

## NEUTRON ACTIVATION ANALYSIS IN BULGARIA

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The first attempt for instrumental neutron activation analysis was made by analysis of indium in intermetall alloys by means of Po-Be source in the Institute of Nuclear Research and Nuclear Energy in Sofia. The development on INAA as a routine method starts with bringing into use in 1960 of the experimental nuclear reactor in Sofia. With the introduction of semi-conductive detectors and high quality multichannel analysers the method finds its wide applications in different parts of science and industry.

## SYSTEMS AND METHODS OF IRRADIATION

At the present the main source of neutrons is the experimental reactor 2 MW - IRT-2000. For the purposes of INAA the vertical channels are used. The neutron flux vary from 1 to  $6 \times 10^{12}$  n/cm<sup>2</sup>s, with Cd ratio for gold of about 4,4. In one of the channels the neutron flux is additionally thermalised with grafite (thermal columnne ). In other vertical channel a pneumatic double-tube rabbit system is installed. One of the irradiation positions is equipped with 1mm Cd shield constantly. With the pressure of the working gas ( air ) of 2 bar the transport time in one direction is 2,5 sec.

In this way for INAA are available isotopes with the half-life of few seconds and more, when the irradiation is carried out in pile or epithermal neutron flux, and few hours and more, when the irradiation is carried out in thermal column. Because of lack of special system for uniform irradiation an accuracy of 3% could be reached by use of iron monitors for long irradiatons and copper monitors for use in the rabbit system.

At the moment in Bulgaria are working also two neutron generators but the application of 14 MeV neutrons for INAA is still quite limited.

Radiochemical methods ( RNAA ) are used at the present only for investigation purposes.

## APPLICATIONS

Geology and pedology: The application of INAA in this area is most developed. Investigated are the composition of the fields, of strongly mineralised underground waters and the possibility to extract from them some useful products. Some investigations are carried out on rocks and sediments for the purposes of geology. The study of soils is conducted for the improvement of agriculture.

Medicine and biology: Model experiments are performed on laboratory animals for the establishment of a connection between the content of essential macro- and microelements in different organs and the development of some processes in disease. Studied is also on model experiment the effect of platinum preparations on the treatment of cancer. Investigated is the elemental content of human tissues, plants and other.

Environment and pollution: Conducted are tracer experiments for the study of the effect of point pollution emitters ( factory chimney for instance). Examined are the possibilities to use some plants and animals as a monitors of air pollution. Studied is the influence of different pollutants on the distribution of toxic elements in human organs, sea water organisms and others.

Archeology: An extensive investigation is carried out of ancient glasses and ceramics for archaeometry purposes. An attempt is made for analogous investigation of ancient flint and obsidian objects.

Technology: By means of INAA is analysed the wearing of some machine parts, controlled are some processes in metallurgy as well as the final technological products. Investigated are the possibilities for regeneration of some valuable spented catalysts from chemical industry.

Meteorology and hydrology: Experiments are conducted with activable tracers for the study of local atmospheric phenomena and the movement of the underground waters.

Criminology: Developed are methods based on INAA for analysis of car paints and traces of shooting for the investigating purposes.

Qualitatively NAA in Bulgaria maintains a good level. The interlaboratory intercomparison runs, organised by IAEA and other institutions offer a perfect opportunity for each group to check the quality of their results.

Quantitatively the further development of NAA and its applications is limited by the possibilities of the reactor. In the near future a reconstruction and modernisation of the reactor is being planned, which will extend the possibilities for the analysis. Building of accelerator and more powerful neutron generator which is due in the near future in Bulgaria will also contribute to the use of neutron activation analysis.