452) **Screen-printed dye-sensitized large area nanocrystalline solar cell**

1999 Materials Research Society (MRS Symposium Proceedings Vol.581 Pages 653-658

Gupta TK, Cirignano LJ, Shah KS, Moy LP, Kelly DJ, Squillante MR, Entine G, Smestad GP

Abstract

The fabrication and testing of screen printed dye-sensitized large solar cell (15 x 15 cm) based on nanocrystalline TiO2 are described. It is the largest photo-electrochemical (PEC) cell that is based on the dye sensitization of thin (8-18-micron) films of TiO2 nanoparticles in contact with a non-aqueous liquid electrolyte. The cell has the potential to be a low cost, commercial, environmentally friendly, photovoltaic option. Surface as well as electrical characterization of the nanostructured PEC cells have been performed. The efficiency of these large commercial cells are compared to the laboratory-made small PEC cells.

451) **Developments in synchrotron X-ray computed microtomography at the National Synchrotron Light Source**

1999 SPIE Proceedings Vol.3772 Pages 224-236

Dowd BA, Campbell GH, Marr RB, Nagarkar V, Tipnis S, Axe L, Siddons DP

Abstract

Last year, the X27A beamline at the National Synchrotron Light Source (NSLS) became dedicated solely to X-Ray Computed Microtomography (XCMT). Recent enhancements will he discussed. These have focused on two issues: the desire for real-time data acquisition and processing and the need for highly monochromatic beam (0.1 percent energy bandpass). The latter will permit k-edge subtraction studies and will provide improved image contrast from below the Cr (6 keV) up to the Cs (36 keV) k-edge. A range of applications that benefit from these improvements will be discussed as well. These two goals are somewhat counterproductive, however; higher monochromaticity yields a lower flux, forcing longer data acquisition times. To balance the two, a more efficient scintillator for X-ray conversion is being developed. Some testing of a prototype scintillator has been performed; preliminary results will be presented here. In the meantime, data reconstruction times have been reduced, and the entire tomographic acquisition, reconstruction and volume rendering process streamlined to make efficient use of synchrotron beam time.

450) **Bismuth iodide crystals as a detector material - Some optical and electrical properties**

1999 SPIE Proceedings Vol.3768 Pages 521-529

Dmitriev YN, Bennett PR, Cirignano LJ, Klugerman M, Shah KS

Abstract

This paper describes the preliminary results obtained from our study of optical and electrical properties of BiI3 crystals. The bismuth iodine polycrystals were grown using commercial starting material by the vertical Bridgman method. For our measurements we used only single crystal samples that were cut out from grown crystals perpendicular to the C6-axis. BiI3 is a layered hexagonal lattice similar to the PbI2 lattice, where two-thirds of the metal sublattice sites are occupied, and the remaining one-third is vacant. The average atomic number of the bismuth iodide (60.5) is very close to that of lead iodide (62.7). Therefore, BiI3 is similar to the better known PbI2, and can be a promising detector material. Our measurements show that bismuth iodide crystals have resistivity on the order of 1 G-ohm/cm and energy gap E(g) = 1.72 eV. The photocurrent, as a function of bias and wavelength, as well as detector responses from excitation by blue LED and X-ray tube photons, were measured. The value of the mobility-lifetime product of the electron (10 exp -5 sq cm/V) was estimated by the Hecht technique. The optical characterization also included measuring of the quantum efficiency for the BiI3 detector. The experimental results demonstrate the potential feasibility of using BiI3 as detector material operating at room temperatures.

449) **Characterization of screen-printed, dye-sensitized, nanocrystalline TiO2 solar cells**

1999 SPIE Proceedings Vol.3789 Pages 149-157

Gupta TK, Cirignano LJ, Shah KS, Moy LP, Kely DJ, Squillante MR, Entine G, Smestad GP

Abstract

Titanium dioxide films have been deposited on SnO2 coated glass substrates by screen printing. Film morphology and structure have been characterized by scanning electron microscopy, X-ray diffraction and BET analysis. Dye-sensitized TiO2 photoelectrochemical (PEC) cells have been assembled and characterized. Cells sensitized with anthocyanin and a ruthenium complex have been investigated. A 0.77 sq cm ruthenium dye sensitized cell with 6.1 percent power conversion efficiency under AM1.5 conditions was obtained. Results obtained with a pure anthocyanin dye and dye extracted from blackberries were compared. Finally, a natural gel was found to improve the stability of anthocyanin sensitized cells.

