MCP Godparents Meeting

March 25, 2010

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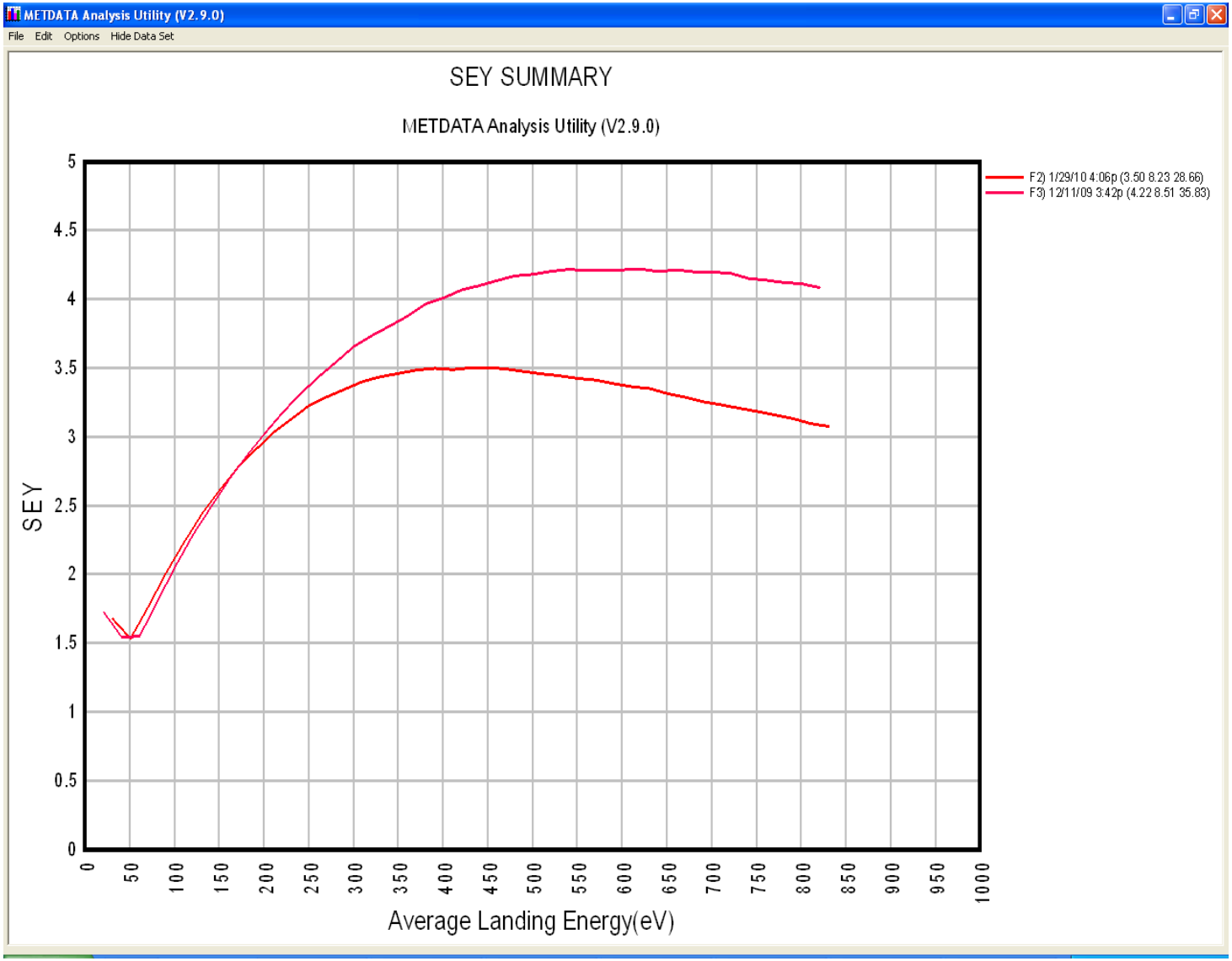
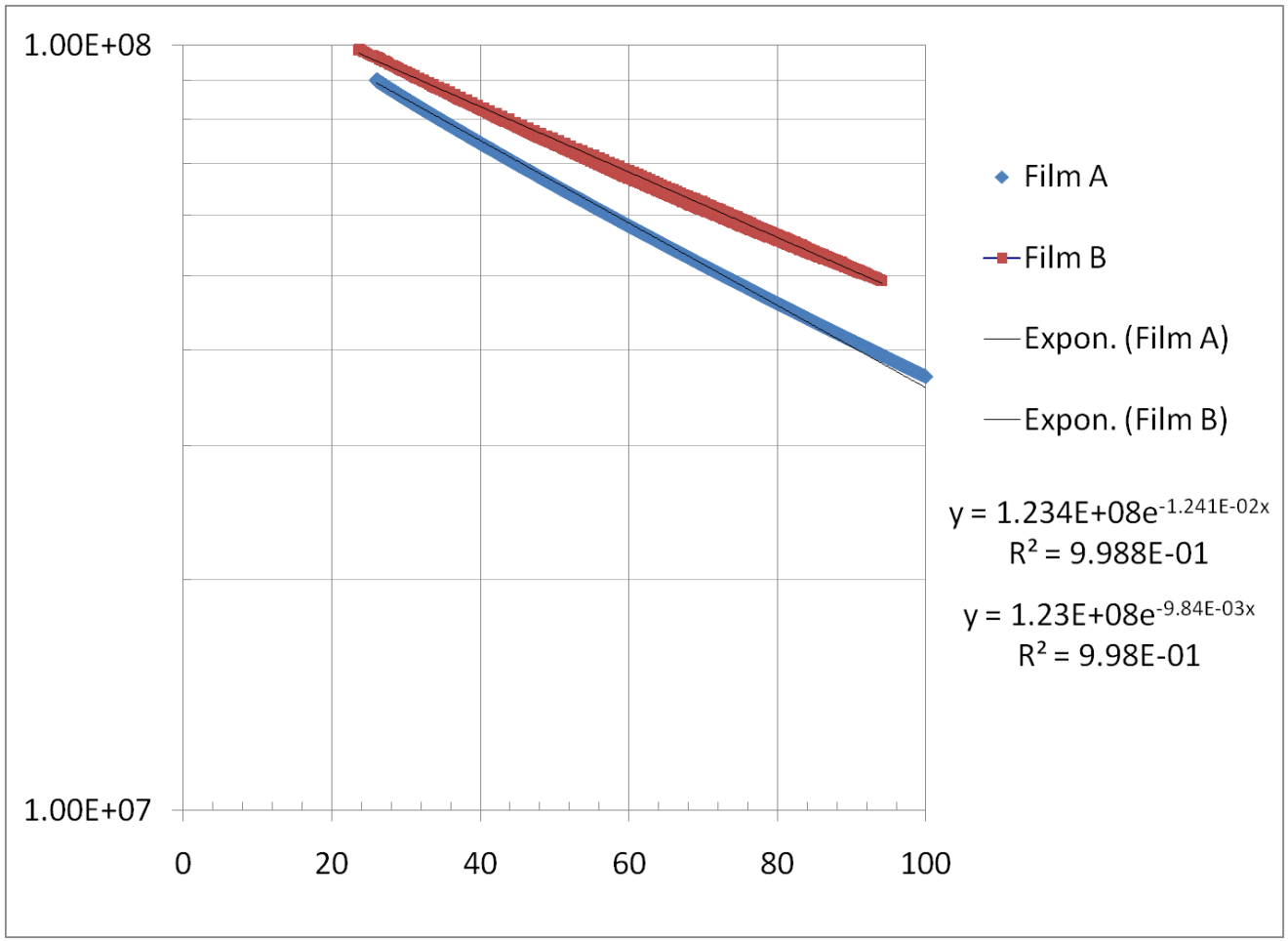
Outline

