CPAD 2021

Thickness Uniformity of Amorphous Selenium Films Utilizing the University of California, Santa Cruz Fabrication Facility

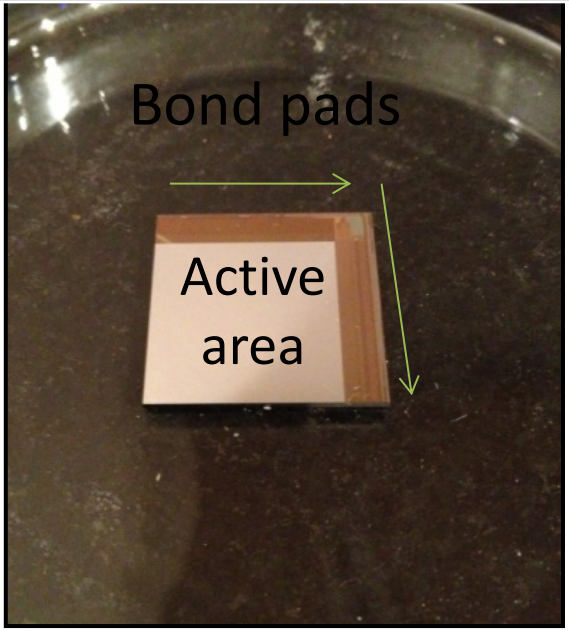
Maryam Farahmandzadeh, Shiva Abbaszadeh

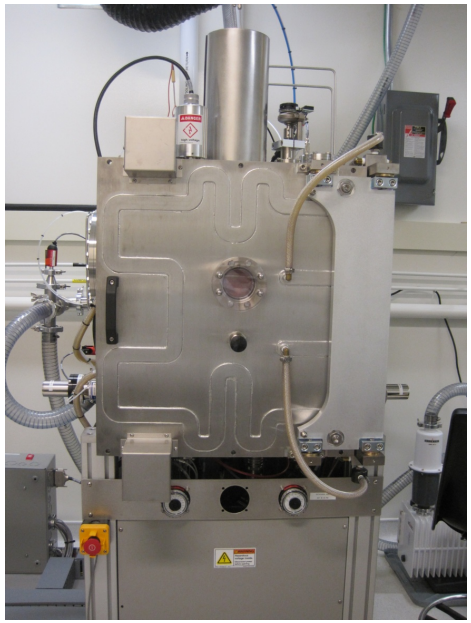
Radiological Instrumentation Laboratory (RIL)
Electrical and Computer Engineering
University of California, Santa Cruz

https://ril.soe.ucsc.edu

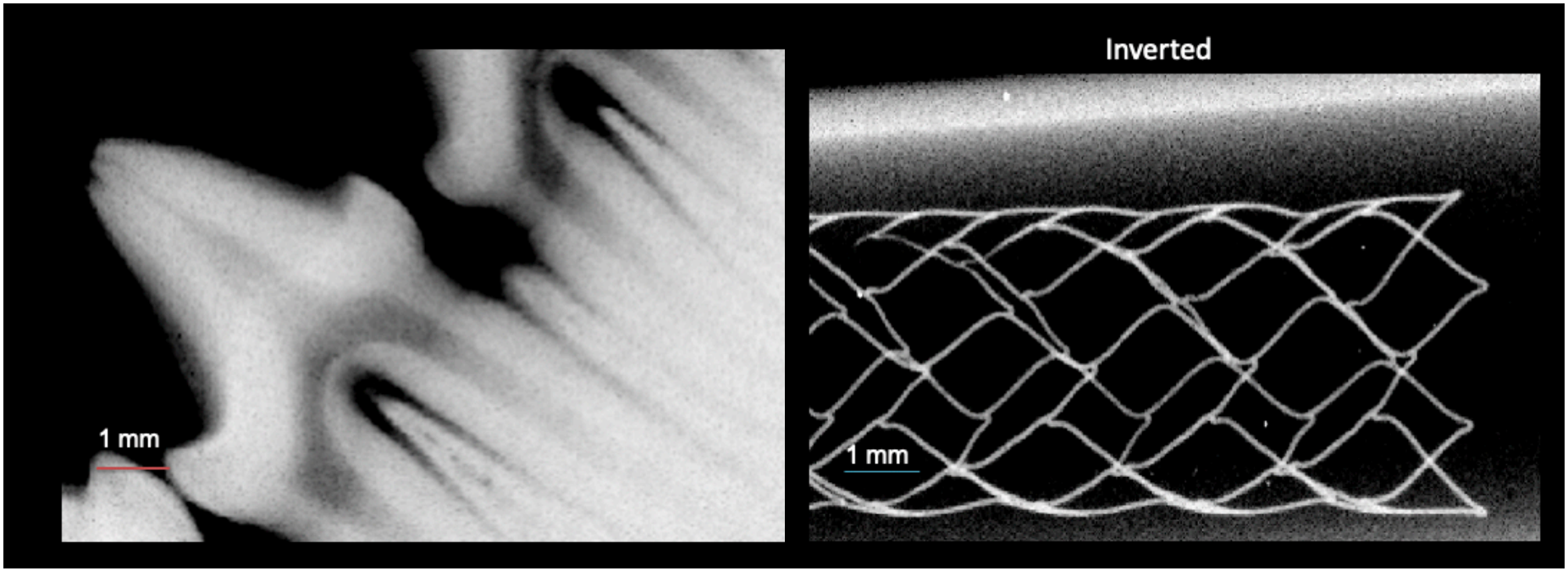
Large area CMOS-a-Se panel

Specifications
3T active pixel sensor
300-400e RMS noise (improvements are possible)
25 µm pixel pitch
640 x 640 pixel array
1.6 x 1.6 cm active area





25 micron Spatial Resolution X-ray detector



Abbaszadeh et al., J. Non-Cryst. Solids, 358(17), 2012.
Abbaszadeh et al., Nature Scientific Reports, 3, 2013
Abbaszadeh et al., IEEE Trans. Electron Dev., 61(9), 2014.
C. C. Scott et al. *Proc. SPIE Medical Imaging*, 2014.

