Nuclear Instruments and Methods in Physics Research A244 (1986) 577–578
North-Holland, Amsterdam

Letter to the Editor

NEW RESULTS ON THE SCINTILLATION PROPERTIES OF BaF_2

Y.C. ZHU, J.G. LU, J. LI, Y.Y. SHAO, H.S. SUN, B.Z. DONG, G.P. ZHOU and Z.P. ZHENG

Institute of High Energy Physics, Academia Sinica, Beijing, P.R. China

F.Z. CUI and C.J. YU

Insitute of Optics and Fine Mechanics, Academia Sinica, Changchun, P.R. China

Received 4 November 1985

Energy resolutions and photoelectron yields are reported for scintillating BaF_2 crystals.

Scintillation detectors using BaF_2 crystals have attracted considerable attention recently, primarily because of the excellent scintillation and timing characteristics of this material. One component of the scintillation light has a decay time of 0.6 ns and a capability for timing resolutions of 112 ps (fwhm), comparable to that of fast plastic scintillators, has been reported [1]. This paper presents new results associated with the photoelectron yield and the energy resolution. These results, obtained with crystals produced at the Changchun Institute of Optics and Fine Mechanics, indicate that the energy resolution, in the low energy region, is comparable to that of NaI and the photoelectron yield is higher.

We used several cylindrical BaF_2 crystals, each optically polished on all surfaces and covered with Al_2O_3 powder, coupled to a XP 2020Q photomultiplier. The energy resolution ($\Delta E/E$), as determined with a ^{137}Cs source, is given, for each crystal, in table 1.

Table 1
Energy resolution of the BaF_2 samples

Sample	Dimension [mm]	Energy resolution ($\Delta E/E$) [%]
Crystal #1	20 (diameter)×5	8.3
Crystal #2	20 (diameter)×10	7.7
Crystal #3	30 (diameter)×20	9.7

Table 2
Energy response

Source	Photoelectron peak position (channel no.)	Energy resolution ($\Delta E/E$) [%]
^{60}Co (1.33 MeV)	489 ± 12	5.9
^{22}Na (1.27 MeV)	470 ± 12	6.2
^{60}Co (1.17 MeV)	432 ± 14	7.4
^{54}Mn (835 keV)	313 ± 11	8.3
^{137}Cs (662 keV)	224 ± 10	9.4
^{22}Na (511 keV)	183 ± 9	11.5

We have also measured the energy spectrum for crystal #2 using ^{60}Co, ^{22}Na, ^{54}Mn and ^{137}Cs sources in order to verify the linearity of the energy response. The results from these measurements are listed in table 2, and plotted in fig. 1. Photographs of the energy spectra from the ^{60}Co, ^{137}Cs and ^{22}Na sources are shown in fig. 2.

We have previously reported on photoelectron yields for the fast component [2]. Here we report our more recent results on the total yield of scintillation light. These measurements were done by comparing the peak position for the photoelectric absorption peak from ^{137}Cs γ-rays with that for single photoelectrons emitted from the photocathode of a XP 2020Q photomultiplier. This tube has a bialkali photocathode with a quartz window. For these measurements we used electronics with a 10 ns differentiation time for the fast component

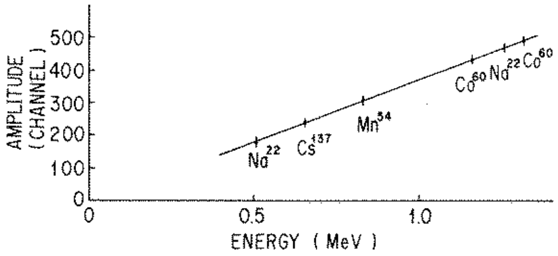

Fig. 1. The mean peak position for photoelectric peaks from ^{22}Na, ^{137}Cs, ^{54}Mn and ^{60}Co, plotted vs the absorbed energy.

