

RMD Publications 2003

511) **A comparison of CsL(TI) screens for mammography**

2003 Proc SPIE: physics of Medical Imaging

Tipnis SV, Nagarkar VV, Gaysinskiy V, Miller SR, Shestakova I

510) **Recent advances in very large area avalanche photodiodes**

2003 SPIE Proceedings Vol.5071 Pages 405-410

Squillante MR, Christian J, Entine G, Farrell R, Karger A, McClish M, Myers R, Shah, K, Taylor D, Vanderpuye K

Abstract

The Avalanche Photodiode (APD) is a unique device that combines the advantages of solid state photodetectors with those of high gain devices such as photomultiplier tubes (PMTs). APDs have internal gain that provides a high signal-to-noise ratio. APDs have high quantum efficiency, are fast, compact, and rugged. These properties make them suitable detectors for important applications such as LADAR, detection and identification toxic chemicals and bio-warfare agents, LIDAR fluorescence detection, stand-off laser induced breakdown spectroscopy (LIBS), and nuclear detectors and imagers. Recently there have been significant technical breakthroughs in fabricating very large APDs, APD arrays, and position sensitive APD arrays (PSAPD). Signal gain of over 10,000 has been achieved, single element APDs have been fabricated with active area greater than 40 cm², monolithic pixelated arrays with up to 28 x 28 elements have been fabricated, and position sensitive APDs have been developed and tested. Additionally, significant progress has been made in improving the fabrication process to provide better uniformity and high yield, permitting cost effective manufacturing of APDs for reduced cost.

509) **Geiger photodiode array for compact, lightweight laser-induced breakdown spectroscopy instrumentation**

2003 Applied Optics Vol.42 Pages 6072-6077

Myers RA, Karger AM, Hahn DW

Abstract

The development of a unique spectrometer based on an array of Geiger photodiodes has been shown to enhance the performance of laser-induced breakdown spectroscopy (LIBS) instrumentation. These compact, silicon-based detectors eliminate the need for postamplification electronics, allow for the detection of single photons at room temperature, and do not require complex gating-timing circuitry. The detectors have dark-count rates of <500 Hz at room temperature and a good response from the UV to the near IR. Their high sensitivity makes them candidates for standoff analysis as part of a LIBS spectrum analyzer.

508) High energy resolution scintillation spectrometers

2003 IEEE Nucl. Sci. Symp. Conf. Rec. Vol.5 Pages 3574-3578

Glodo J, Gupta T, Higgins W, Klugerman M, Shah KS, Wong P

Abstract

In this paper, we report on cerium doped scintillator LaBr₃:Ce for gamma ray spectroscopy. Crystals of this scintillator have been grown using the Bridgman process. This material when doped with cerium has high light output (~60,000 photons/MeV) and fast principal decay constant (~30 ns). The peak of LaBr₃:Ce emission is at 360 nm. LaBr₃:Ce shows excellent energy resolution for gamma ray detection. For 662 keV gamma rays (137Cs source), energy resolution of 2.7% (FWHM) has been recorded at room temperature for LaBr₃:Ce crystals coupled to a photomultiplier. This energy resolution is over two times better than that of NaI(Tl) scintillators. Analysis of the energy resolution of LaBr₃:Ce scintillators is presented and the performance of this scintillator at other gamma ray energies is covered. Energy resolution of LaBr₃:Ce crystals coupled to silicon avalanche photodiodes is discussed. Potential applications of this material are addressed.

507) A hybrid position sensitive avalanche photodiode detector for scintillation spectroscopy and imaging

2003 IEEE Nucl. Sci. Symp. Conf. Rec. Vol.2 Pages 1358-1362

Benz R, Farrell R, Glodo J, Grazioso R, Karplus E, McClish M, Shah KS

Abstract

We investigate a prototype hybrid position sensitive avalanche photodiode (HPSAPD) that combines conventional photomultiplier tube (PMT) and solid-state photodiode technology to form a rugged, compact, high gain (similar to similar to 10^{6-7}), high signal-to-noise ratio (S/N) photodetector. This detector uses a photocathode to convert incident light into photoelectrons that are accelerated to a position sensitive avalanche photodiode (PSAPD). Through impact ionization initiated by the incident accelerated photoelectrons, the PSAPD provides additional gain. The PSAPD provides an output signal used for energy and timing resolution information and 4 additional output signals for position information. Here we characterize and show the initial spectroscopic and imaging capabilities of a prototype HPSAPD that uses a GaAs photocathode and a planar PSAPD of 14 × 14 mm² area.