- **Accomplishments** to date with ALD coating, resistive and emissive
- **Status** of your work on the project now
- Your view of **future** work
- Problems, challenges you either face now or foresee in the future

Accomplishments - Emissive: SEY measurements



Accomplishments - Conductive: TCR summary
$B\tau < 0.01$

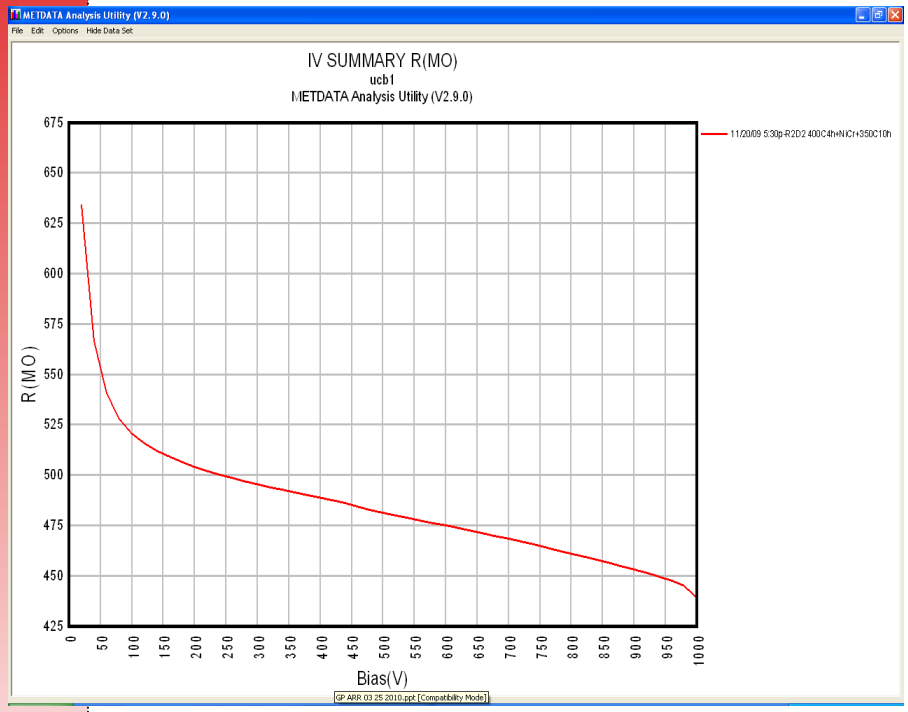


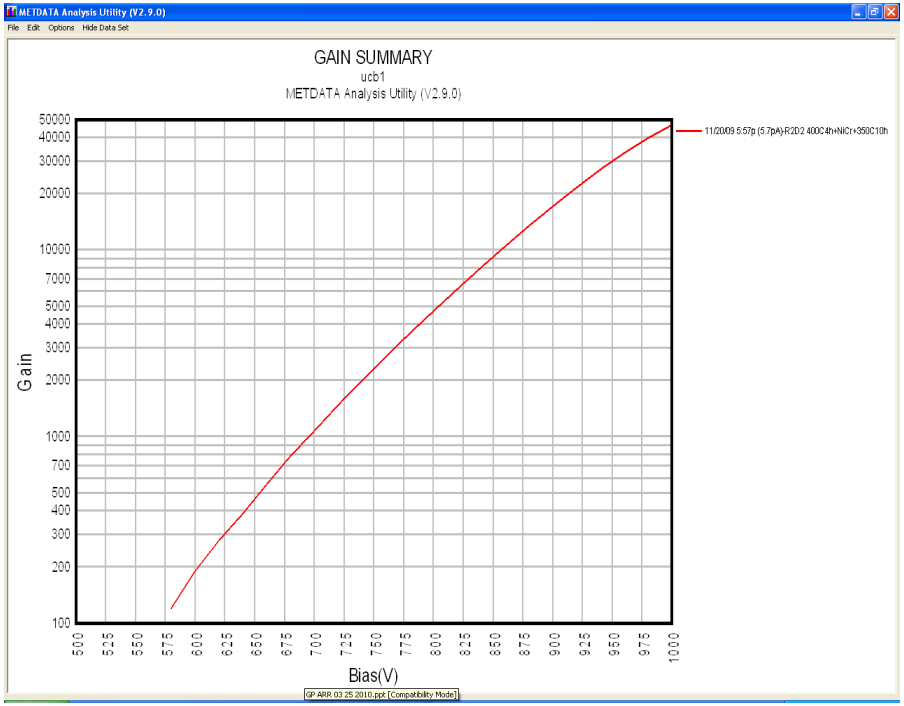
Accomplishments – Incom 40:1, 40um, 65% OAR Nov 2009