448) **Development of Geiger mode micro-avalanche photodiode arrays for FiberGLAST**

1999 SPIE Proceedings Vol.3765 Pages 2-11

Vasile S, Shamo D, Shera S, Fishman GJ

Abstract

The Gamma-Ray Large Area Space Telescope (GLAST) mission is planned as the next major challenge in high-energy astrophysics. FiberGLAST is one of the technologies being developed for GLAST and is using arrays of scintillation fibers (greater than 100,000) for the pair-tracking and calorimeter detectors. The instrument requires optical detectors with high gain, low cost, and low power to read out the large number of individual fibers. We evaluated the feasibility of using Geiger-mode-operated micro-Avalanche Photodiode (micro-APD) arrays in conjunction with optical concentrator arrays as scintillating fiber readouts for FiberGLAST. The micro-APD detection efficiency and dark count rate were measured for different micro-APD configurations and temperatures. Prototype concentrators were fabricated and the light losses evaluated. Additionally, low power, simple passive quenching circuits for micro-APDs were investigated. Using the components' measured performance, we analyzed the tradeoffs between the concentrator light transfer efficiency, micro-APD sensitive area, and speed, in order to maintain high detection efficiency at preset dark count rates. We found that there is a minimum size of the micro-APD sensitive area required to operate the integrated APD-concentrator detector at high detection efficiency (greater than 90 percent). Cone concentrators, of potentially low cost, would allow for the fabrication of gAPDs with smaller areas, and consequently reduced dark count rate. We concluded that fibers ranging from 0.3 to 0.7 mm can be efficiently read out by the integrated detector, while maintaining less than 100 Hz dark count rate.

447) **Bismuth iodide crystals as a detector material: Some optical and electrical properties**

1999 Proceedings of SPIE - The International Society for Optical Engineering Vol.3768 Pages 521-529

Dmitriyev Y, Bennett PR, Cirignano LJ, Klugerman M, Shah KS

Abstract

This paper describes the preliminary results obtained from our study of optical and electrical properties of BiISUB3 crystals. The bismuth iodine polycrystals were grown using commercial starting material by vertical Bridgman method. For our measurements we used only single crystal samples that were cut out from grown crystals perpendicular to CSUB6-axis. BiISUB3 is a layered hexagonal lattice similar to the PbISUB2 lattice, where two-thirds of the metal sublattice sites are occupied and the remaining one-third are vacant. The average atomic number of the bismuth iodide (left angle bracket Z right angle bracket equals 60.5) is very close to that of lead iodide (left angle bracket Z right angle bracket equals 62.7). Therefore, BiISUB3 is similar to the better known PbISUB2 and can be a promising detector material. Our measurements have shown that bismuth iodide crystals have resistivity on the order of 1G Omega center dot cm and energy gap ESUBg equals 1.72 eV. The photocurrent, as a function of bias and wavelength, as well as detector responses from excitation by blue LED and X-ray tube photons were measured. The value of the mobility-lifetime product of the electron (mu tau to approximately 10SUP minus SUP5 cmSUP2/V) was estimated by the Hecht technique. The optical characterization also included measuring of quantum efficiency for BiISUB3 detector. The experimental results demonstrate the potential feasibility of using BiISUB3 as detector material operating at room temperatures. (Author abstract) 20 Refs.

446) **High gain avalanche photodiode arrays for DIRC applications**

1999 IEEE Transactions on Nuclear Science Vol.46 Pages 848-852

Vasile S, Wilson RJ, Shera S, Shamo D, Squillante MR

Abstract

The detection of light emitted in Cherenkov radiators requires fast detector arrays with high sensitivity to short wavelength photons. Photomultiplier tubes, the traditional imaging detectors for short wavelength optical radiation, have limited spatial resolution and require expensive anti-magnetic shielding. We report on the performance of a new, Geiger mode operated, silicon micro-avalanche photodiode (mu APD) array, designed for Cherenkov light imaging applications. We address issues of optical interfacing, speed, and pulse spectra achievable with these mu APDs. The new mu APD array provides a high sensitivity detector for applications requiring two dimensional light mapping with single photon sensitivity. These features make it a promising candidate for the detection of Cherenkov light in modern high energy physics experiments.