506) Lu₃:Ce - A new scintillator for gamma ray spectroscopy

2003 IEEE Nucl. Sci. Symp. Conf. Rec. Vol.2 Pages 891-894

Derenzo SE, Dorenbos P, Glodo J, Gupta T, Higgins W, Klugerman M, Moses WW, Shah KS, Weber MJ, Wong P

Abstract

In this paper, we report on a new cerium doped, high atomic number scintillator - Lu₃:Ce for gamma ray spectroscopy. Crystals of this material have been grown using Bridgman process. Lu₃ crystals doped with 0.5 and 5% Ce³⁺ show high light output (~50,000 photons/MeV) and fast principal decay constant (23 to 31 ns). The Ce³⁺ emission peaks at 474 nm. Energy resolution of Lu₃:Ce coupled to photo multiplier (PMT) and measured at 662 keV was similar to 10% (FWHM). Timing resolution of Lu₃-PMT and BaF₂-PMT detectors operating in coincidence mode was measured to be 210 ps (FWHM). Potential applications of this scintillator are discussed.

505) A high efficiency pixelated detector for small animal PET

2003 IEEE Nucl. Sci. Symp. Conf. Rec. Vol.4 Pages 2288-2290

Cherry SR, Nagarkar VV, Shah K, Shestakova I, Tipnis SV

Abstract

We report on the development of a new high efficiency detector for small animal PET. The detector is based on a monolithic block of LSO pixelated using laser ablation technique. The laser processing allows pixelation with very narrow, 70 μ m wide, inter-pixel gaps resulting in a substantially enhanced sensitivity when the detectors are operated in coincidence mode. This paper presents the first results of a detector module fabricated using this approach. Preliminary imaging data at 511 keV obtained by coupling the pixelated LSO to a position sensitive photomultiplier tube (PSPMT) and a position sensitive avalanche photodiode (PSAPD) are presented.

504) Lu₂O₃:Eu scintillator screen for x-ray imaging

2003 Proc SPIE Int Soc Opt Eng Vol.5199 Pages 167-172

Brecher C, Lempicki A, Lingertat H, Miller SR, Nagarkar VV, Shestakova I, Tipnis SV

Abstract

We report on a new x-ray converter screen based on the powdered Lu₂O₃:Eu scintillator. Lu₂O₃:Eu offers high density (9.4 g/cm³), high average atomic number (63), and a peak emission of 610 nm. The high density of the material and a high packing fraction of the coating provide higher x-ray absorption efficiency, even with thin screens. As a result Lu₂O₃:Eu screens are expected to provide superior spatial resolution and x-ray stopping power compared to commercial powdered screens. This newly developed screen has excellent imaging performance and offers several practical advantages such as ease of fabrication, low cost, and durability. This paper will discuss preliminary results of the imaging performance of this novel screen.

503) LaBr₃:Ce Scintillators for Gamma-Ray Spectroscopy

2003 IEEE Trans Nucl Sci Vol.50 Pages 2410-2413

Derenzo SE, Glodo J, Klugerman M, Moses WW, Shah KS, Weber MJ

Abstract

In this paper, we report on a relatively new scintillator - LaBr₃:Ce for gamma-ray spectroscopy. Crystals of this scintillator have been grown using Bridgman process. This material when doped with cerium has high light output (similar to 60000 photons/MeV) and fast principal decay constant (~25 ns). Furthermore, it shows excellent energy resolution for γ -ray detection. Energy resolution of 3.2% (FWHM) has been achieved for 662 keV photons (137Cs source) at room temperature. High timing resolution (260 ps - FWHM) has been recorded with LaBr₃:Ce-PMT and BaF₂-PMT detectors operating in coincidence mode using 511-keV positron annihilation γ -ray pairs. Details of its scintillation properties, and variation of these properties with changing cerium concentration are reported. Potential applications of this material are also addressed.

502) **Recent advances in very large area avalanche photodiodes**

2003 Proc SPIE International Society Optical Engineering Vol.5071 Pages 405-410

Christian J, Entine G, Farrell R, Karger A, McClish M, Myers R, Shah K, Squillante MR, Taylor D, Vanderpuye K, Waer P, Woodring M

Abstract

The Avalanche Photodiode (APD) is a unique device that combines the advantages of solid state photodetectors with those of high gain devices such as photomultiplier tubes (PMTs). APDs have internal gain that provides a high signal-to-noise ratio. APDs have high quantum efficiency, are fast, compact, and rugged. These properties make them suitable detectors for important applications such as LADAR, detection and identification toxic chemicals and bio-warfare agents, LIDAR fluorescence detection, stand-off laser induced breakdown spectroscopy (LIBS), and nuclear detectors and imagers. Recently there have been significant technical breakthroughs in fabricating very large APDs, APD arrays, and position sensitive APD arrays (PSAPD). Signal gain of over 10,000 has been achieved, single element APDs have been fabricated with active area greater than 40 cm², monolithic pixelated arrays with up to 28 × 28 elements have been fabricated, and position sensitive APDs have been developed and tested. Additionally, significant progress has been made in improving the fabrication process to provide better uniformity and high yield, permitting cost effective manufacturing of APDs for reduced cost.

