Development of X-ray detector using optical switching readout for high-speed imaging

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I. Introduction

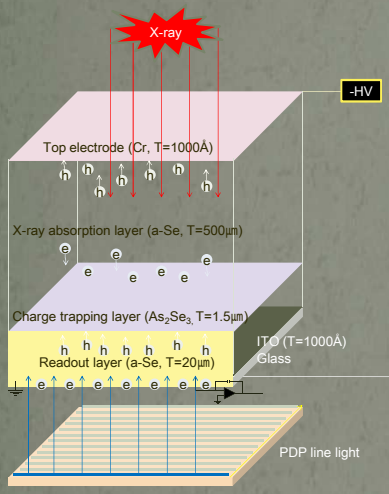
• Objectives

- To solve electric noise in matrix circuit structure of TFT readout system.
- To enhance conversion efficiency in high definition of TFT readout.
- To obtain high X-ray conversion efficiency by using double-layer of a-Se.
- To obtain lower noise and high DQE in switching by light without TFT.
- To obtain image in high speed by electrical scanning of optical line light of 2D readout light source.

II. Performance & Fabrication

• Operations

Schematic diagram

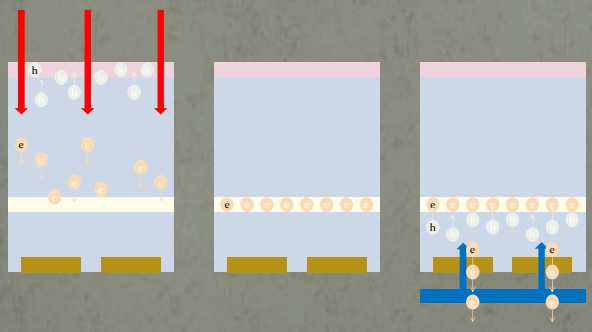


- Direct conversion
  &
- A-Se double layer
  &
- Direct optical switching

- Double layer of a-Se
  - ✓ High absorption of X-ray
- Switched by light without TFT
  - ✓ Low noise & High DQE

- X-ray absorption layer
  - ✓ X-ray exposure
  - ✓ Generation of free electron-hole pairs
  - ✓ Direct conversion of X-ray to electron
- Charge trapping layer
  - ✓ Accumulation of electrons
- Readout layer
  - ✓ Light exposure from linear optical source
  - ✓ Generation of free electron-hole pairs
  - ✓ Drift to accumulated electrons
  - ✓ Readout of electrons

Imaging processes

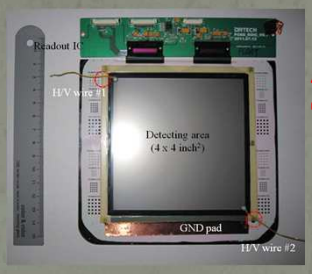


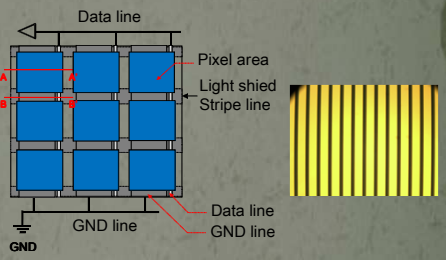
(a) Conversion (b) Accumulation (c) Readout

- Conversion
  - ✓ High negative voltage
  - ✓ X-ray exposure
  - ✓ Direct conversion of X-ray to electron
- Accumulation
  - ✓ Turn off of high negative voltage
  - ✓ Charge distribution
- Readout
  - ✓ Light exposure
  - ✓ Readout of electron

• Fabricated devices

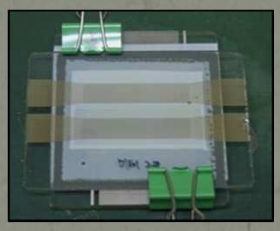
X-ray sensor

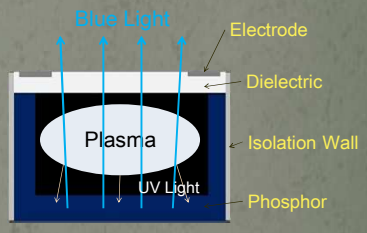


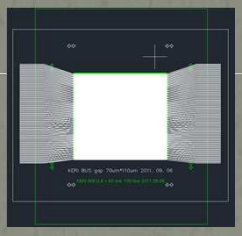


- X-ray sensor
  - ✓ 512 x 512
  - ✓ 200 x 200 μm
  - ✓ Charge storage : ETL(As_2Se_3)
- Layout & Readout electrode
  - ✓ Readout electrode patterning to enhance readout efficiency
  - ✓ Opaque electrode :block the readout light
  - ✓ Transparent electrode : readout path

PDP line light





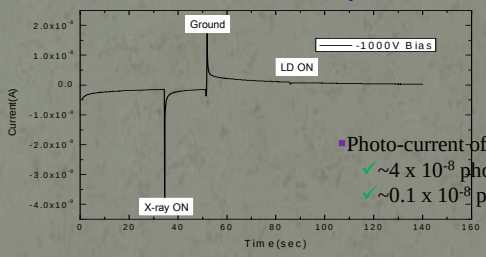


- 3-electrode AC PDP
  - ✓ Ne-Xe dielectric barrier discharge
  - ✓ Blue phosphor
  - ✓ MgCaO protective layer
  - ✓ Ray tracing technique
  - ✓ 4 x 4 inch

III. Results and Discussions

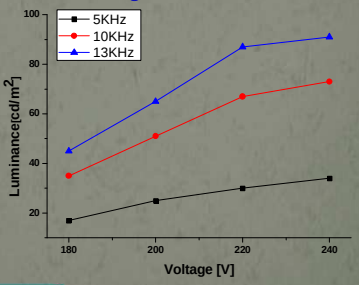
• Characteristic Measurements

Generated currents of X-ray sensor



- Photo-current of X-ray sensor
  - ✓ ~4 x 10^{-8} photo-current by X-ray
  - ✓ ~0.1 x 10^{-8} photo-current by blue light

Luminance of PDP line light



- Luminance of line light
  - ✓ 30 ~ 90cd/m²

• Conclusions & Future works

- Optical switching readout X-ray detector is developed.
- Optical line light can be operated to electrical scanning for high-speed imaging.
- X-ray imaging will be acquired by reducing electro-magnetic interference.