Lateral UV detector

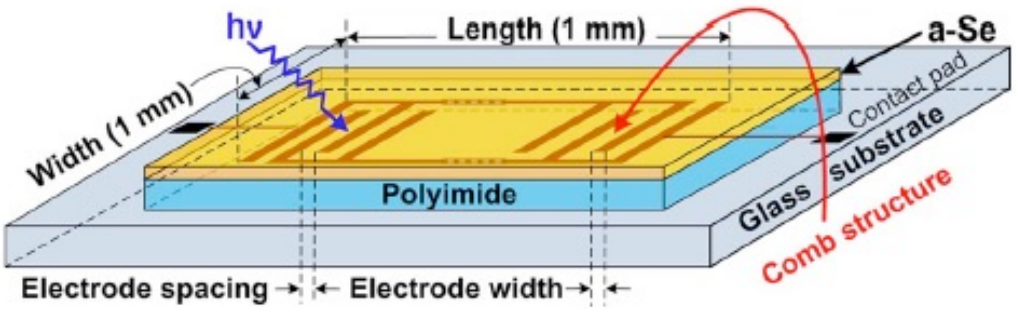


Fig. 1. Device structure (illustration not to scale).

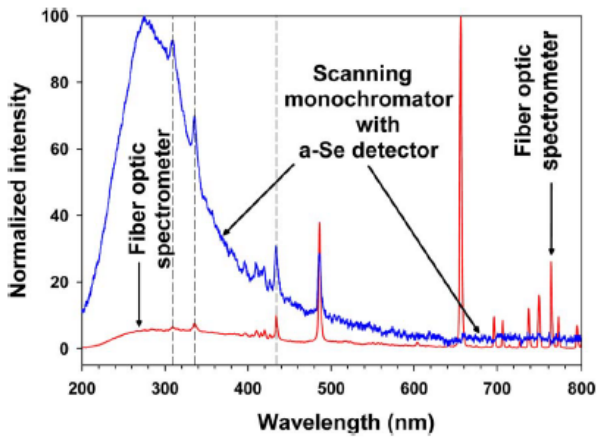


Fig. 4. Microplasma background emission.

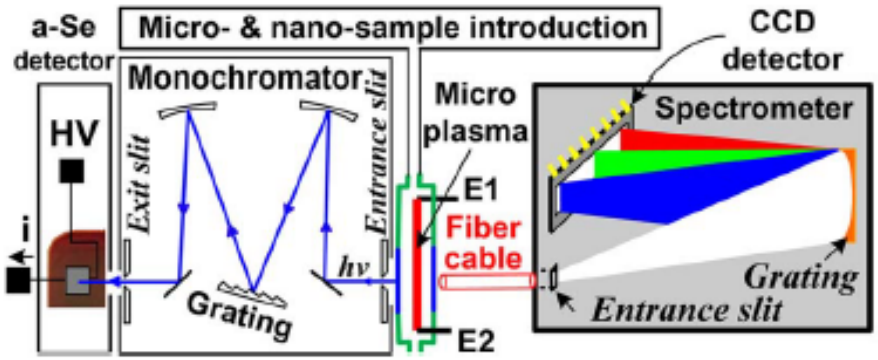
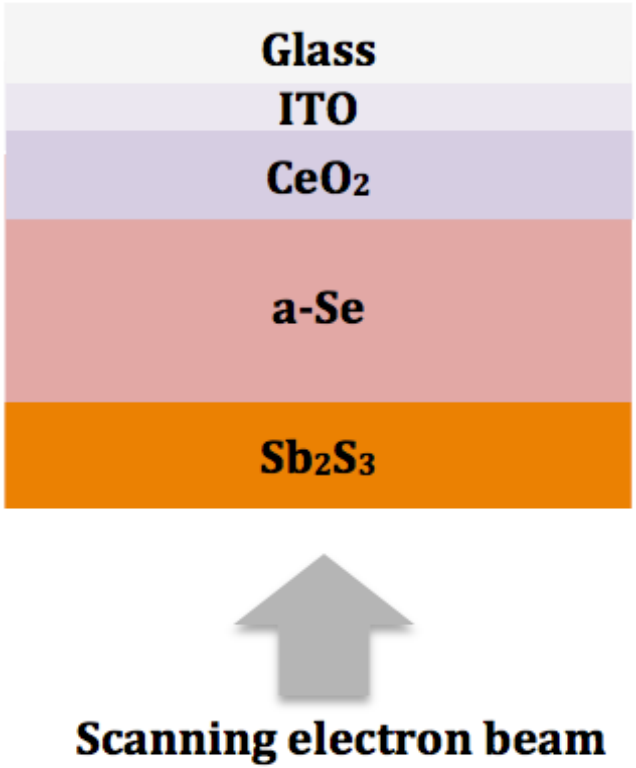
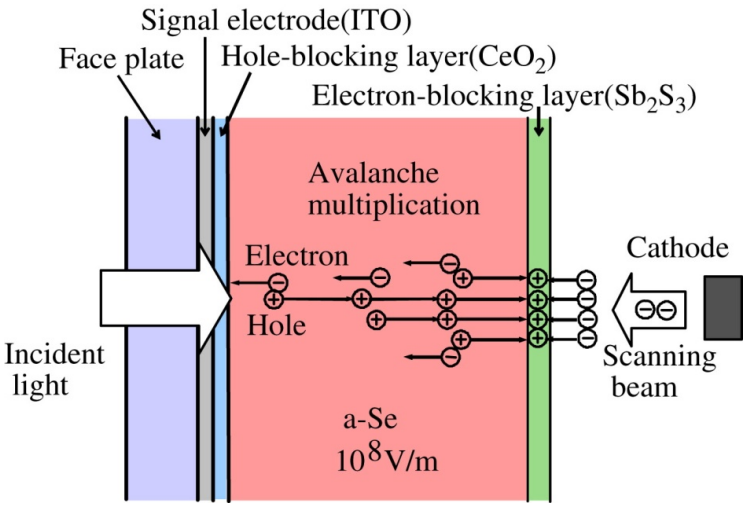


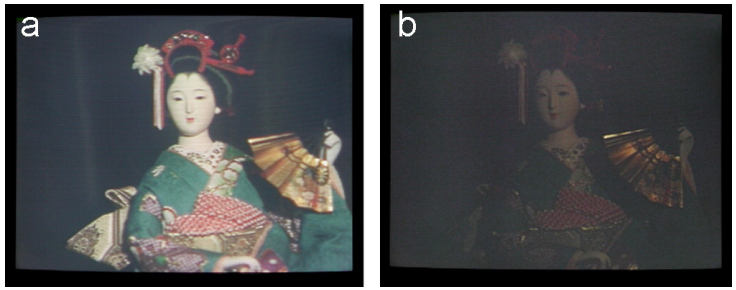
Fig. 2. Experimental setup (E1 and E2 are electrodes).