501) **Geiger photodiode array for compact, lightweight laser-induced breakdown spectroscopy instrumentation**

2003 Applied Optics Vol.42 Pages 6072-6077

Hahn DW, Karger AM, Myers RA

Abstract

The development of a unique spectrometer based on an array of Geiger photodiodes has been shown to enhance the performance of laser-induced breakdown spectroscopy (LIBS) instrumentation. These compact, silicon-based detectors eliminate the need for postamplification electronics, allow for the detection of single photons at room temperature, and do not require complex gating-timing circuitry. The detectors have dark-count rates of ≤ 500 Hz at room temperature and a good response from the UV to the near IR. Their high sensitivity makes them candidates for standoff analysis as part of a LIBS spectrum analyzer. \$CPY 2003 Optical Society of America.

500) **New design of a structured CsI (TI) screen for digital mammography**

2003 Proc SPIE Int Soc Opt Eng Vol.5030 (II) Pages 541-546

Gaysinskiy VB, Karellas A, Miller SR, Nagarkar VV, Tipnis SV, Vedantham S

Abstract

Columnar CsI(Tl) screens are now routinely used for digital x-ray imaging in a wide variety of applications such as mammography, dental radiography, and non-destructive testing. While commercially available CsI(Tl) screens exhibit excellent properties, it is possible to significantly improve their performance. Here, we report on a new design of a columnar CsI(Tl) screen. Specifically, columnar CsI(Tl) screens were subjected to mechanical pixelation for minimizing the long range spread of scintillation light within the film, thus enhancing spatial and contrast resolution, and increasing the detective quantum efficiency (DQE(f)) of the digital imaging detector. To date we have fabricated up to 200 μm thick pixelated CsI(Tl) screens for mammography, and characterized their performance using a CCD camera. This paper presents a comparison of the new pixelated CsI(Tl) screens, conventional columnar CsI(Tl) screens, and Gd₂O₃(Tb) screens. The data show that pixelated screens substantially improve the DQE(f) of the digital imaging system.

499) A new X-ray scintillator for digital radiography

2003 IEEE Trans Nucl Sci Vol.50 (III) Pages 297-300

Brecher C, Lempicki A, Lingertat H, Miller SR, Nagarkar VV, Szupryczynski P, Tipnis SV

Abstract

The authors report a new scintillator based on a transparent ceramic of Lu₂O₃:Eu. The material has an extremely high density of 9.4 g/cm³ and a light output comparable to CsI:TI. Its narrow-band emission at 610 nm perfectly matches the spectral response of charge coupled devices (CCDs). To enhance the spatial and contrast resolution, the authors have developed a special process to pixelate the scintillator and prevent the spread of light within the scintillator volume. The imaging performance of this pixelated device was evaluated using a thermoelectrically cooled CCD camera. The new scintillator is expected to play a major role in digital radiographic systems when readout technologies capable of taking advantage of the transparency are developed further.

498) Polycrystalline lead iodide films for digital X-ray sensors

2003 Nuclear Instrumentation Methods Phys Res Sect A Vol.505 Pages 269-272

Bennett PR, Dmitriev Y, Gupta T, Klugerman M, Partain L, Pavyluchova R, Shah KS, Squillante M

Abstract

Polycrystalline lead iodide (PbI₂) is one of only a few materials commonly mentioned as a potential direct converter for digital X-ray sensors. Previous evaluations have noted higher than desirable leakage currents and commented on imaging characteristics from sensors constructed with PbI₂ films deposited onto amorphous Si thin film transistor arrays. Changes in film growth parameters show a significant reduction in leakage current, to 10's of pA/mm² (or less than 1pA/pixel). Sensitivity remains good but is limited by incomplete X-ray absorption and lag. Image samples are derived from two different a-Si TFT designs, demonstrating high resolution and good contrast. ©CPY 2003 Elsevier Science B.V. All rights reserved.

497) LaCl₃:Ce scintillator for γ -ray detection

2003 Nucl Instrum Methods Phys Res Sect A Vol.505 Pages 76-81

Cirignano L, Derenzo SE, Glodo J, Klugerman M, Moses WW, Shah KS, Weber MJ

Abstract

In this paper, we report on a relatively new cerium-doped scintillator - LaCl₃ for γ -ray spectroscopy. Crystals of this scintillator have been grown using Bridgman method. This material when doped with 10% cerium has high light output (similar to 50,000 photons/MeV) and fast principal decay time constant (similar to 20 ns). Furthermore, it shows excellent energy resolution for γ -ray detection. For example, energy resolution as low as 3.2% (FWHM) has been achieved with 662 keV photons (¹³⁷Cs source) at room temperature. Also, high timing resolution (264 ps - FWHM) has been recorded with LaCl₃-PMT and BaF₂-PMT detectors operating in coincidence using 511 keV positron annihilation γ -ray pairs. Details of crystal growth, scintillation properties, and variation of these properties with cerium concentration are also reported. ©CPY 2003 Elsevier Science B.V. All rights reserved.

496) Advanced multi-dimensional imaging of gamma-ray radiation

2003 Methods Phys Res Vol.505 Page 415

Woodring M, Beddingfield D, Souza D, Entine G, Squillante M, Christian J, Kogan A

495) Avalanche photodiode light detectors and arrays for homeland security

2003 SPIE Aerosense J Vol. Pages

Gurjar RS, Karger AM, Squillante MR