445) **Characterization of polycrystalline TlBr films for radiographic detectors**

1999 IEEE Transactions on Nuclear Science Vol.46 Pages 266-270

Bennett PR, Shah KS, Cirignano LJ, Klugerman MB, Moy LP, Olschner F, Squillante MR

Abstract

Vapor deposited films of thallium bromide are evaluated as potential photoconductive layers in new large-area radiographic detectors. The attractiveness of the material lies in its inherent high effective atomic number and high density. Polycrystalline films up to 200 mu m have been grown and show a columnar structure with grains reaching 100 mu m in diameter. Current-voltage (IV) tests indicate a bulk resistivity of 10SUP9-10SUP1SUP0 Omega center dot cm, limited by ionic conduction. Instability of current with time is also observed, but it can be minimized with cooling. The films demonstrate high gain at relatively low field strengths as compared to other photoconductive layers. Benefits and drawbacks of TlBr are compared to other materials, and possible solutions are discussed.

444) **High speed x-ray imaging camera using a structured CsI(Tl) scintillator**

1999 IEEE Transactions on Nuclear Science Vol.46 Pages 232-236

Nagarkar VV, Tipnis SV, Gupta TK, Miller SR, Gaysinskiy VB, Klugerman Y, Squillante MR, Entine G, Moses WW

Abstract

A prototype fast x-ray imaging system was constructed by using a structured CsI(Tl) scintillator coupled to a fast-frame 1K multiplied by 1K CCD. The system was successfully used to capture 1024 multiplied by 64 pixel x-ray images at a rate of 1000 frames per second (fps) with a 12 bit dynamic range. The system exceeds the capabilities of the current high speed x-ray imaging systems which typically operate at the rate of 30 fps.

443) **Characterization of polycrystalline TlBr films for radiographic detectors**

1999 IEEE Nuclear Science Symposium and Medical Imaging Conference Vol.1 Pages 689-693

Bennett PR, Shah KS, Cirignano LJ, Klugerman MB, Moy LP, Olschner F, Squillante MR

Abstract

Vapor deposited films of thallium bromide are evaluated as potential photoconductive layers in new large-area radiographic detectors. The attractiveness of the material lies in its inherent high effective atomic number and high density. Polycrystalline films up to 200 mu m have been grown and show a columnar structure with grains reaching 100 mu m in diameter. Current-voltage (IV) tests indicate a bulk resistivity of 10SUP9-10SUP1SUP0 Omega center dot cm, limited by ionic conduction. Instability of current with time is also observed, but it can be minimized with cooling. The films demonstrate high gain at relatively low field strengths as compared to other photoconductive layers. Benefits and drawbacks of TlBr are compared to other materials, and possible solutions are discussed.

442) **High speed x-ray imaging camera using structured CsI(T1) scintillator**

1999 IEEE Nuclear Science Symposium and Medical Imaging Conference Vol.1 Pages 158-162

Nagarkar VV, Tipnis SV, Gupta TK, Miller SR, Gaysinskiy VB, Klugerman Y, Squillante MR, Entine G, Moses WW

Abstract

A prototype fast x-ray imaging system has been developed using a structured CsI(T1) scintillator coupled to a fast-frame 1K multiplied by 1K CCD. The system exceeds the capabilities of the current high speed x-ray imaging systems that operate at the rate of 30 fps.

441) **High gain avalanche photodiode arrays for DIRC applications**

1999 IEEE Nuclear Science Symposium and Medical Imaging Conference Vol.1 Pages 117-121

Vasile S, Wilson RJ, Shera S, Shamo D, Squillante MR

Abstract

The detection of light emitted in Cherenkov radiators requires fast detector arrays with high sensitivity to short wavelength photons. Photomultiplier tubes, the traditional imaging detectors for short wavelength optical radiation, have limited spatial resolution and require expensive anti-magnetic shielding. We report on the performance of a new, Geiger mode operated, silicon micro-avalanche photodiode (mu APD) array, designed for Cherenkov light imaging applications. We address issues of optical interfacing, speed, and pulse spectra achievable with these mu APDs. The new mu APD array provides a high sensitivity detector for applications requiring two dimensional light mapping with single photon sensitivity. These features make it a promising candidate for the detection of Cherenkov light in modern high energy physics experiments.