Abbaszadeh et al., IEEE Trans. Electron Devices, vol. 60, pp. 880, 2013

HARP Structure (Avalanche)





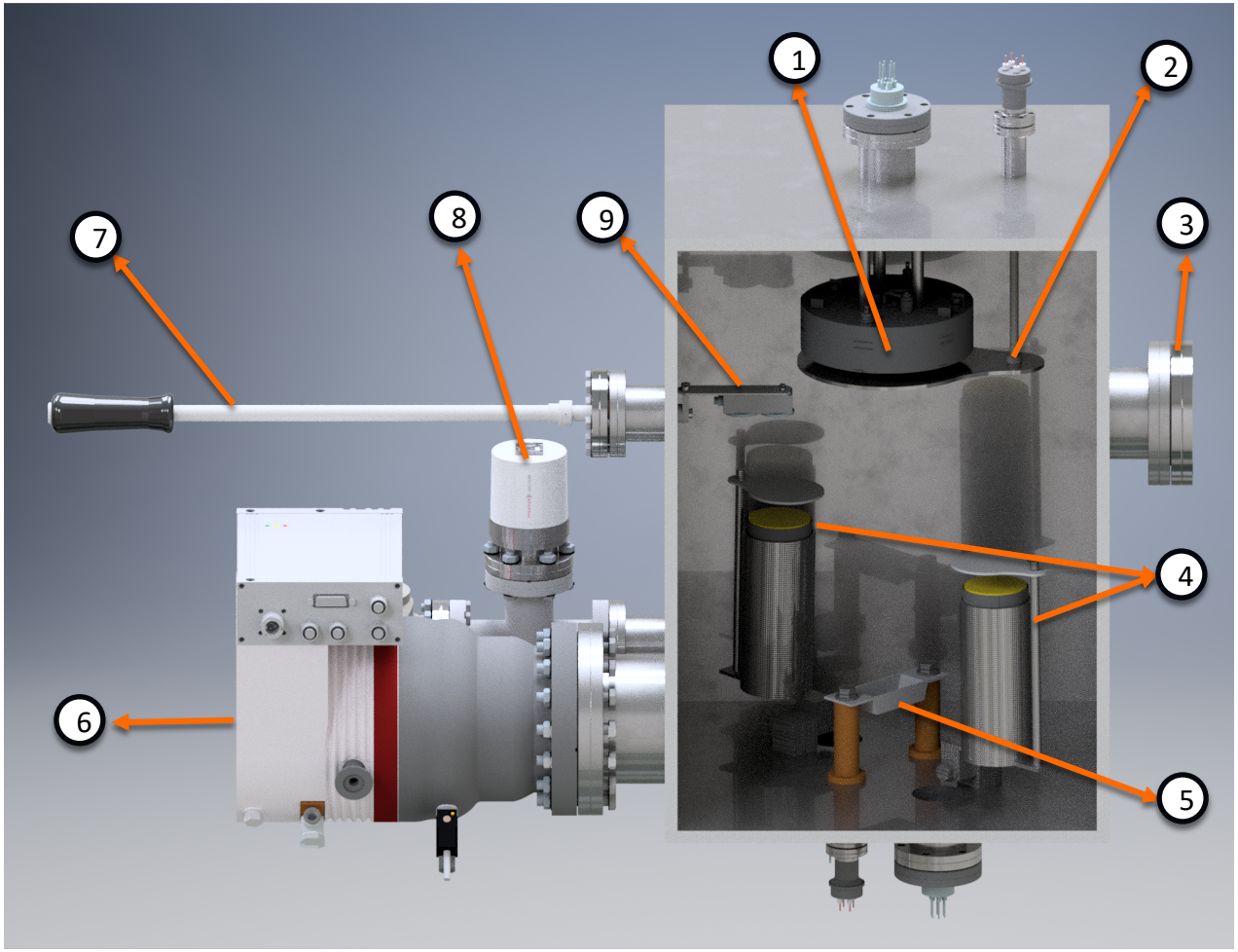


K. Tanioka, *Nucl. Instrum. Methods A*, 608, S15-S17, 2009.

Large Area Avalanche Photodetector (APD)

Sensitivity: 220-800 nm
Efficiency in blue: 90%
Gain: 100-1000
Position resolution: 5-100 um is possible if high channel density is not a problem
Time resolution: <1 ns
Module size: 4 inch by 4 inch
Cost: low
B-filed susceptibility: low

