion packets of any element with the help of the mass analyzer. It discusses occurring physical processes taking place during evaporation sample, generation and expansion of plasma in the ion source and the separating system, the detection and recording of mass spectra. Discriminatory factors are analyzed at different stages of these processes. Different approaches of construction of analytical systems for measuring the ion composition by means of various TOF analyzers are used. The elemental analysis by laser ionization highlighted three main areas: Routine elemental analysis in various industrial technologies for production of solid materials where it is enough to have the resolution R=500-800, the detection limit equals 0.1-1 ppm; the elemental analysis of high-purity substances, where it is necessary resolution at the level of $R\sim10^4$, and the detection limit about hundreds of ppt; trace element analysis of gas-forming, where it is necessary to have a detection limit in the concentration at levels of $\sim10^{-7}$-10^{-8}%, and the main problem is the high background of adsorbed gases at surface of samples. New principles of analytical systems of laser TOF mass spectrometers are disclosed. Their basis is the synthesis of the ion source and the TOF analyzer as a single separation unit, the rejection of the additional acceleration of ions in the source, the use of innovative analyzers with wedge-form reflectors of ions. All this is complemented by no discriminatory methods of generation, separation and formation of analytical signals. Of fundamental importance for standard less analysis is the formation of the analytical signal for each element, as the sum of the signals of singly and doubly charged ions for the total spread of ion by energies. Some technical solutions are also considered.

Biography

Alexander A. Sysoev defended his PhD thesis at the age of 29 in Moscow Engineering Physics Institute (MEPhI), Russian Federation. Later (at the age of 44), he defended his second dissertation for the degree of Doctor of Physics & Mathematics Sciences. He is the head of the Mass Spectrometry Laboratory in National Research Nuclear University MEPhI. He has published more than 80 papers in different areas of science and education. He published more than 10 books, three monographs on mass spectrometry (in Russian). He is a member of the editorial boards of two Russian journals: "Mass Spectrometry" and "Nuclear Science and Technology, Series: Technical Physics and Automation". He is a Member of the Presidium and the Council of the All-Russian Mass Spectrometric Society; inventor of USSR, Honorary Professor of Moscow Engineering Physics Institute, and Honorary Employee of High Professional Education of Russian Federation. Research interests: analytical chemistry, ionization processes, ion optics, time-of-flight mass analyzers, and some other. He has developed and implemented new "Educational Technology by Imitation of Professional Activity" for students in the Moscow Engineering Physics Institute. Among his graduates there are Alexander Makarov, Vyacheslav Artayev, Dmitry Bandura, and many others working in the leading mass spectral companies, universities, and laboratories all over the world.

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