440) **Development of Geiger mode micro-avalanche photodiode arrays for fiberGLAST**

1999 Proceedings of SPIE - The International Society for Optical Engineering Vol.3765 Pages 2 - 11

Vasile S, Shamo D, Shera S, Fishman GJ

Abstract

A study was conducted to evaluate the feasibility of using Geiger mode operated micro-Avalanche Photodiode arrays in conjunction with optical concentrator arrays as scintillating fiber readouts for FiberGLAST. The photodiode detection efficiency and dark count rate were measured for different photodiode configurations and temperatures. Prototype concentrators were fabricated and the light losses evaluated. In addition, low power, simple passive quenching circuits for photodiodes were investigated. Using the components' measured performance, the tradeoff between the concentrator light transfer efficiency, photodiode sensitive area, and speed, were analyzed to maintain high detection efficiency at preset dark count rates.

439) **Spectroscopic radiation imager for internet-based safeguards and monitoring**

1999 Proceedings of SPIE - The International Society for Optical Engineering Vol.3769 Pages 234-242

Woodring M, Souza D, Honig L, Squillante MR, Entine G

Abstract

Monitoring nuclear material that is dangerously radioactive, remotely located, or difficult to access is a challenging task. The necessary research required to develop a system capable of remotely monitoring radioactive materials has been undertaken at Radiation Monitoring Devices, Inc. We report on a system utilizing a spectroscopic gamma-ray imager for real-time observation of sensitive nuclear materials over the Internet or dedicated networks. Research at RMD has produced a spectroscopic gamma-ray imager centered on a position-sensitive photomultiplier tube coupled to scintillation crystal and a coded aperture. A gamma-ray intensity pattern from the detector is stored and processed by a portable computer workstation and then mathematically corrected to yield the original radiation-source image. The pseudo-color, radiation-source image is overlaid on a co-registered video picture of the same area captured by a high-resolution charge-coupled device. The combined image is displayed as an accurate map of gamma-ray sources in the physical environment. Recent developments involve instrument control and data transmission through computer networks. Alarm triggers based on changes in the video image, the radiation image, the energy spectrum are under development. Work to remotely control alarm sensitivity and type, as well as the image update frequency, has also been examined.

438) **High gain avalanche photodiode arrays for DIRC applications**

1999 IEEE Transactions on Nuclear Science Vol.46 Pages 848-852

Vasile S, Shera S, Shamo D, Squillante MR, Wilson RJ

Abstract

The detection of light emitted in Cherenkov radiators requires fast detector arrays with high sensitivity to short wavelength photons. Photomultiplier tubes, the traditional imaging detectors for short wavelength optical radiation, have limited spatial resolution and require expensive anti-magnetic shielding. The authors report on the performance of a new, Geiger mode operated, silicon micro-avalanche photodiode (micro APD) array, designed for Cherenkov light imaging applications. They address issues of optical interfacing, speed, and pulse spectra achievable with these micro APDs. The new micro APD array provides a high sensitivity detector for applications requiring two dimensional light mapping with single photon sensitivity. These features make it a promising candidate for the detection of Cherenko light in modern high energy physics experiments.

437) **PbISUB2 for high resolution digital X-ray imaging**

1999 Proceedings of SPIE - The International Society for Optical Engineering Vol.3770 Pages 164-171

Shah KS, Bennett P, Dmitriyev Y, Cirignano L, Klugerman M, Squillante MR, Street RA, Rahn JT, Ready SE

Abstract

In this paper, we discuss recent progress that has been made in the development of high resolution X-ray imaging detectors using photoconducting films of lead iodide (PbISUB2). PbISUB2 is a wide bandgap semiconductor with high X-ray stopping efficiency. We have been investigating thick films of lead iodide which can be prepared in large areas in a cost effective manner. These films can be coupled to readout technologies such as amorphous silicon flat panel arrays and vidicon tubes to produce X-ray imaging detectors for applications such as mammography, fluoroscopy, X-ray diffraction and non-destructive evaluation. Recent results obtained when these PbISUB2 films are coupled to 512 multiplied by 512 flat panel a-Si:H array are reported. This includes dark current signal and resolution measurements. Properties of lead iodide films which are relevant to imager performance are also discussed.