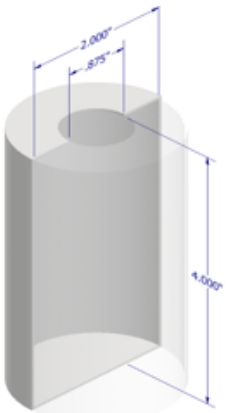
Thermal Evaporator Design

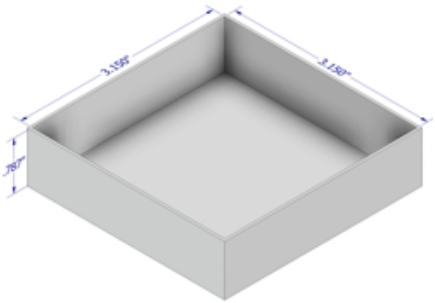


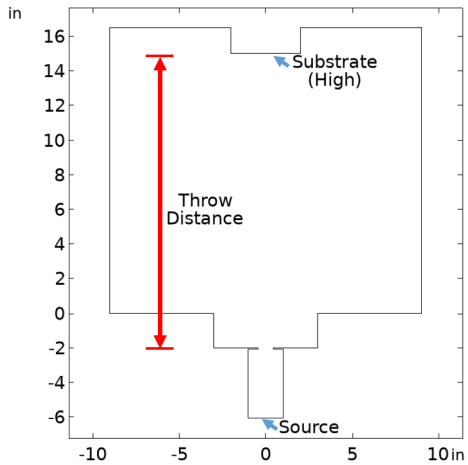
Port	Instrument
1	Substrate
2	Substrate shutter
3	Viewport
4	Additional evaporators
5	Se boat evaporator
6	Turbomolecular pump
7	Wobble stick
8	Pressure gauge
9	Quartz crystal microbalance

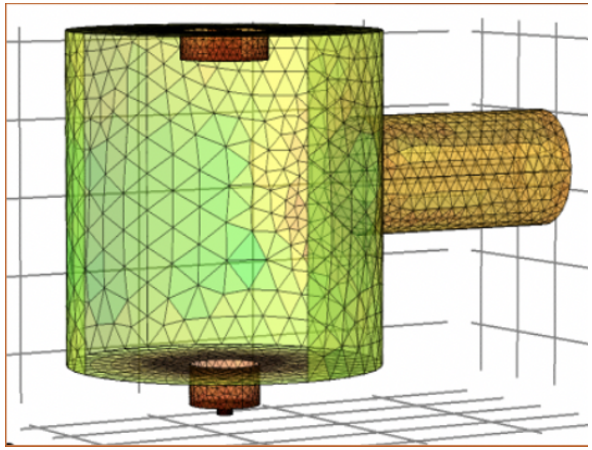
- ✓ Thermal evaporation is a relatively straightforward, fast, and dry approach that allows deposition of films of tens of microns of thickness with negligible contamination from other species that would be present in a chemical process.