MetData Report For INCOM 031610
Metrology Data File Report Detail

ARRADIANCE Substrate DataBase (V1.2.1)
3/16/2010

Supplier / Serial#	Lot Description / MDate	System	Filename	Lot ID	Cust	Created	Modified	MetData at 700 and 1000V: Last R(MO)	MAX Gain
INCOM	INC-GCA-D25-P40-L40-O65-B8			111209 (SO 08.186) INC-D25-P40-L40-O65-B8					
S000028(UCB1)	11/20/09	CUBE	ucb1.txt		Argonne	11/20/09	11/24/09 10:50 AM	419	396	1,070	46,703





Accomplishments - UCB SSL Test results

Space Sciences Laboratory, University of California, Berkeley

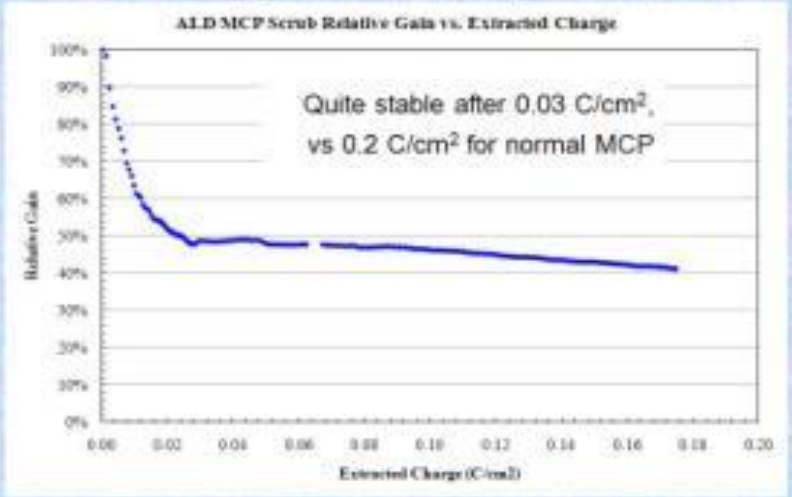
SSL-UCB, ALD/Incom MCP Test

- Incom substrate
  - 40µm pores, 8 deg bias, 40:1 L/D
- Sent to Arradiance for resistive and emissive layer application + electrode
- Resistance approx 750 MΩ in vacuum
- Arradiance tests show 50,000 gain @ 1000v
- UV - bright image, no light - black!
- Tested as a single MCP + Phosphor
- It works! We have a functional, uniform, and stable (1hr) MCP using borosilicate and ALD.
- Project milestone under 5.1 year 1 deliverable

