OREGON NANOSCIENCE AND MICROTECHNOLOGIES INSTITUTE

From Technology Push to Market Pull: Commercializing Nanoscience Research via Startups and Spinouts

Nanomanufacturing Summit
September 4-6, 2012
Boston, MA

Robert D. "Skip" Rung
President and Executive Director

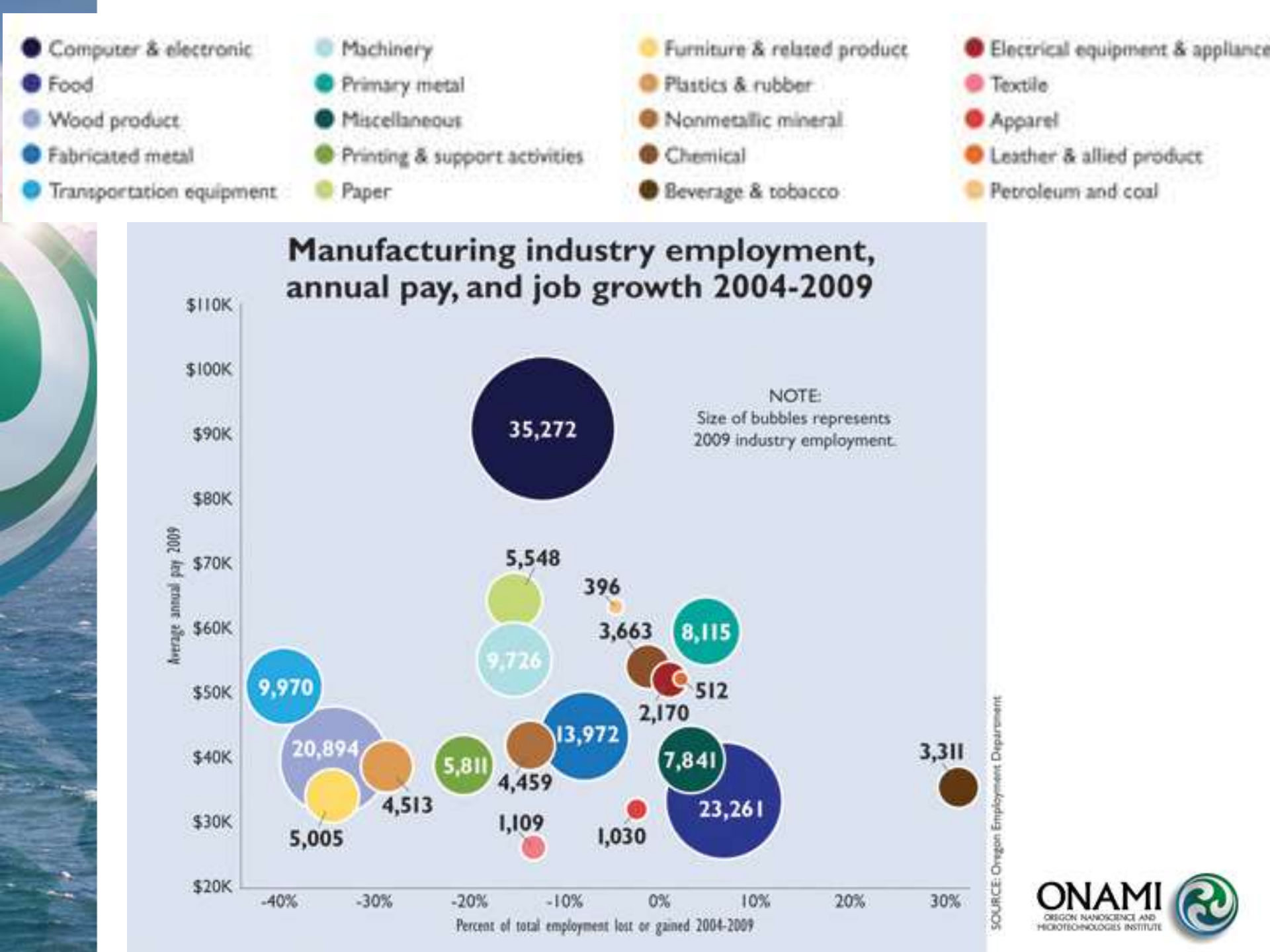
ONAMI

Agenda

- ONAMI Investment Thesis and Results
- Research Focus – Green Nanoscience for High Performance Materials and Thin Films
- Results Focus: Innovation, Commercialization, ROI, Jobs
  - Entrepreneur-scientist partnerships
  - Shared facility access for startup companies
  - Commercialization Gap Fund
- Selected Company/Technology Profiles

Pacific Northwest Micro and Nano Industry Assets

9 posters (3 CA, 2 MA, 2 TX,1 AZ, 1 PNW) available at www.siliconmaps.com


Computer & electronic
Food
Wood product
Fabricated metal
Transportation equipment
Machinery
Primary metal
Miscellaneous
Printing & support activities
Paper
Furniture & related product
Plastics & rubber
Nonmetallic mineral
Chemical
Beverage & tobacco
