Advanced Photodetector System and Methods

Tech ID: 34008 / UC Case 2022-812-0

BACKGROUND

X-radiation (X-ray) imaging is one of the most common imaging techniques in medicine. Presently, thin-film transistor flat panel detectors are the gold standard for X-ray detection; however, these detectors average across the absorbed X-ray spectrum and thus suffer from poor material decomposition and lesion differentiation. Modern efforts to address this focus on three methods of energy differentiation: dual-shot, photon counting, and dual-layer detectors. Dual-shot detection utilizes a single detector to image a patient with two shots of X-rays at low and high energies. While this has been shown to effectively differentiate between soft and hard tissues, (e.g., chest radiography) this results in a higher dose level to the patient and motion artifacts from slight movement between images. Photon counting detectors offer an alternative to multiple shots, providing high spatial resolution, low dose, and multiple energy binning with photon weighting. However, these detectors also require more complex circuit design for fast readout, have limited material options with great enough yield and detective quantum efficiency at low to mid energy ranges, and are limited in detective area. Dual-layer detectors that stack two detector layers to each process low and high energy X-rays remove motion artifacts by utilizing a single shot of polyenergetic X-rays. These most commonly employ two indirect detectors separated by a Cu filtering layer, which photon-starves the second higher energy detector. Unfortunately, this also requires a higher X-ray intensity, resulting in a higher dose level to the patient.

TECHNOLOGY DESCRIPTION

To help address unmet needs in X-ray imaging, a research team at UC Santa Cruz (UCSC) has developed a new dual-layer detector system with aims on energy differentiation. Using specialized amorphous alloys containing chalcogenides – with preliminary focus on selenium (a-Se) and tellurium (Te) – UCSC's laboratory results show high absorption and quantum efficiency for electromagnetic radiation detection. The lab's new dual-layer design combines a direct detector (higher spatial resolution) with an indirect detector (higher gain), enabling better differentiation between materials, such as soft and hard tissue. In particular, the new detector system showed robust charge transport mechanisms at high electric fields (e.g., 20-50 V/μm) which in turn improves quantum efficiencies, especially for a-Se alloyed with Te. These research results support the potential for tunable dual-layer detectors with better quantum efficiencies at both shorter (<450nm) and longer (>450nm) wavelengths, diminished dark current, and enhanced signal-to-noise.

APPLICATIONS

- diagnostics – medical imaging
- research tools – biological imaging

FEATURES/BENEFITS

- Support high-absorbing, quantum-efficient detector systems
- Enables improved differentiation between materials, such as soft and hard tissues
- Combines benefits of direct and indirect detection methods, suggesting better overall performance than single-layer
- Compatible with large-area deposition techniques for larger-scale applications

INTELLECTUAL PROPERTY INFORMATION

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Published Application	WO 2025/048885	03/06/2025	2022-812

Additional Patent Pending

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OTHER INFORMATION

KEYWORDS

X-ray, X-ray detection, radiology, dual-layer detector, indirect detector, flat panel detector, amorphous selenium, photodetector, chalcogenides, chalcogenide, a-Se, tellurium

CATEGORIZED AS

- Imaging
  - Medical
- Medical
  - Imaging
  - Research Tools
- Sensors & Instrumentation
  - Medical
  - Position sensors

RELATED CASES

2022-812-0

RELATED MATERIALS

- Hellier, Kaitlin, et al. "Tuning amorphous selenium composition with tellurium to improve quantum efficiency at long wavelengths and high applied fields." ACS Applied Electronic Materials 5.5 (2023): 2678-2685.
- Hellier, Kaitlin, et al. "Performance evaluation of an amorphous selenium photodetector at high fields for application integration." IEEE Sensors Journal 23.12 (2023): 12759-12766.

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