Functional Materials 9, No.3 (2002) 

# Crystal shape variation as a way to improve the axial directionality of scintillation gamma detectors

***B.V.Grinyov, V.I.Melnik, V.Yu.Pedash***

Institute for Single Crystals, National Academy of Sciences of Ukraine,
60 Lenin Ave., 61001 Kharkiv, Ukraine

*Received December 28, 2001*

Axially directional scintillation detectors of gamma radiation are considered. The effect of the scintillation crystal geometry on the detector directivity diagram is studied. Simulation results have been presented for cylindrical and biconical crystals. The biconical shape has been found to be the optimum one for the scanning of a radioisotope spread over a plane. A new method has been proposed for determination of resolution.

В работе рассматриваются осенаправленные сцинтилляционные детекторы гамма-излучения. Исследуется влияние геометрии сцинтилляционного кристалла на диаграмму направленности детектора. Приведены результаты моделирования цилиндрических и биконических кристаллов. Выявлено, что биконическая форма является оптимальной при сканировании радиоактивного изотопа, распределенного на плоскости. Предложен новый способ определения разрешающей способности.

Solution of many problems arising in detection of ionizing radiation is connected with the use of detectors sensitive to the gamma quantum arrival direction. Such detectors can be subdivided conventionally into two groups. Let the detectors providing the trajectory determination for each individual quantum be included in the first group. The second one includes the detectors having the output signal depending on the incident flow. The first type detectors are rather sophisticate devices and are used when low activities are to be observed. The second type ones are much simpler in design and are applied in a much wider field. In what follows, it is just the second type detectors that will be considered.

The gamma quanta flows themselves may also differ considerably. Here, it is just the flow characteristics associated with its directionality that are of interest. In the case when one or more radiation source are disposed at a distance exceeding considerably the detector characteristic size (in the long-range zone), the flow is believed to be parallel. If the detector dimensions are comparable to the distance at the source(s) (in the short-range zone), the flow is considered to be diverging. When determining the detector directivity properties, in the first case, a dependence can be used expressed as the ratio of the detector output signal under its irradiation by a fixed flow from a certain direction to the signal obtained under the same flow but from a preset direction. In the second case, it is difficult to speak about any direction, the flow radial divergence must be taken into account. Here, the gamma quanta source spatial position and not their propagation direction is more expedient to consider. Proceeding from the above, let a definition be introduced that will be used in what follows. The absolute recording efficiency (ARE) is defined as a quantity equal to the ratio of gamma quanta number recorded by the detector to their total number radiated from a certain spatial region. The detector directivity can