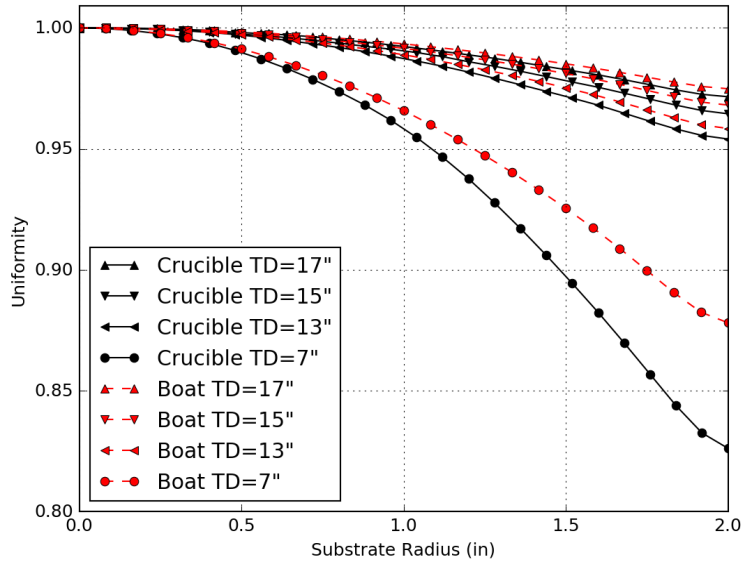
Molecular flow regime





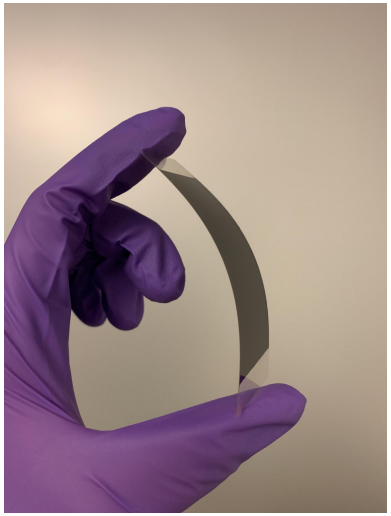


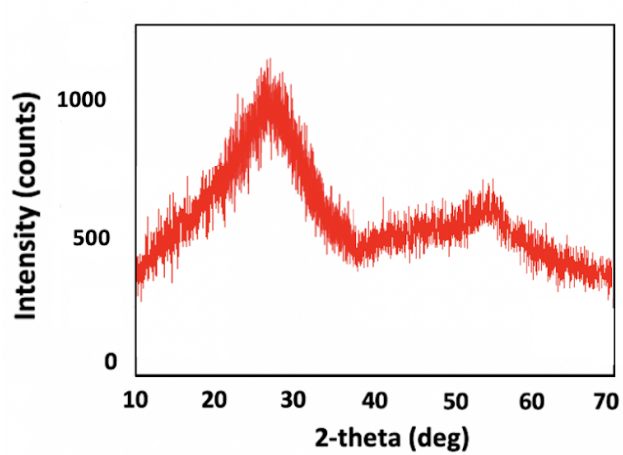


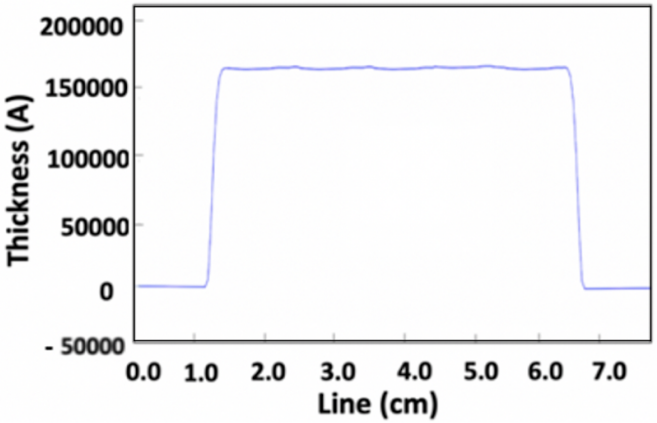


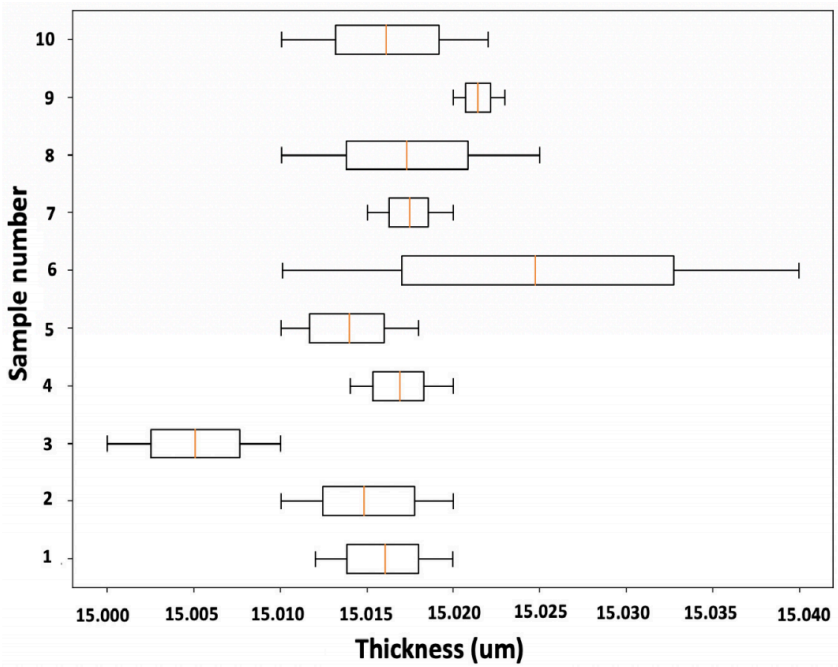
UCSC a-SeAPD Fabrication Facility