Space Sciences Laboratory, University of California, Berkeley

UV Scrub 25mm 40µm 40:1 ALD MCP

Starts at Bias = 700V, gain x1000, 0.6µA, change to 850v, 0.8µA at 0.03C/cm²



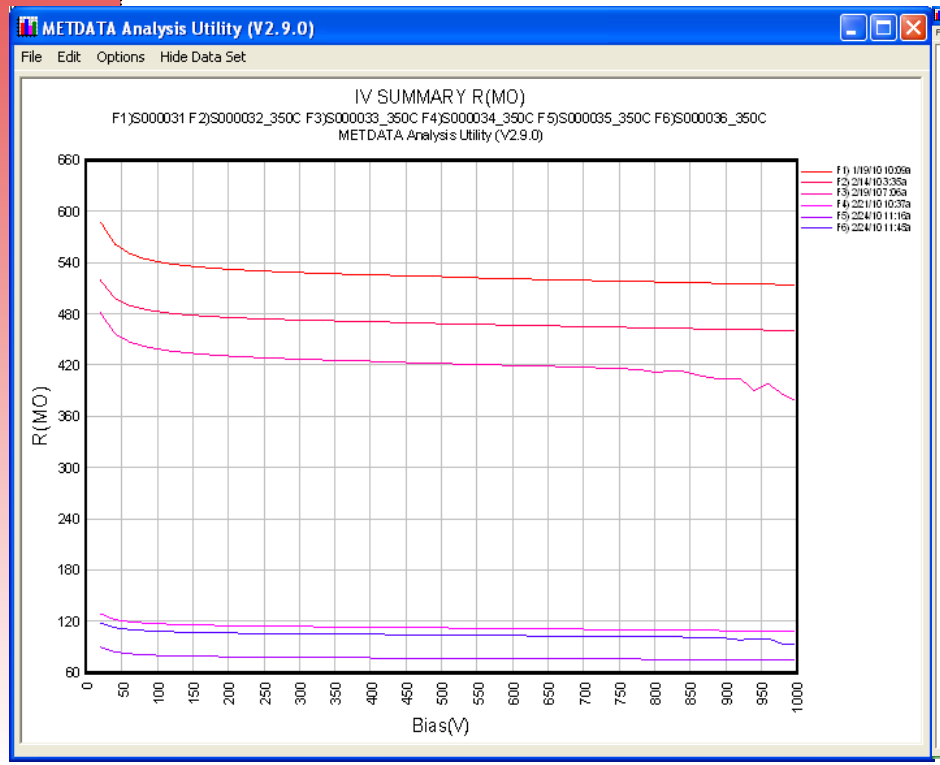
Note: no pre-vacuum bake

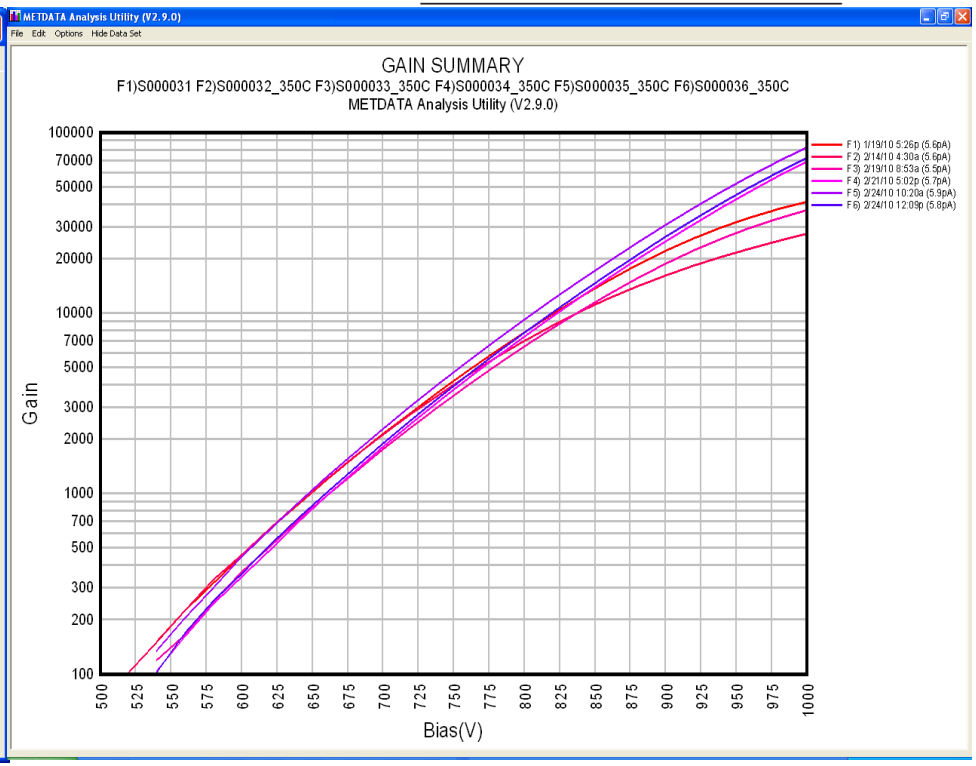
Accomplishments - Incom 40:1, 40um, 83% OAR Feb 2010

MetData Report For INCOM 031610
Metrology Data File Report Detail

ARRADIANCE Substrate DataBase (V1.2.1)
3/16/2010

Supplier Serial#	Lot Description MDate	System	Filename	Lot ID	Cust	Created	Modified	MetData at 700 and 1000V Last R(MO)		MAX Gain	
INCOM	INC-GCA-D33-P40-L40-083-B8			011310 (SO 08.186) INC-D33-P40-L40-083-B8							
S000031(1)	1/19/10	CUBE	S000031.txt		Argonne	1/19/10	1/19/10 6:50 PM	519	514	2,136	41,249
S000032(2)	2/12/10	CUBE	S000032_350C.txt		Argonne	2/14/10	2/14/10 5:37 PM	465	460	2,111	27,461
S000032(2)	2/12/10	CUBE	S000032.txt		Argonne	2/12/10	2/12/10 2:17 PM	439	435	1,432	28,028
S000033(3)	2/17/10	CUBE	S000033_350C.txt		Argonne	2/19/10	2/19/10 11:11 AM	417	378	1,752	37,082
S000033(3)	2/17/10	CUBE	S000033.txt		Argonne	2/17/10	2/18/10 11:46 AM	403	398	1,246	22,567
S000034(4)	2/19/10	CUBE	S000034_350C.txt		Argonne	2/21/10	2/23/10 11:53 AM	111	108	1,807	68,591
S000034(4)	2/19/10	CUBE	S000034.txt		Argonne	2/19/10	2/19/10 12:37 PM	99	98	1,372	42,487
S000036(6)	2/23/10	CUBE	S000036_350C.txt		Argonne	2/24/10	2/24/10 2:08 PM	101	100	1,886	72,018
S000036(6)	2/23/10	CUBE	s000036.txt		Argonne	2/23/10	2/23/10 2:31 PM	96	94		
S000035(5)	2/24/10	CUBE	S000035_350C.txt		Argonne	2/24/10	2/24/10 12:45 PM	76	74	2,271	82,576



