New materials for radiation detection and measurement

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We summarize recent progress in compound semiconductor and scintillator development for X-and gamma-ray applications. For radiation detection, compound semiconductors have a number of distinct advantages over their elemental counterparts, Si and Ge, arising from the wide range of physical and electronic properties available. For example, wide-gap materials offer the ability to operate in a range of hostile thermal and radiation environments while still maintaining spectral resolutions <2% FWHM. Narrow-gap materials offer the potential of exceeding the spectral resolution of Ge by a factor of three. However, while compound semiconductors are routinely used as detection media at infra-red and optical wavelengths, for hard X- and gamma-ray applications their development has been plagued by material and fabrication problems. So far only a few have evolved sufficiently to produce commercial detection systems.

As well as on-going activities in semiconductors, considerable effect has also been carried out developing new scintillators - the most notable result of which has been the recent availability of large volume LaBr3 and LaCl3 crystals. Currently the effort is on developing the next generation of low noise, high resolution scintillators, such as CeBr3 and SrI2, as well as exploring new activators such as Eu and Pr. In addition to growth programs, experimental and theoretical work is now focusing on the origin of non-proportionality in scintillators which has been a long standing problem for more than four decades. Simply stated, the scintillation response for energy depositions < ~100 keV does not vary linearly with energy and can be as much as 50% deviant from that expected based on statistical arguments. The net effect is a degraded energy resolution.

In this talk, we explore the current status of research in compound semiconductor and scintillators. We examine their limitations and possible work around solutions. The conclusions drawn indicate that in the long term, effort should concentrate on material perfection. For semiconductors, the immediate future lies in the controlled and directed manipulation of charge, while for scintillators it lies with the understanding and reduction of non-proportional effects.