0168-9002/86/$03.50 © Elsevier Science Publishers B.V.
(North-Holland Physics Publishing Division)

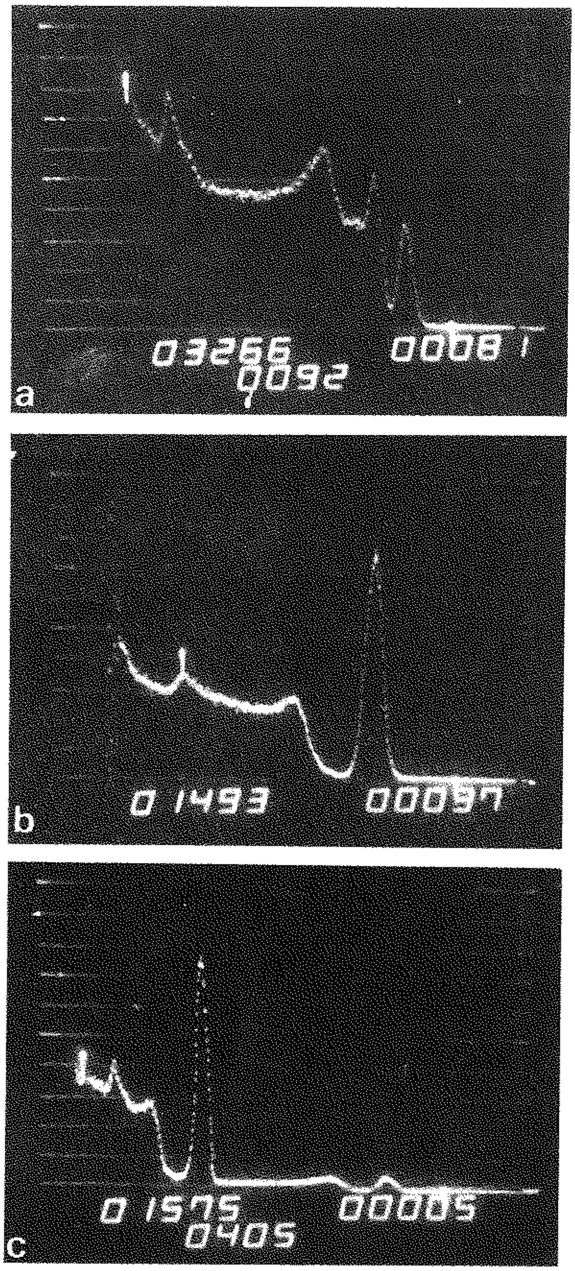

Fig. 2. The recorded pulse height spectra for (a) ^{60}Co (b) ^{137}Cs, (c) ^{22}Na radioactive sources.

Table 3
Photoelectron yield

Sample	Fast component [p.e./MeV]	All components [p.e./MeV]
Crystal #1	448	2666
Crystal #2	484	2832
Crystal #3	403	2518

and 6.4 μs for the slow component. The results are given in table 3.

These results indicate that BaF_2 is well suited for detector applications. For example, it could be used as an electromagnetic energy calorimeter for high energy electrons and γ's as described in ref. [3], or as a 4π γ-ray detector for precision measurements of neutron capture cross sections (see ref. [4]). The short wavelength character of the scintillation light may make these crystals well suited to low-pressure wire chamber readout systems [5].

Acknowledgment

The authors would like to express their appreciation to Prof. M.H. Ye for supporting the present work. Prof. S.L. Olsen helped with the preparation of this manuscript.

References

[1] M. Laval et al., Nucl. Instr. and Meth. 206 (1983) 169.
[2] Z.P. Zheng et al., Phys. Ener. Fort. Phys. Nucl. 8 (1984) 392.
[3] F. Takasaki et al., Nucl. Instr. and Meth. 226 (1984) 344.
[4] K. Wisshak and F. Kappeler, Nucl. Instr. and Meth. 227 (1984) 91.
[5] D.E. Anderson et al., Nucl. Instr. and Meth. 217 (1983) 217.

Nucle
North-

Lette

MEA

Y.C.

Institut

Y.D.

The Be

Receive

We
scintilla

As
higher
detecti
gard, t
length
crystals
cal pro
raw ma
for larg
energie
photoel
decay t
this ma
Rep
mentior
was not
6 mm^3
versity,
here; th
were op
Al_2O_3 p
plier (PI
quartz w
The
(p.e./M
compari
due to
single pl
by first
toelectro
the intro
attenuat
the sam
observed
tron yiel

0168-900
(North-F