a-Se Films Fabrication and Characterization



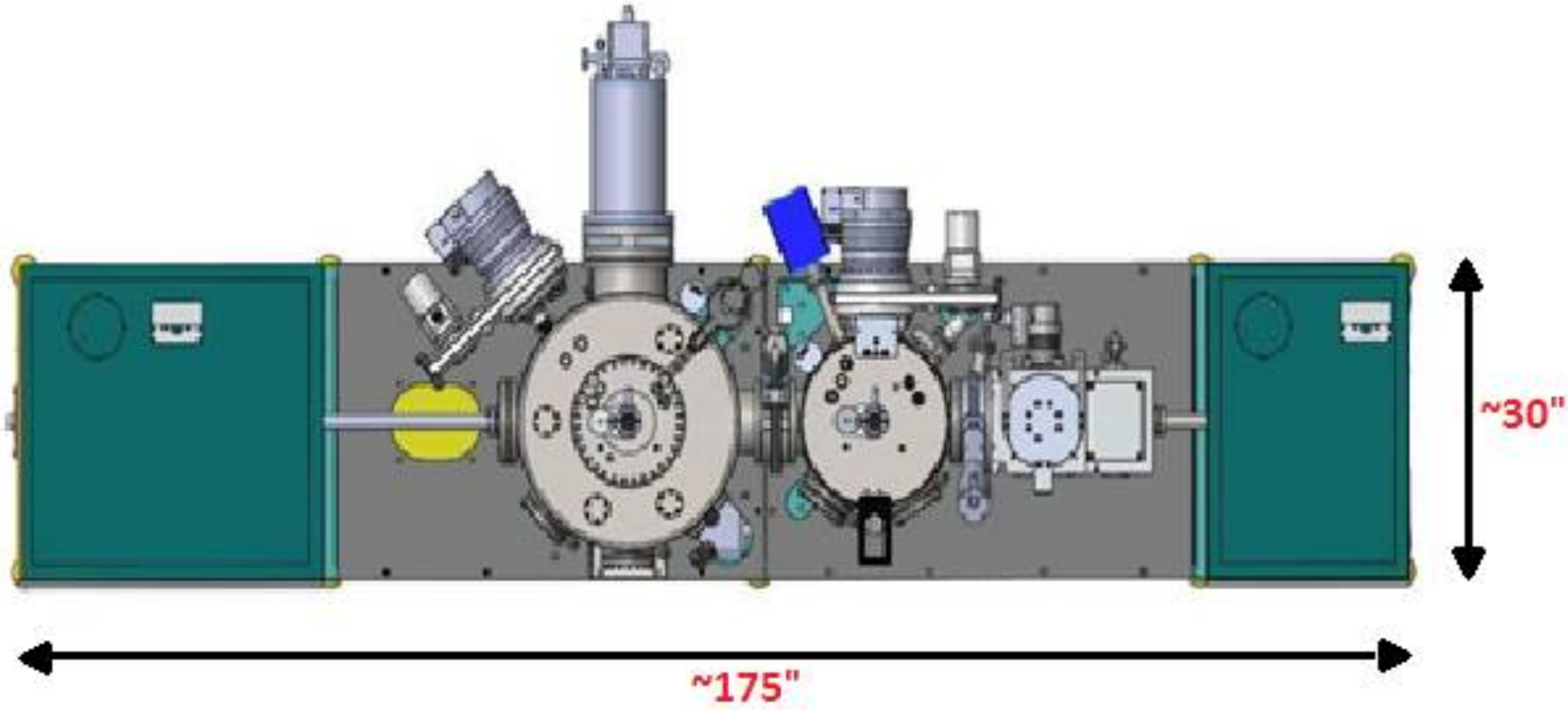




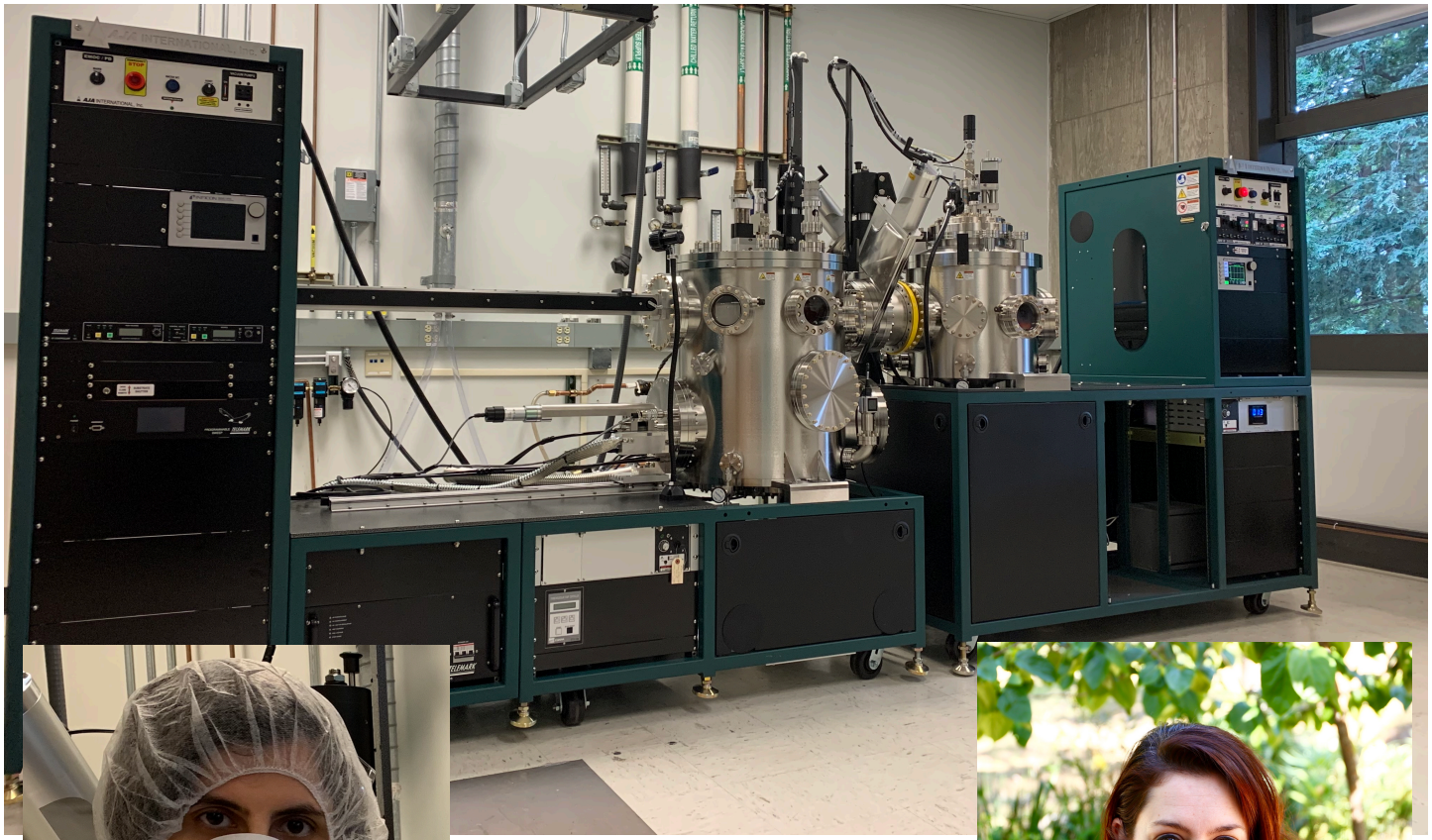


The mean value and standard deviation of uniformity for the ten samples were calculated as 98.01% (compared to 98%–99% in simulation results) and 0.12%, respectively.