436) **High speed x-ray imaging camera using a structured CsI(Tl) scintillator**

1999 IEEE Transactions on Nuclear Science Vol.46 Pages 232-236

Nagarkar VV, Tipnis SV, Gupta TK, Miller SR, Gaysinskiy VB, Klugerman Y, Squillante MR, Entine G, Moses WW

Abstract

New third generation x-ray sources such as the Advanced Photon Source have created a need for a detector that can provide multiple frames of detailed x-ray images on the millisecond time scale. Such detectors will prove invaluable in applications such as time-resolved x-ray diffraction, x-ray microtomography, as well as materials science applications like polymer processing. Currently, detectors capable of acquiring high resolution x-ray images at such high speed do not exist, thus limiting progress in many of these important areas of research. To address these needs the authors have developed a prototype fast x-ray imaging system, using a structured CsI(Tl) scintillator coupled to a fast-frame 1K x 1K CCD. The system has been successfully employed to capture 1024 x 64 pixel x-rays images at a rate of 1000 frames per second (fps) with a 12 bit dynamic range. The system exceeds the capabilities of the current high speed x-ray imaging systems which typically operate at the rate of 30 fps. Fabrication of a large area detector is currently underway, using a microstructured CsI(Tl) scintillator coupled to a fast-frame CCD with a 3:1 fiberoptic taper. The camera will operate in a burst mode, acquiring 8 1K x 1K images at rates up to 1000 frames per second with 12 bit dynamic range. Higher image capture speeds can be accomplished by reducing the image area. This paper will discuss the specific characteristics of the CsI(Tl) screens, experimental details of the prototype and the new design for the large area detector being developed specifically for time-resolved x-ray diffraction experiments in structural biology.

435) **Characterization of polycrystalline TlBr films for radiographic detectors**

1999 IEEE Transactions on Nuclear Science Vol.46 Pages 266-270

Bennett PR, Shah KS, Cirignano LJ, Klugerman MB, Moy LP, Olschner F, Squillante MR

Abstract

Vapor deposited films of thallium bromide are evaluated as potential photoconductive layers in new large-area radiographic detectors. The attractiveness of the material lies in its inherent high effective atomic number and high density. Polycrystalline films up to 200 micro m in diameter. Current-voltage (IV) tests indicate a bulk resistivity of 10 sup 9 --10 sup 10 Omega -cm, limited by ionic conduction. Instability of current with time is also observed, but it can be minimized with cooling. The films demonstrate high gain at relatively low field strengths as compared to other photoconductive layers. Benefits and drawbacks of TlBr are compared to other materials, and possible solutions are discussed.

434) **Planar APD arrays for high resolution PET**

1999 Proceedings of SPIE - The International Society for Optical Engineering Vol.3770 Pages 104-111

Shah KS, Farrell R, Cirignano L, Grazioso R, Bennett P, Cherry SR, Shao Y

Abstract

In this paper, characterization of new, planar silicon avalanche photodiode arrays for high-resolution PET applications is discussed. High gain, monolithic 4 multiplied by 4 element APD arrays (2 mm pixels) have been fabricated using planar processes. These devices were characterized by measuring their gain (greater than 10SUP3), quantum efficiency (60% at LSO emission) and noise (200 eV FWHM). Energy and timing resolution of these APDs were also measured by coupling them to LSO scintillators (2 multiplied by 2 multiplied by 10 mm) and were found to be 12% and 4 ns, respectively. An APD array was also coupled to a matching LSO array and successful experiments were conducted to identify the crystal which scintillated. Finally, initial experiments to measure depth of interaction have also been performed.

