# Effect of activator concentration on quenching factor in NaI:Tl crystal for fission fragments detection

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Quenching factor is used to identify the particle with large specific energy loss in the track of charged particle. Quenching factor means a difference in scintillation efficiencies for examined particle compare to proton. Scintillation efficiency for proton has a maximum value is taken as a unit. In practice we often use so called gamma-equivalent which represents the position of maximum for heavy ionized particle with energy $E_p$ in the equivalent scale of γ-ray energy. So, for example, to determine a real energy of α-particle we should divide the position of its maximum of full energy absorption in pulse height spectrum on α/γ-ratio. In this case the α/γ-ratio means the same as quenching factor but relatively to scintillation efficiency of gamma-rays.

The goal of present work consists in confirmation of Kubota's conclusion [1] that conversional efficiency for heavy ions like fission fragments can be improved by increasing of activator concentration. This conclusion contradicts to common idea presented in handbooks on scintillation technique [2, 3] that quenching factor doesn't depend on activator concentration.

To confirm the effect of Tl concentration on quenching factor we measure pulse height spectra for three NaI:Tl crystals with $C_{Tl}$ from 0.01 up to 0.23 mole %. Selected crystals were grown by Bridgman-Stockbarger technique in oxygen atmosphere. Contrary to Kubota's results [1] the concentration quenching of light yield doesn't observed at excitation by gamma-rays of 662 keV energy for sample with $C_{Tl}$ = 0.23 % while light yield at excitation by alpha-particle increases in all interval of $C_{Tl}$. To prevent negative influence of dead layer near entrance surface of scintillator we used the technique of photochemical modification of polished surface.

Crystals were excited by alpha-particle from $^{239}$Pu source. $^{252}$Cf radionuclide as a source fission fragments is used also. An average energy of light and heavy fragments is about 90 MeV.

It has been shown that quenching factor depends on $C_{Tl}$ both for alpha-particle and fission fragments. This conclusion confirms the Kubota's results on NaI:Tl [1] and data of paper [3] on CsI:Tl. An explanation why Birks [2] describes an opposite conclusion is given in the work [3].

**References:**

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