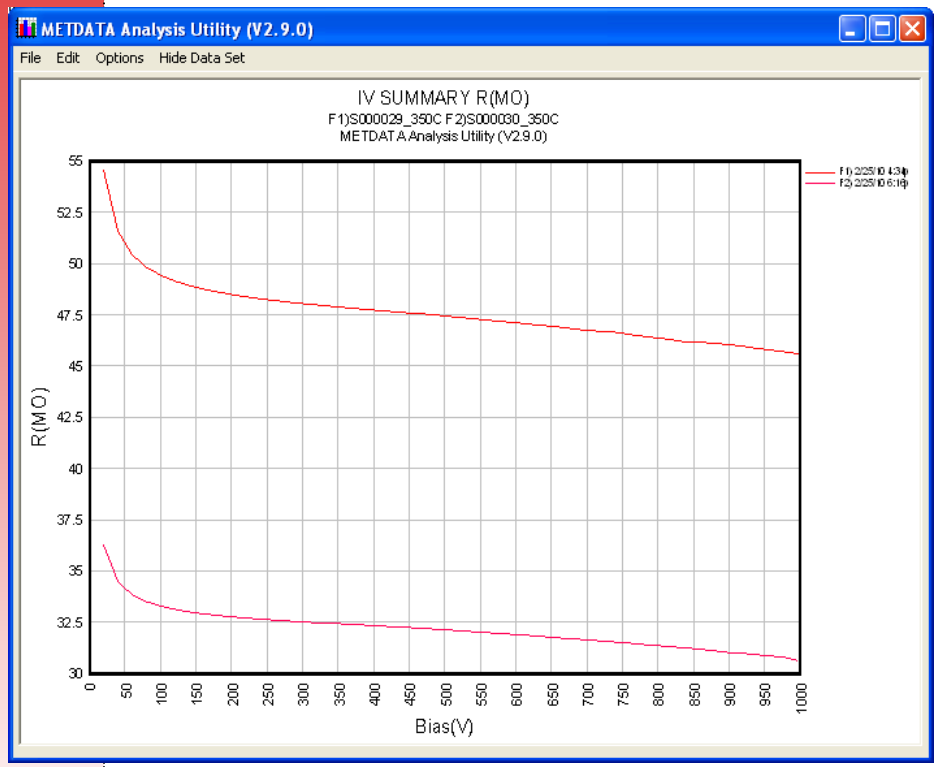


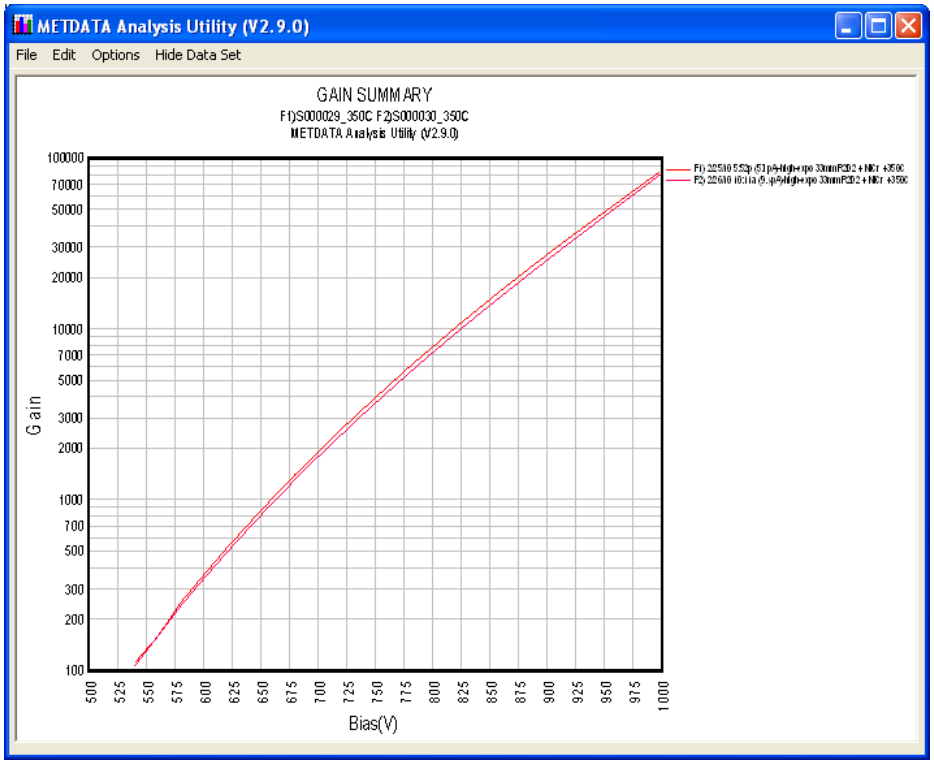
Accomplishments - Incom 40:1, 40um, 65% OAR Feb 2010

MetData Report For INCOM 031610
Metrology Data File Report Detail

ARRADIANCE Substrate DataBase (V1.2.1)
3/16/2010

Supplier / Serial#	Lot Description / MDate	System	Filename	Lot ID	Cust	Created	Modified	MetData at 700 and 1000V Last R(MO)		MAX Gain	
INCOM	INC-GCA-D33-P40-L40-O65-B8			011310 (SO 08.186) INC-D33-P40-L40-O65-B8							
S000029(1)	2/25/10	CUBE	S000029_350C.txt		Argonne	2/25/10	2/25/10 7:15 PM	46	45	1,912	84,844
S000030(2)	2/25/10	CUBE	S000030_350C.txt		Argonne	2/25/10	2/26/10 11:42 AM	32	31	1,784	81,553

