NEUTRON ACTIVATION ANALYSIS(NAA)

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Introduction

Neutron activation analysis (NAA) is a non-destructive analytical method commonly used to determine the identities and concentrations of elements within a variety of materials. Unlike many other analytical techniques, NAA is based on nuclear rather than electronic transitions. In NAA, samples are subjected to neutron radiation (i.e., bombarded with neutrons), which causes the elements in the sample to capture free neutrons and form radioactive isotopes, such a

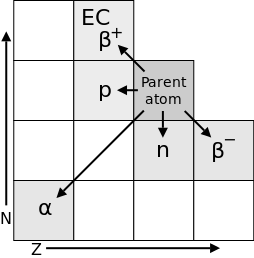
27Co59 + 0n1 → 27Co60

## Sample preparation

In order to analyze a material with NAA, a small sample of at least 50 milligrams must be obtained from the material and it is suggested that two different samples are obtained from the material using two drill bits of different compositions.The small samples are encapsulated in vials of either quartz or high purity linear polyethylene.

WORKING PRINCIPLE.

1. NAA works through the processes of neutron activation and radioactive decay.
2. In neutron activation, radioactivity is induced by bombarding a sample with free neutrons from a neuron source.
3. The target atomic nucleus captures a free neutron and, in turn, enters an excited state.
4. This excited and therefore unstable isotope undergoes nuclear decay, a process in which the unstable nucleus emits a series of energetic particles that can include neutrons, protons, alpha, and beta particles in an effort to return to a low-energy, stable state.
5. As suggested by the several different particles of ionizing radiation listed above, there are many different types of nuclear decay possible. These are summarized in the figure under.

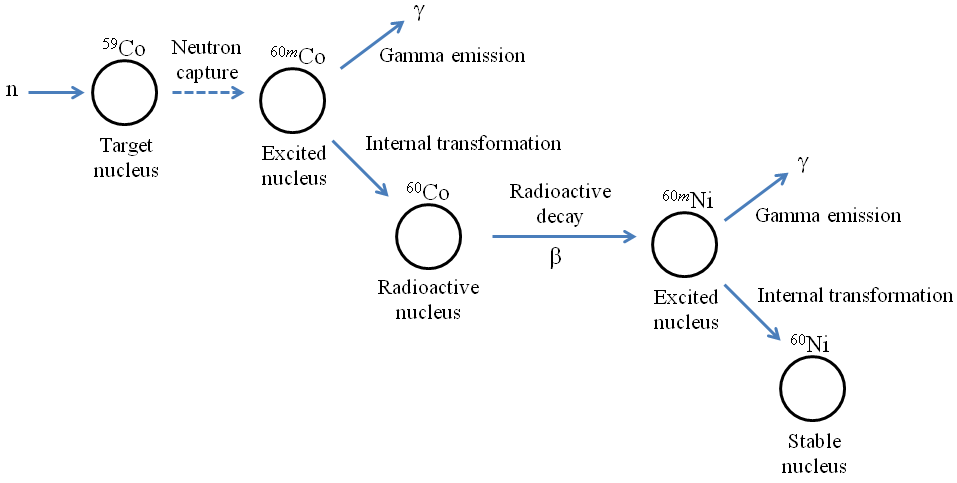


**Figure .** Transition diagram illustrating the changes in neutron number N and atomic number Z for different nuclear decay modes – alpha decay (α), normal beta decay (β-), positron emission (β+), electron capture (EC), proton emission (p), and neutron emission (n).

An additional type of nuclear decay is that of gamma radiation (denoted as γ), a process in which the excited nucleus emits high-energy gamma ray photons. There is no change in either neutron number N or atomic number Z, yet the nucleus undergoes a nuclear transformation involving the loss of energy. In order to distinguish the higher energy parent nucleus (prior to gamma decay) from the lower energy daughter nucleus (after gamma decay), the mass number of the parent nucleus is labeled with the letter *m*, which means “metastable.” An example of gamma radiation with the element technetium is shown here.

43Tc 99 → 9943Tc 99+ γ

In NAA, the radioactive nuclei in the sample undergo both gamma and particle nuclear decay. The figure below presents a schematic example of nuclear decay. After capturing a free neutron, the excited *60m*Co nucleus undergoes an internal transformation by emitting gamma rays. The lower-energy daughter nucleus *60*Co, which is still radioactive, then emits a beta particle. This results in a high-energy *60*Ni nucleus, which once again undergoes an internal transformation by emitting gamma rays. The nucleus then reaches the stable *60*Ni state.



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