AEC-NASA TECH BRIEF

AEC-NASA Tech Briefs describe innovations resulting from the research and development program of the U.S. AEC or from AEC-NASA interagency efforts. They are issued to encourage commercial application. Tech Briefs are published by NASA and may be purchased, at 15 cents each, from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Pulse-Height Defect Due to Electron Interaction in Dead Layers of Ge(Li) Gamma-Ray Detectors

Study of the pulse-height degradation of gamma-ray spectra in germanium detectors has shown it to be due to electron interaction in the "dead layers" that exist in all semiconductor detectors (see reference). These interactions give rise to pulses having slower rise times than ordinary or normal pulses. Effective means to eliminate this problem are discussed.

This effect, of the amplifier time constants being shorter than the rise time of the pulse, had been observed previously and labeled the "ballistic deficit." However, this study appears to be the first systematic attack on the problem of the origin of the slow-rising pulse and the ballistic deficit.

Gamma rays giving rise to ionizing electrons, in the dead layers of Ge(Li) detectors, result in the slow pulses of reduced amplitude that degrade energy spectra and coincidence resolution. These pulse-height defects are not inherent in the detectors' properties, but result from current detector-fabrication techniques. The factors affecting spectral degradation include the thickness of the dead layer relative to the compensated region, the field intensity in the dead layer, and the pulse-shaping time constants in the main amplifier.

It is shown that, when internal-conversion electrons from ^{207}Bi (about 1 MeV) impinge on a detector with a thin dead layer of 10μ, the peaks characteristic of the K and L electrons are well defined; however, when they impinge on a detector with a dead layer of 0.3 mm, the electron spectrum shows no features except a continuum that rises at the low-energy end. The distribution of rise times, resulting from the interaction of conversion electrons in the latter detector, exhibits a peak indicating abundance of slow pulses.

A similar peak is apparent in the rise-time distribution from gamma rays in the continuum of the energy spectrum, but not from gamma rays in the full-energy peak. This fact suggests that a significant fraction of the pulses in the continuum is due to electron and/or positron interaction in the dead layers.

A pulse-shape-discrimination technique was developed whereby defective pulses are identified and rejected. Gamma-ray spectra from a single Ge(Li) detector and from a Ge(Li)–NaI(Tl) three-crystal pair spectrometer were studied. Comparison of these spectra with and without rejection of slow pulses shows that, in an 11-mm-thick detector, the portion of the continuum due to defective pulses approaches 50%.

The discrimination technique is described, and results of several experiments are presented.

Reference:

1. Strauss, M. G.; Larsen, R. N.: Pulse Height Defect Due to Electron Interaction in the Dead Layers of Ge(Li) γ-Ray Detectors. Argonne National Laboratory, May 1967.

Notes:

1. Organizations using high-resolution spectroscopy may be interested.
2. Inquiries concerning this information may be directed to:

Office of Industrial Cooperation
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
Reference: B69-10767

(continued overleaf)

Patent status:

Inquiries concerning rights to commercial use of this information may be made to:

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439

Source: M. G. Strauss and R. N. Larsen
Electronics Division
(ARG-10362)