433) **Characterization of screen-printed, dye-sensitized, nanocrystalline TiOSUB2 solar cells**

1999 Proceedings of SPIE - The International Society for Optical Engineering Vol.3789 Pages 149-157

Gupta TK, Cirignano LJ, Shah KS, Moy LP, Kelly DJ, Squillante MR, Entine G, Smestad GP

Abstract

Titanium dioxide (TiOSUB2) films have been deposited on SnOSUB2 coated glass substrates by screen-printing. Film morphology and structure have been characterized by scanning electron microscopy, x-ray diffraction and BET analysis. Dye-sensitized TiOSUB2 photoelectrochemical (PEC) cells have been and characterized. Cells sensitized with anthocyanin and a ruthenium complex have investigated. A 0.77 cmSUP2 ruthenium dye sensitized cell with 6.1% power conversion efficiency under Air Mass 1.5 (AM1.5) conditions was obtained. Results obtained with a pure anthocyanin dye and dye extracted from blackberries were compared. Finally, a natural gel was found to improve the stability of anthocyanin sensitized cells.

432) **Planar APD arrays for high resolution PET**

1999 PROC SPIE INT SOC OPT ENG Vol.3770 Pages 104-111

Shah KS, Farrell R, Cirignano L, Grazioso R, Bennett P, Cherry SR, Shao Y

Abstract

In this paper, characterization of new, planar silicon avalanche photodiode arrays for high-resolution PET applications is discussed. High gain, monolithic 4 x 4 element APD arrays (2 mm pixels) have been fabricated using planar processes. These devices were characterized by measuring their gain (>10 super(3)), quantum efficiency (60% at LSO emission) and noise (200 eV FWHM). Energy and timing resolution of these APDs were also measured by coupling them to LSO scintillators (2x2x10 mm) and were found to be 12% and 4 ns, respectively. An APD array was also coupled to a matching LSO array and successful experiments were conducted to identify the crystal which scintillated. Finally, initial experiments to measure depth of interaction have also been performed.

431) **PbI sub(2) for high resolution digital X-ray imaging**

1999 PROC SPIE INT SOC OPT ENG Vol.3770 Pages 164-171

Shah KS, Bennett P, Dmitriyev Y, Cirignano L, Klugerman M, Squillante MR, Street RA, Rahn JT, Ready SE

Abstract

In this paper, we discuss recent progress that has been made in the development of high resolution X-ray imaging detectors using photoconducting films of lead iodide (PbI sub(2)). PbI sub(2) is a wide bandgap semiconductor with high X-ray stopping efficiency. We have been investigating thick films of lead iodide which can be prepared in large areas in a cost effective manner. These films can be coupled to readout technologies such as amorphous silicon flat panel arrays and vidicon tubes to produce X-ray imaging detectors for applications such as mammography, fluoroscopy, X-ray diffraction and non-destructive evaluation. Recent results obtained when these PbI sub(2) films are coupled to 512 x 512 flat panel a-Si:H array are reported. This includes dark current signal and resolution measurements. Properties of lead iodide films which are relevant to imager performance are also discussed.

430) **Planar processed APDs and APD arrays for scintillation detection**

1999 IEEE Nuclear Science Symposium. Conference Record. 1999 Nuclear Science Symposium and Medical Imaging Conference Vol.1 Pages 56-60

Shah KS, Farrell R, Grazioso RF, Cirignano L, Squillante MR, Entine G

Abstract

In this paper, performance characteristics of new, planar processed silicon avalanche photodiodes (APD) and arrays are discussed for scintillation spectroscopy as well as direct X-ray detection. We have successfully fabricated large area APDs with sizes ranging from 1 cm/sup 2/ to 13 cm/sup 2/ using a novel planar process. The devices have shown very high gain (10/sup 4/), low noise (<1 keV for 1 cm/sup 2/ size) and high quantum efficiency (>60% for lambda >400 nm). Direct X-ray detection has been achieved with high energy resolution (1.5 keV FWHM for 5.9 keV X-rays for 1 cm/sup 2/ size) at room temperature.

429) **Large area CCD-based imaging system for mammography**

1999 IEEE Trans Nucl Sci Vol.2 Pages 1043-1046

Tipnis S, Nagarkar VV, Miller S, Gaysinskiy V, Klugerman Y, O'Dougherty P