Electrical equipment & appliance
Textile
Apparel
Leather & allied product
Petroleum and coal
Manufacturing industry employment, annual pay, and job growth 2004-2009
NOTE:
Size of bubbles represents 2009 industry employment.
$110K
$100K
$90K
$80K
$70K
$60K
$50K
$40K
$30K
$20K
Average annual pay 2009
35,272
5,548
396
3,663
8,115
9,726
9,970
512
2,170
20,894
13,972
7,841
3,311
5,811
4,459
4,513
23,261
5,005
1,109
1,030
-40%
-30%
-20%
-10%
0%
10%
20%
30%
Percent of total employment lost or gained 2004-2009
SOURCE: Oregon Employment Department
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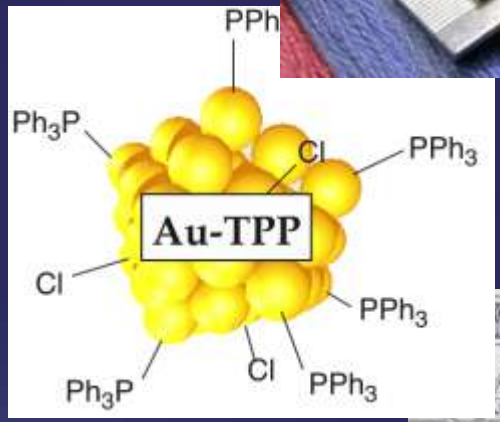
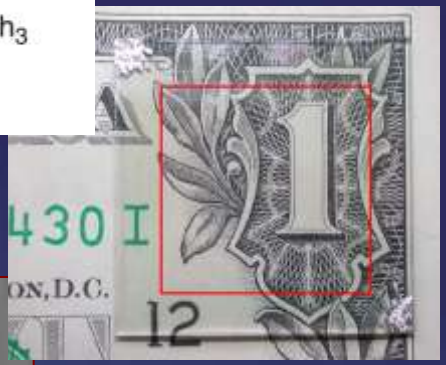
Identified Research Strengths

- *Microtechnology-based Energy and Chemical Systems*

- ***Green Nanomaterials and Nanomanufacturing***
- ***Nanolaminates and Transparent Electronics***

- *Nanoscale Metrology and Nanoelectronics*





Mission: Create Jobs and Attract Investment by Accelerating Materials & Device Research and Commercialization in Oregon