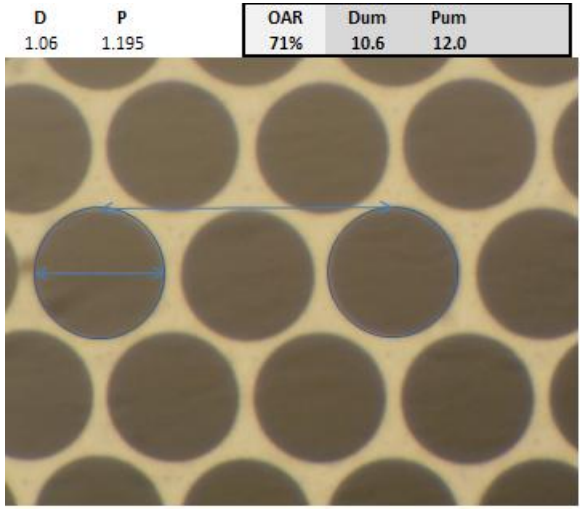


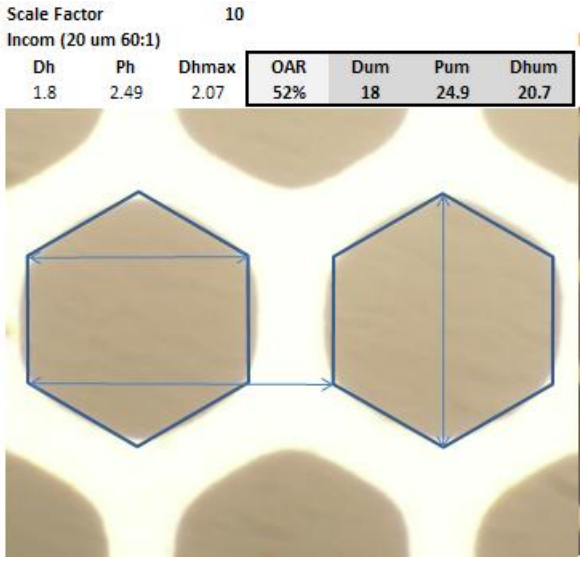


Status - Substrate observations

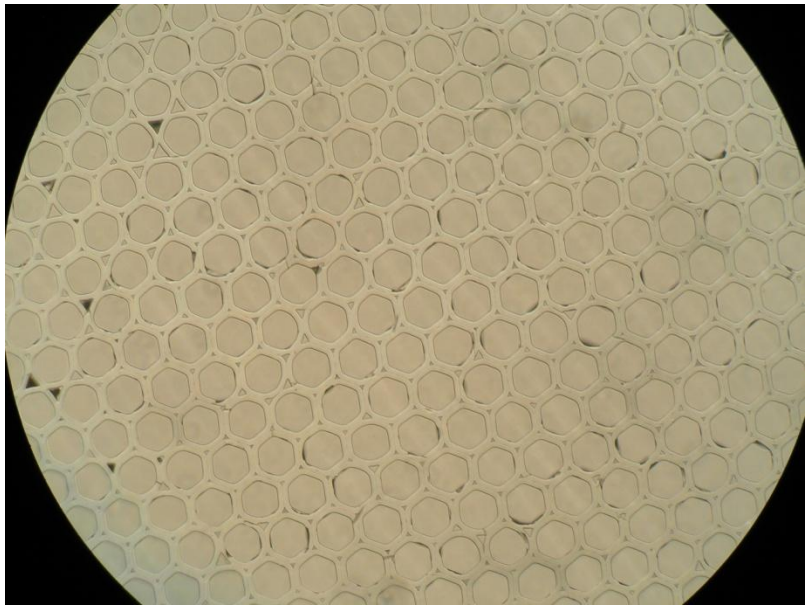
- Open area different than specified.
- L:D different than specified
- Notch in some samples.
- The pores look OK but gaps & distortions exist where cells fuse.
- Chamfer @ edge opposite notch (visible to the naked eye)
- There appeared to be some particulate on the wafer that would not blow off.