UCSC a-Se APD Fabrication Facility

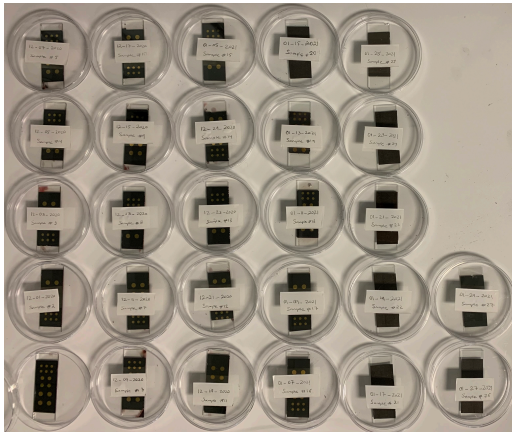


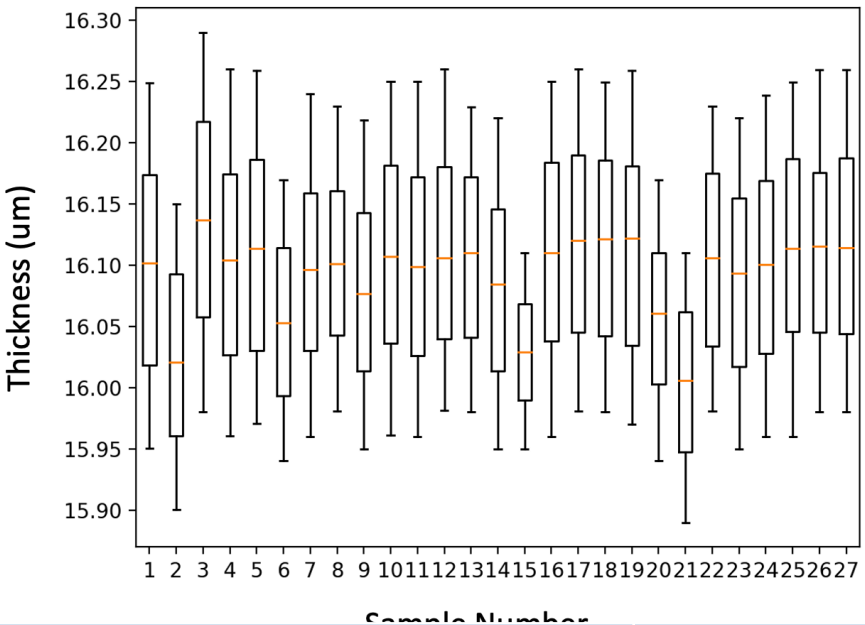
UCSC a-Se APD Fabrication Facility



Maryam Farahmandzadeh, MS
PhD student

Katie Helllier, PhD
Postdoc fellow



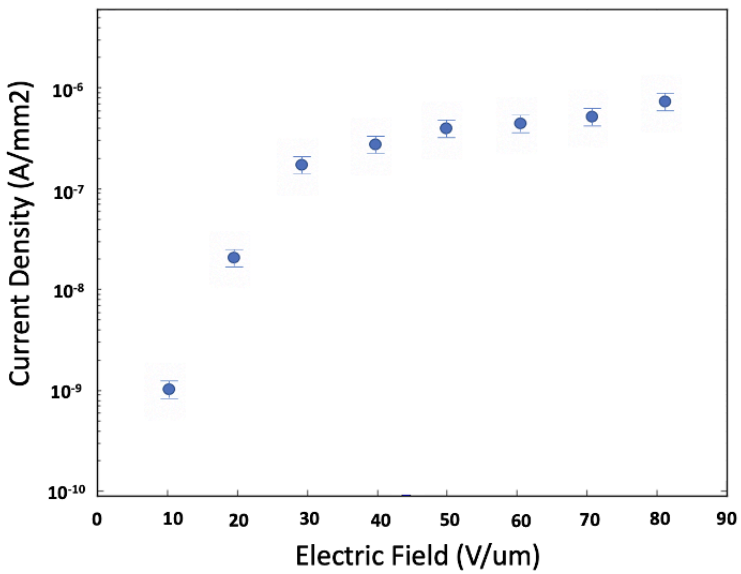


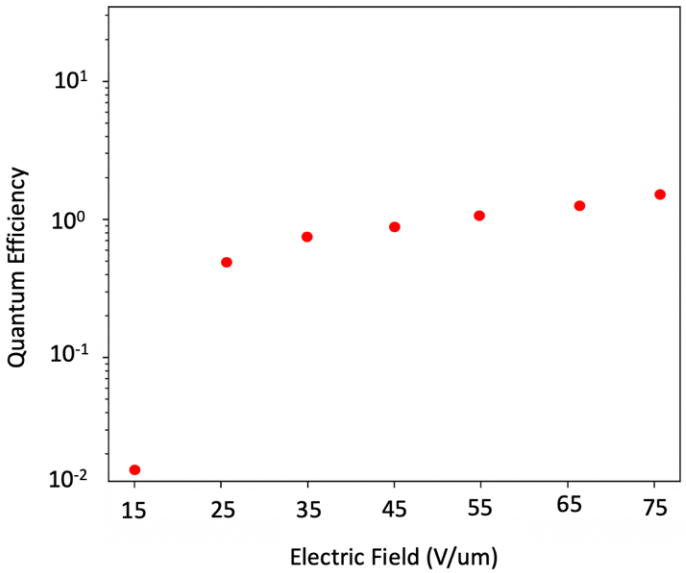
Hole blocking layer	Dark current (pA/mm2)	Comment	Reference
None	>1000	We do not go above 45 V/um	
Bulk CeO2	20	Higher than the dark current achieved in this work	Ohshima et al[1]
1 um of PI	3.5	Easy to fabrication	This work
CeO2 Quantum dots	0.12	Large area compatibility	Goldan et al[2]

[1] Ohshima, T., et al. Excess noise in amorphous selenium avalanche photodiodes. J. Appl. Phys., Part 2 1991, 30, L1071–L1074

[2] Goldan, A., et al. Ultralow Dark Currents in Avalanche Amorphous Selenium Photodetectors Using Solution-Processed Quantum Dot Blocking Layer, ACS Photonics *2020 7 (6), 1367-1374, DOI: 10.1021/acsphotonics.9b01651*

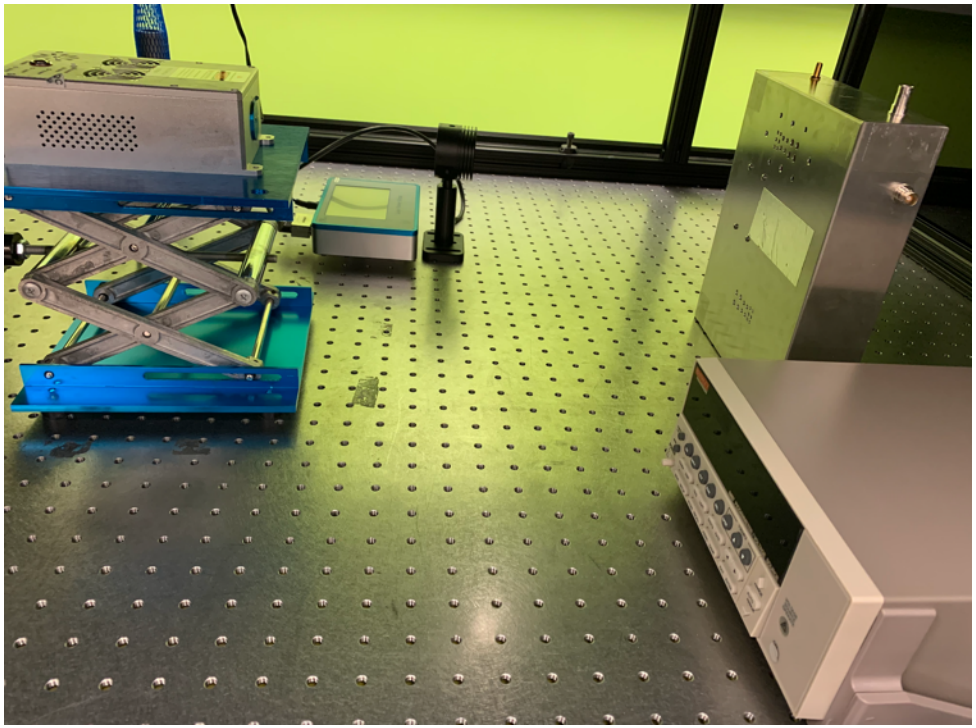
a-Se Films Fabrication and Characterization





