

Chemical analysis with neutrons: from activation analyses to neutron depth profiling

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When an atomic nucleus absorbs a neutron, the excitation energy is emitted in different forms of characteristic radiation. In most cases, prompt and delayed gamma rays are released, whose energy identifies the nuclides, and their intensity is proportional to their amounts, i.e. chemical analysis can be performed when using gamma spectrometry. More than 80 years after its discovery, neutron activation analysis is still one of the most sensitive analytical techniques for trace elements, while prompt gamma activation analysis is suitable for the bulk analysis of the matrix components. With the combination of the activation analyses, a broad range of samples have been analyzed in archaeometry, geology, material science, investigating the contents of closed container, or following in situ chemical processes.

Charged particles are sometimes also released after the neutron capture and their detection opens new horizons in nuclear analytical techniques. The detection of beta particles following the radioactive decay enable the determination of components not emitting (strong enough) gamma radiation. Neutron Depth Profiling has been successfully used in the investigation of the distribution of B, Li, and N in thin layers for decades, and recently, the interest has further increased because of its prosperous use in the investigation of Li-ion batteries.

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