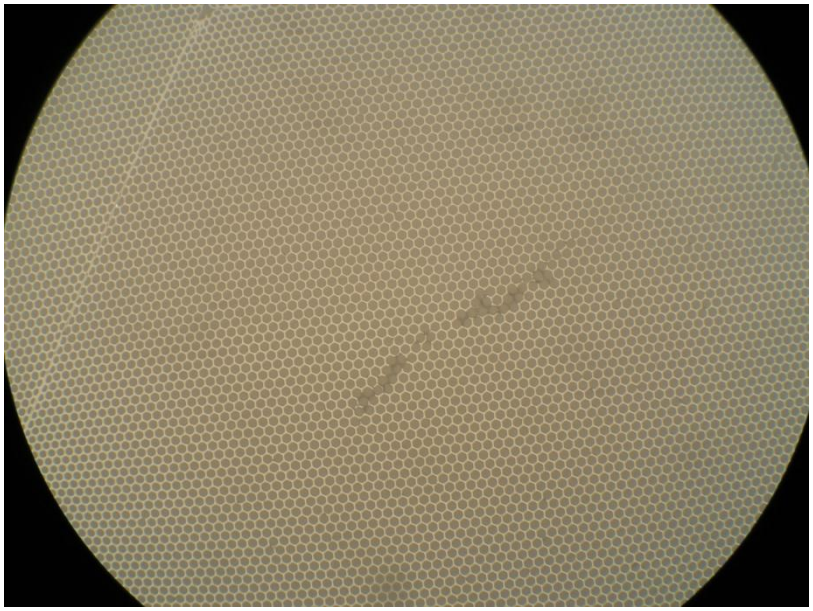
Benchmark: Image Quality MCP

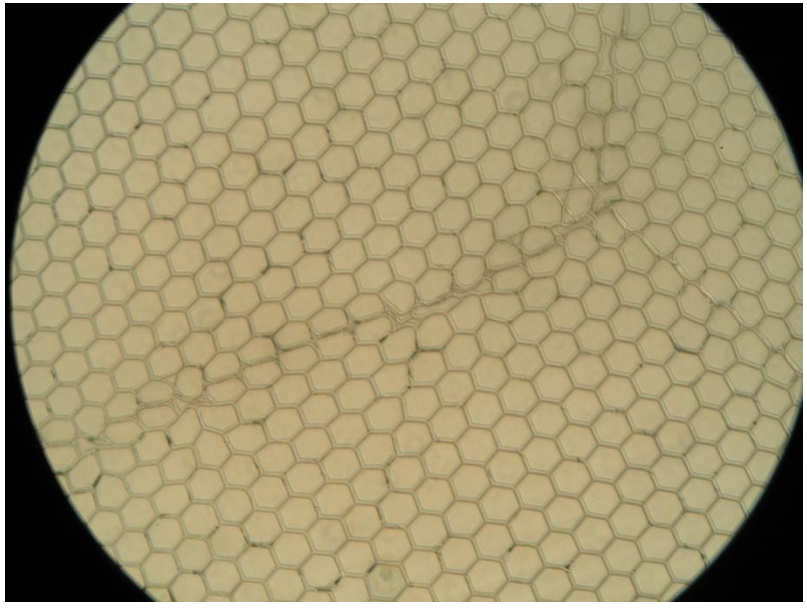


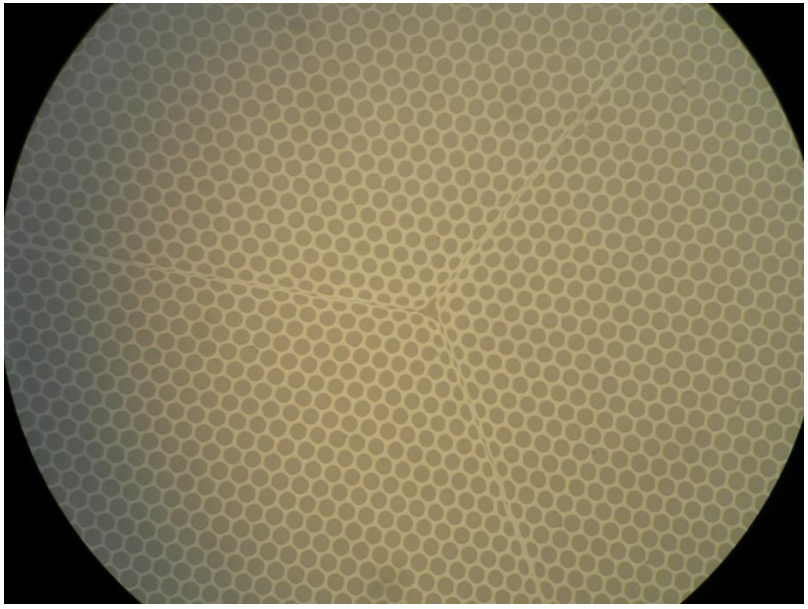


Status - Substrate observations:

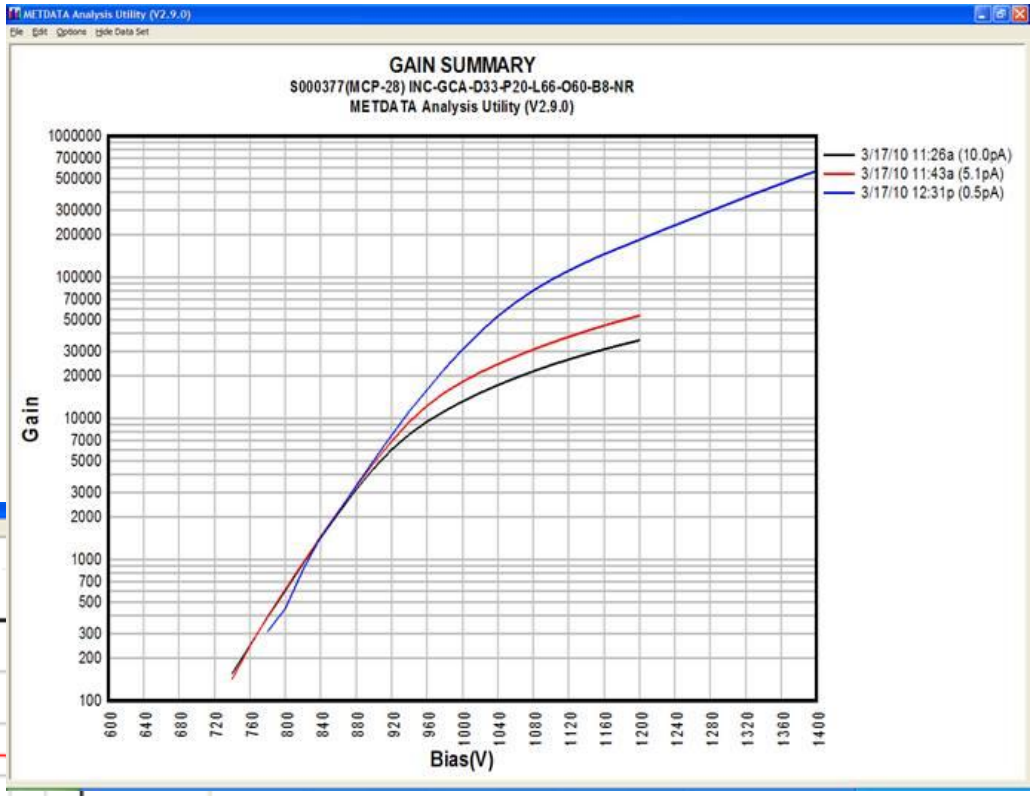


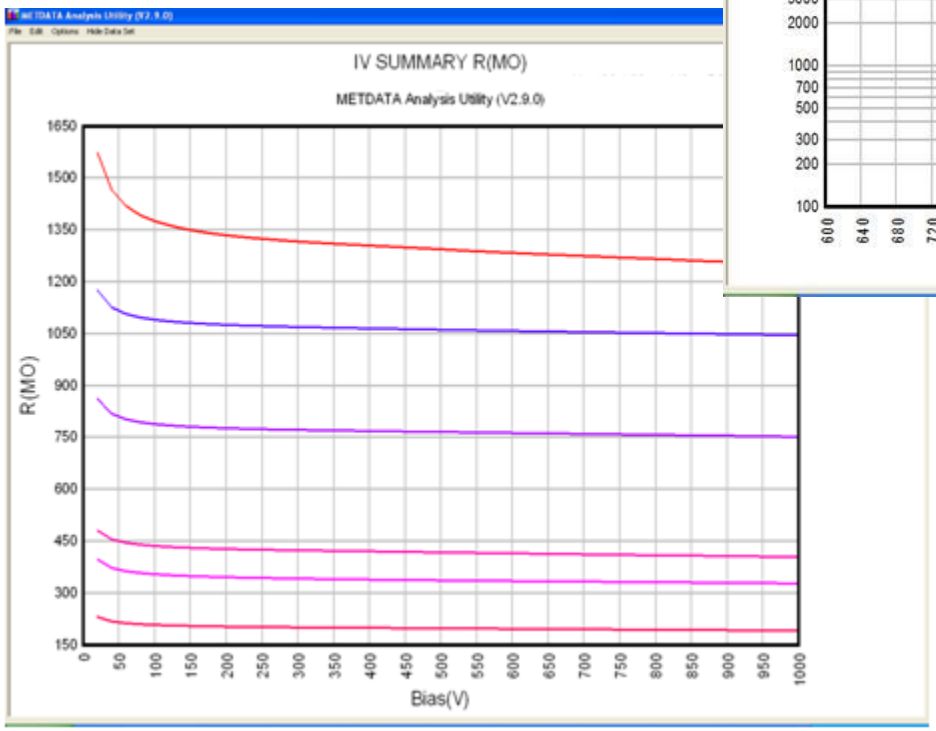






Status - Incom 66:1, 20um, 60% OAR March 2010





Future – Modified Programmatics

- Year 1 deliverables expected to be completed Q1 2010
  - Optimize Arradiance thin film technology process & process equipment to meet base performance requirements for LAPR-TOF glass & small sample AAO substrate prototype development.
  - Work Plan Deliverables:
    - ALD emissive and resistive films meet gain, resistance & uniformity specifications.
    - Process & test up to 20 Incom & 20 AAO (or glass, depending on availability) MCPs.
    - Proof of Principle Report to the project
- Year 2 deliverables expected to be completed Q2 2010
  - Optimize Arradiance thin film technology process & process equipment to meet base performance requirements for batch processing of small format (33mm) AAO and Incom substrates.
  - Work Plan Deliverables :
    - Report on high surface area production process resistance & gain targeting on small format (33mm) AAO and/or Incom substrates of pre-determined geometry (up to 3 geometry variations).
    - Argonne-supplied substrates [AAO or GCA] coated in a high surface area environment.
    - Report on correlation & optimization of SEE between Argonne & Arradiance for standard or alternative D2 process.
    - Final report and test data of all results from high surface area project.

Future – DOE SBIR funding proposal

- Large Area -> 8”
- DOE SBIR Proposal w/ University of Chicago
- Funding from current DOE $$$’s?

Company: Arradiance Inc.
Principle Investigator: Neal T. Sullivan
Project Title: Efficient manufacture of extreme surface area Microchannel plate devices functionalized by atomic layer deposition thin films
Topic 61, Subtopic a

The work proposed in this SBIR proposal is intended to follow the basic R&D effort of a consortium of national laboratories, universities, and industry, led by Argonne National Laboratory and the University of Chicago for the development of new, large area, photo-detector devices. This project proposes to address the commercialization gap that exists between the proof-of-principle large area photo-detector (LAPD) program and the efficient manufacture of large area Microchannel plate devices using atomic layer deposition (ALD). For programs such as the Deep Underground Science and Engineering Laboratory (DUSEL) project and other applications in high energy physics, medical discovery and diagnostics and homeland security applications this will be transformational.

Arradiance, as the key commercial ALD component of the Argonne LAPD collaboration, will develop productive recipes, without sacrificing MCP performance, for the LAPD device. In parallel, Arradiance will develop production equipment that can effectively and efficiently produce the large area MCP devices, in which a single 8” square device comprises the same surface area as nearly 100 state-of-the-art 300mm integrated circuit wafers.

The techniques required for large-scale commercial ALD production of LAPD a family of large-area robust detectors that can be tailored for a wide variety of applications for which large-area economical photon detection would be transformational. We believe that the success of this program, namely efficient coating of high surface area MCP devices, has the potential to extend far beyond this niche of ALD application and could impact other applications where ALD is used to coat extremely high surface area materials in technology areas such as: catalysis, fuel cell, energy storage and filtration.

Key Words: microchannel plate, atomic layer deposition, special nuclear material detection, particle physics, medical imaging, advanced detectors, nanomaterials, nanomanufacturing, thin films

Summary for members of Congress:

Efficient manufacture of extreme surface area Microchannel plate devices functionalized by atomic layer deposition thin films is an essential component of next generation high energy physics detector designs as well as novel detection applications in medical discovery and diagnostics and homeland security applications.

Problems, challenges you either face now or foresee in the future

- NiCr evaporation throughput
  - Present - single plate capacity ~ 2 Hr process
  - Future three plate capacity – with new fixturing. Expect by late April 2010
- MCP Test capacity
  - Present – single test chamber ~ 4 Hr process
  - During high volume periods may be able to allocate second test facility for short periods
- Arradiance participation in 8” MCP process development and prototype build
  - Program has accelerated aspects of 8” development
  - 8” development not defined in Arradiance SOW