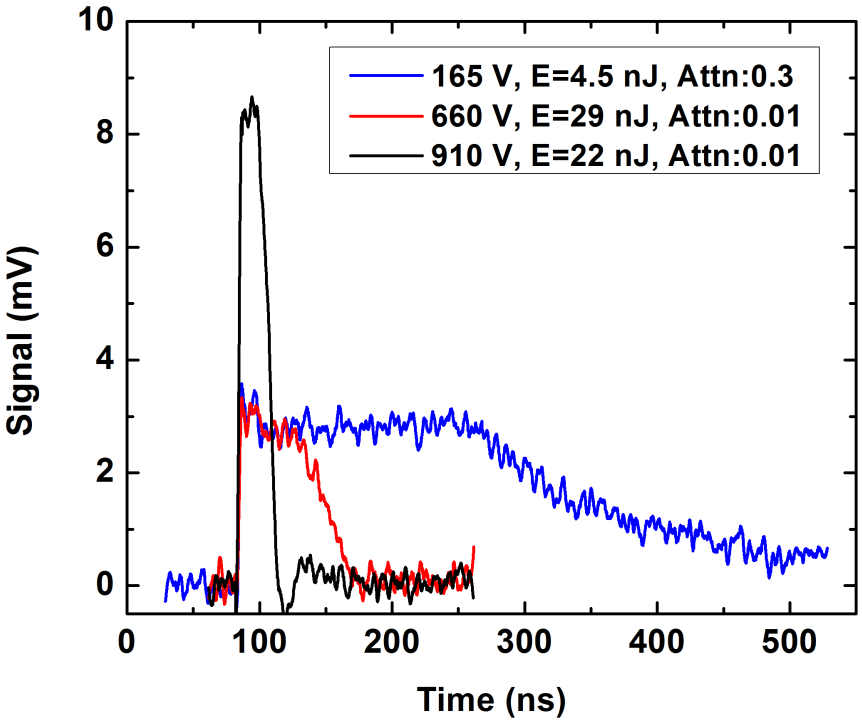
Photocurrent as a function of electric field under illumination of a blue LED with wavelength of 470 nm and light intensity of 150 µW/cm2

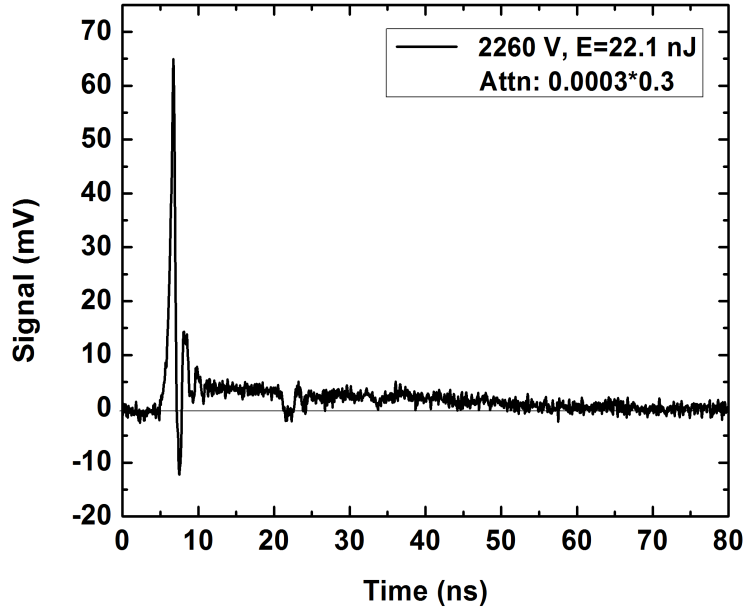
Coming soon

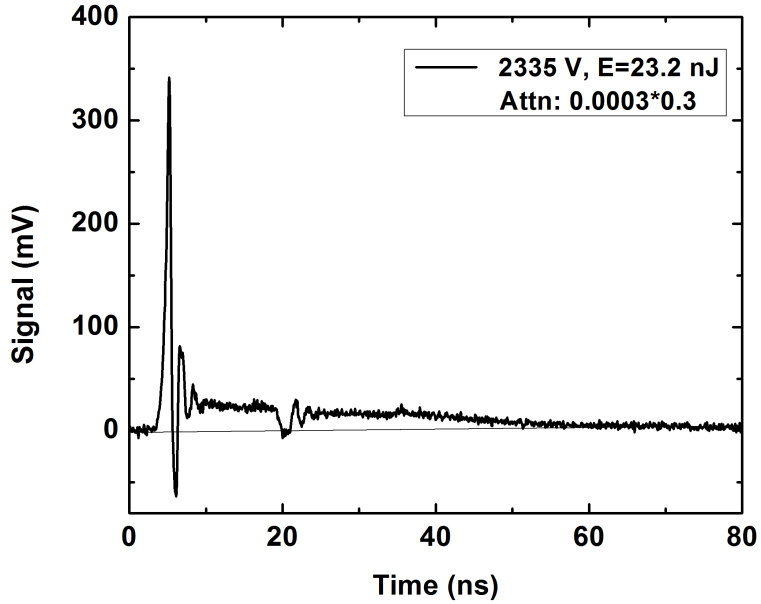


Coming soon

Below Avalanche region







Abbaszadeh et al., Nature Scientific Reports, 3, 2013

A-Se Photodetector

Following the hypothesis that having a soft interface with a-Se will reduce the stress generated from creation of a crystalline nucleus and prevent radiation-induced crystallization, we propose to develop a-Se APD on flexible substrate.

Sensitivity: 220-800 nm
Efficiency in blue: 90%
Gain: 100-1000
Position resolution: 100 um is possible if high channel density is not a problem
Time resolution: <1 ns
Module size: 4 inch by 4 inch
Cost: low
B-filed susceptibility: low

Thank You

Interested in collaborations:

https://ril.soe.ucsc.edu

sabbasza@ucsc.edu