

How to Enhance Detection Limits of Neutron Activation Analysis

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Neutron activation analysis (NAA) is a well-established analytical technique used in many parts of the world for the determination of 50+ elements in a variety of samples for both research and commercial purposes. Although NAA is inherently sensitive for many elements, detection limits of a number of elements in real samples can be further improved by either enhancing the activity of interest or suppressing interfering activities or both. In this talk we will focus on several methods we developed over the years to improve detection limits of conventional NAA using reactors. First we developed a conventional instrumental NAA (INAA) method using one-shot irradiation coupled with conventional gamma-ray spectroscopy and found that about 20 elements can be determined with better limits via their short-lived nuclides compared to their longer-lived counterparts. Then we developed cyclic INAA (CINAA) and pseudo-cyclic INAA (PCINAA) methods where irradiation-decay-counting cycles are repeated for an optimum number of cycles to achieve better detection limits. Then we improved these limits further by using anticoincidence gamma-ray spectroscopy. We also developed INAA methods using epi-thermal neutrons in conjunction with both conventional and anti-coincidence gamma-ray spectroscopy, and found that the limits for a number of elements can be significantly improved in several types of sample containing high amounts of salt. We used derivative INAA (DINAA) methods to determine elements like silicon and phosphorus which are not very sensitive by conventional INAA. We have also developed preconcentration NAA (PNAA) and radiochemical NAA (RNAA) methods for lowering detection limits of elements which produce short-, medium- and long-lived neutron activation products. We have also increased sample size to improve detection limits. It is now possible to measure sub-ppb levels of many elements with high precision and accuracy. We extended the scope of NAA by modifying PNAA methods to determine the species of an element and called it speciation NAA (SNAA). Since the toxicity of an element depends significantly on its species and can be influenced by other species present in the same sample, we have developed simultaneous SNAA methods. We will present details of the above methods with examples.

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