FROM THE EDITOR-IN-CHIEF

X-Ray Methods of Analysis¹

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Those who work in X-ray spectrochemical analysis (XRS) render homage to the discovery by Wilhelm Roengen, fundamental works by Henry Moseley, and the results of works by György Hevesy (he not only discovered hafnium using the Moseley law, but also was one of the pioneers of X-ray fluorescence analysis, and a coauthor of the monograph “Chemical Analysis by X-Rays and Its Applications” translated into Russian in 1934). The researchers evidently remember the fact that, in 1951, R.F. Casten and A. Guinier, on the one hand, and I.B. Borovskii and N.P. Il’in, on the other hand, proposed X-ray electron probe microanalysis.

In Russia, we have not too many discoverers of principally new analytical methods: M.S. Tswett (chromatography), B.V. L’vov (electrothermal atomic absorption spectroscopy), and five or six more scientists. Nikolai Petrovich Il’in is among them; he actively works up till now and has recently published a number of original papers.

Certainly, many people have made their contributions to the development of X-ray spectrochemical analysis, more so, physics of X-rays, and X-ray spectroscopy. A place of honor is occupied by M.A. Blokhin. He was one of the first who applied X-ray spectroscopy to the analysis of geological objects. He wrote well-known books on X-ray spectroscopy and X-ray spectrochemical analysis, including the monograph published in coauthorship with I.B. Borovskii in 1939. Mikhail Arnol’dovich has organized the production of the first domestic X-ray instruments for chemical analysis at the Rostov State University and contributed greatly to their commercial production at the Burevestnik plant in Leningrad. He edited numerous collections of articles on the equipment and methods of X-ray spectroscopy and actively participated in the organization of specialized conferences. However, perhaps his main achievement was the establishment of the Rostov School, which is even now widely known in Russia.

Let me now express my opinion on the current status of different methods X-ray spectrochemical analysis, from a detached point of view.

X-ray fluorescence analysis (XRF) has become of one of the basic methods of elemental analysis; today it is evidently the most important method of X-ray spectrochemical analysis. The role and importance of XRF

are determined by its advantages, among which are multielement determinations, the possibility of carrying out analyses without sample destruction, rapidity, relatively high accuracy, possibility of automation, possibility of substance analysis in different states of aggregation, etc. The drawbacks of XRF are often considerable matrix effects and related calibration difficulties, and also a relatively low sensitivity; these are gradually overcome on the basis of theoretical studies and using modern mathematical methods and original technical solutions. Among important steps in the sophistication of XRF are the use of total external reflection (total internal reflection XRF), synchrotron radiation, capillary X-ray optics, new calibration techniques, and the preconcentration of trace elements; Let me separately note the creation of methods and instruments for X-ray fluorescence microanalysis.

Numerous instruments were created for XRF; among them is a whole series of commercially accessible instruments manufactured by various companies. Energy-dispersive instruments are produced along with those with wavelength dispersion; the market proposes both complex and expensive spectrometers and special-purpose analyzers, including portable and manual ones. In Russia, instruments are produced by Research-and-Production Enterprise Burevestnik, Spektron Company, Research-and-Production Enterprise Nauchpribor, All-Russia Research Institute of Technical Physics and Automatics, and other enterprises and companies.

As for applied analytical problems solved by XRF, these, of course, are numerous and grow in number. The most important place among such problems is occupied by the analysis of geological objects, metals and alloys, and also cements, glasses, and environmental objects. Among the less important problems, more of research character, are problems of comparison and identification of materials and products, for example, in forensic examination; the comparison of the elemental composition of healthy and affected human organs important for medical diagnosis; the determination of the origin, history, and authenticity of archaeological samples and works of art; the identification of various chemical species of elements.

X-ray emission microanalysis (electron probe) durably occupies its place as one of the main methods of distribution (local) analysis, especially in studying geological objects, metals and alloys, electronic materials, etc. It is being developed as a quantitative method, towards increasing the sensitivity of determination,

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although it faces a lot of difficulties. The locality reached nowadays is very high. Today attachments for microanalysis are supplied with electron microscopes, both transmission and raster. The devices used in this method are produced mainly abroad, especially in Japan and France. The method is often used in combination with other methods of local analysis and surface examination.

X-ray absorption analysis has a limited application; it is suitable for determining heavy elements in a light matrix (lead in gasoline). Because of the poor availability of the corresponding instruments, the possibilities of proton-induced X-ray emission (PIXE) analysis are also limited.

In the USSR and Russia, there were centers and groups that actively developed X-ray methods of analysis: St. Petersburg, Rostov-on-Don, Irkutsk (school created by N.F. Losev), Moscow, Novosibirsk (many works, in particular, electronic probes), and others. Many doctoral and candidate's dissertations on these methods were defended. Conferences on X-ray methods were regularly organized; many books, starting

from the translations of the early 1930s and pre-war monograph by Borovskii and Blokhin mentioned above were devoted to X-ray methods. Our experts in X-ray methods can be proud of many things. In the beginning of 2008, the Scientific Council on Analytical Chemistry of the Russian Academy of Sciences has awarded its prize to the founder of X-ray capillary optics of M.A. Kumakhov. Interesting works are conducted on accounting different influences on the results of analyses, on the use of synchrotron radiation, on the determination of element speciation in the test sample, on the analysis of loose nonuniform substances, in particular on the conveyor belt, and on many, many other things.

All this inspires certain optimism. Moreover, we can be sure that the banner with the names of those who made the main contribution to the creation and development of XRS will not be let down by today's researchers. Those who now join the experts on XRS will bear this banner further with new names on it.

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