

Fast neutron activation of aluminum samples

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Each scintillator which is part of the detector in the Gamma-ray Camera (GC) at JET is placed in an aluminium capsule. Due to the strong neutron and gamma fluxes produced during experiments performed at JET the capsule material is activated by neutrons. It is then necessary to check which radioactive nuclei are present by registering their gamma lines.

At NCBJ we used a *Genie 16D* neutron generator which emits a neutron flux equal to 10^8 n/s with an average energy of 14 MeV [1]. Spectra registered with a HPGe detector were analysed with a TUKAN analyser. Two samples of PA6 aluminium were used: a solid aluminium cylinder with dimensions of $\phi 30 \times 7$ mm and an aluminium capsule with dimensions of $\phi 35 \times 34$ mm and a wall thickness of 1.2 mm [2],

Irradiation time of each sample was 600 s and after a pause of 60 s a gamma spectrum was measured for 1200 s (40×30 s). Measurements without any aluminium material were performed as well to determine the laboratory background.

Natural aluminium contains only one stable isotope ^{27}Al . In Fig. 1 cross section values for selected reactions induced by neutrons on ^{27}Al are shown.

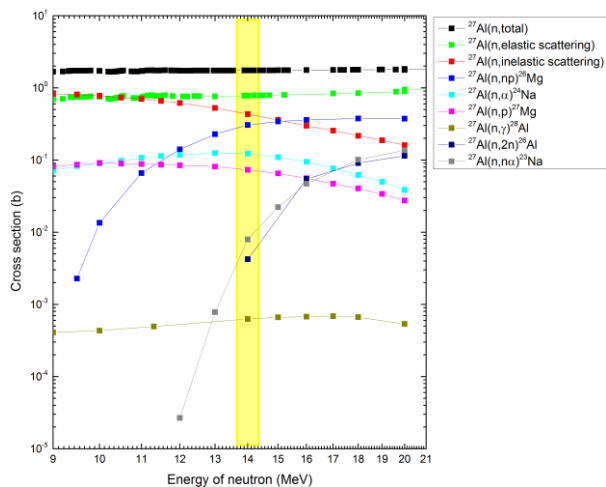


Fig. 1. Cross section for selected reactions induced by neutrons on ^{27}Al [3].

In Table 1 a short summary of the most pronounced gamma lines observed during aluminium activation by fast neutrons is presented.

Table 1. Summary of isotopes activated by fast neutrons in aluminium [3].

Reaction	Half-life of product	Emitted gamma lines
$^{27}\text{Al}(n,\gamma)^{28}\text{Al}$	2.24 m	1779 keV
$^{27}\text{Al}(n,p)^{27}\text{Mg}$	9.46 m	170, 844, 1014 keV
$^{27}\text{Al}(n,\alpha)^{24}\text{Na}$	14.96 h	1369, 2754 keV

Sample gamma spectra from the performed irradiations are presented in Fig. 2. Two naturally occurring peaks are seen at 1461 keV caused by gammas from ^{40}K and at 2615 keV from ^{208}Tl .

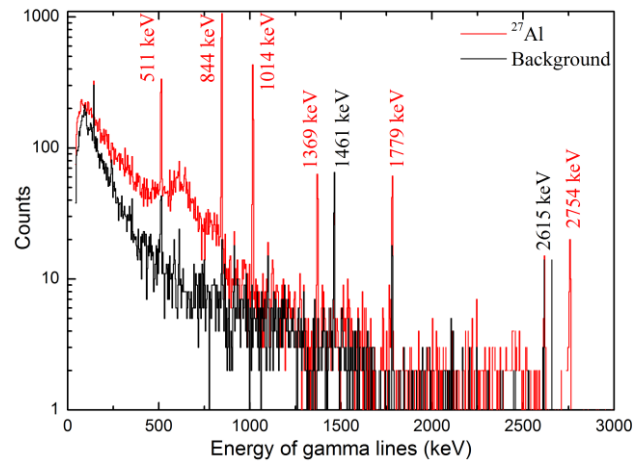


Fig. 2. Sample of gamma spectra from an irradiated ^{27}Al sample (red) and background after irradiation without a sample (black).

The observed gamma lines could be used to obtain an energy calibration of the detector setup.

References

- [1] <https://www.nrc.gov/docs/ML1408/ML14085A270.pdf>
- [2] <http://www.dostal.com.pl/metale-kolorowe-aluminium.html>
- [3] P. Obložinský *et al.*, *Special Issue on ENDF/B-VII.1 Library*, Nuclear Data Sheets (2011).

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