Afterpulses in α -Ray Excitation of Plastic Scintillator

Osamu YURA

5-4-1, Mukodai-cho, Tanashi-shi, Tokyo, Japan

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Porter, et al.¹⁾ reported low amplitude pulses due to long lived state of plastic scintillator as well as NaI and anthracene scintillators at the incidence of mono-energetic electrons. In high-gain liquid scintillation counting of β emitting nuclides, in particular, of high end-point energy, afterpulses superimpose on the inherent low amplitude fraction of the pulse height spectrum, making high efficiency counting impossible, as reported by some authors²⁾⁻⁶⁾. Disagreement, however, exists among their views for the sources of afterpulsing. As a first step of understanding afterpulsing in a general basis, a further investigation of afterpulses on plastic scintillator was undertaken in consideration of relatively high intensity of afterpulses in this scintillator.

For providing a mono-energetic particle source, a ^{210}Po α -ray source unit was assembled on the cylindrical housing of an EMI 9635QB photomultiplier. In this set-up, a collimated beam of α -rays irradiates a thin disc of plastic scintillator coupled to the photomultiplier tube. The outer surface of the scintillator is tightly covered with aluminum foil of 1.4 mg/cm^2 thickness for avoiding the exposure of the photomultiplier to the luminescence which arises from the excitation of air in the traveling passage of α -rays. Output pulses from the detector are fed to an amplifier, and applied to a multichannel analyzer via an amplitude limiting circuit. Since the pulse height of afterpulses is low, a high amplifier gain should be provided to give sufficient counts to afterpulses, and consequently the α output pulses from the amplifier are mostly saturated. The am-

plitude limiting circuit is incorporated for admitting even such pulses into the analyzer. Fig. 1 shows the net pulse height distribution of the main peak and afterpulses along with the background spectrum. Since no significant change was indicated in the background spectrum before and after the irradiation of α -rays, these afterpulses can not be attributed to phosphorescence of long decay time which might be initiated by the exposure of the photomultiplier and/or scintillator to room light. Time relationship of afterpulses with respect to the main pulse was recorded with the aid of the multiscaling mode of the multichannel analyzer. The result revealed a monotonous decrease of afterpulse occurrence ceasing in about $500\text{ }\mu\text{s}$ after the main peak. This fact suggests the usefulness of a dead-time circuit for eliminating these afterpulses. It was actually demonstrated by analysing the output pulses in the anticoincidence mode of the multichannel analyzer, with the gate pulses of various widths up to $500\text{ }\mu\text{s}$ triggered by

Fig. 1 Integral pulse height distribution of α -pulse and afterpulses.

Table 1 Afterpulse suppression by use of dead-time

Dead-time (μ s)	Afterpulse count rate (cps)	Main pulse count rate observed (cps)	Dead-time correction	Main pulse count rate corrected (cps)
0	244.9	403.4	0	403.4
50	149.9	396.2	0.018	404.2
100	71.3	389.9	0.039	405.8
200	17.1	370.5	0.074	400.2
300	9.7	357.5	0.107	400.4
400	6.7	344.0	0.138	398.9
500	5.0	331.9	0.166	397.9

main pulses. The results are summarized in Table 1.

It is also interesting that some materials such as glass, quartz, lucite, air etc. show pulses quite similar to the afterpulse above mentioned, due to the incidence of α -rays. This fact should be taken into account in the theoretical and practical consideration of afterpulsing in the scintillators.

References

- 1) F.T. Porter, et al.: *Nucl. Instr. and Meth.*, **39**, 35 (1966)
- 2) D.L. Horrocks and M.H. Studier: *Anal. Chem.*, **33**, 615 (1961)
- 3) J.O. Burgman: *Atompraxis*, **11**, 37 (1965)
- 4) K. Friedrich und M. Leistner: *Isotopenpraxis*, **4**, 251 (1968)
- 5) P. Fodor-Csányi and SzilaÁgyi-Gyori: *Int. J. Appl. Radiat. Isotopes*, **19**, 712 (1968)
- 6) P. Fodor-Csányi and B. Levay: *ibid.*, **20**, 223 (1969)