- Grow research and talent development at Oregon universities

  Metric: Federal and private awards and contracts

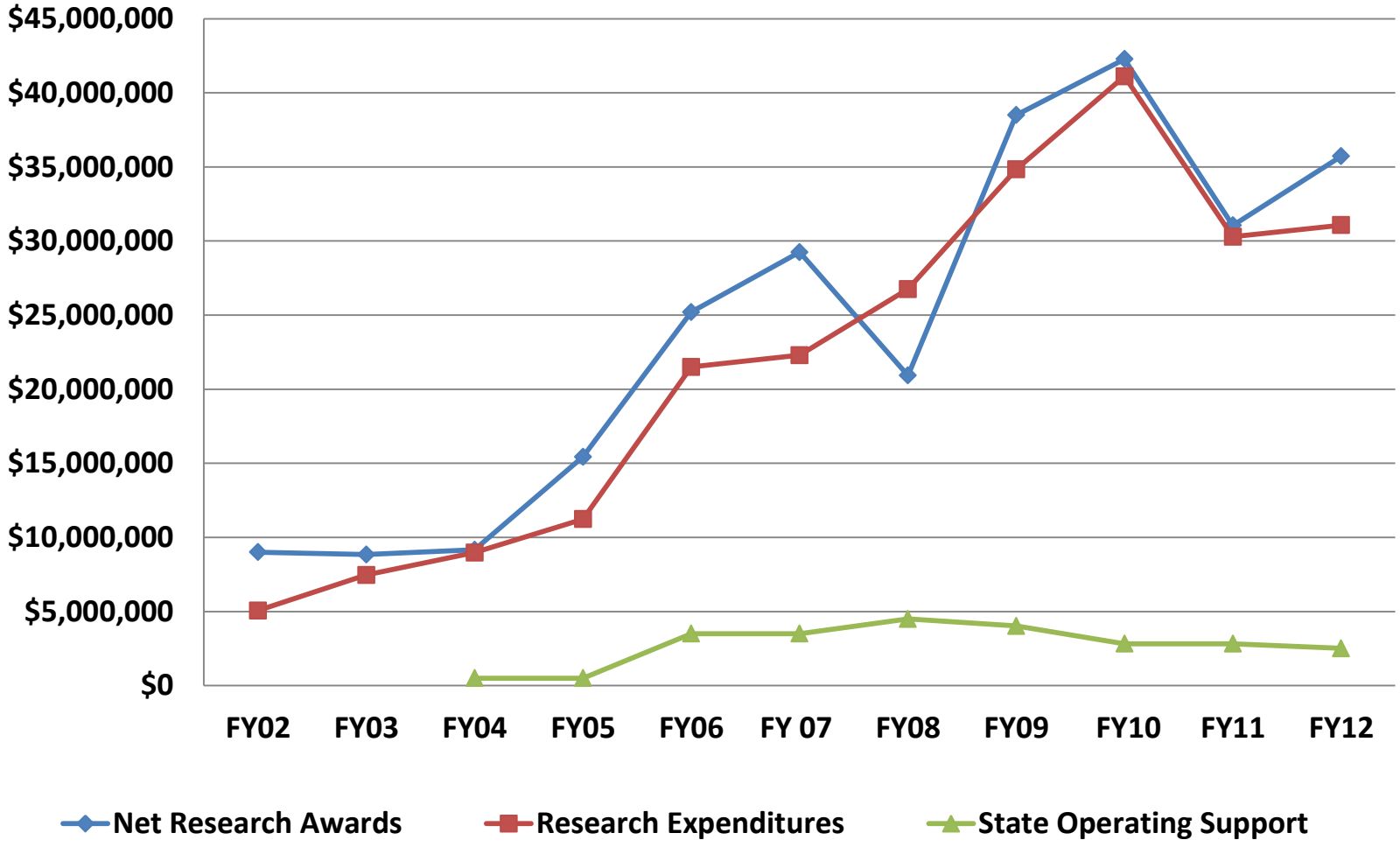
- Support Oregon industry and start-ups with accessible shared high-tech facilities and tools

  Metric: # of external clients, service revenue

- Attract capital to Oregon start-ups via a professionally managed commercialization gap fund

  Metric: #FTE employed, leveraged capital investment and grant $$

ONAMI Research Member Award History



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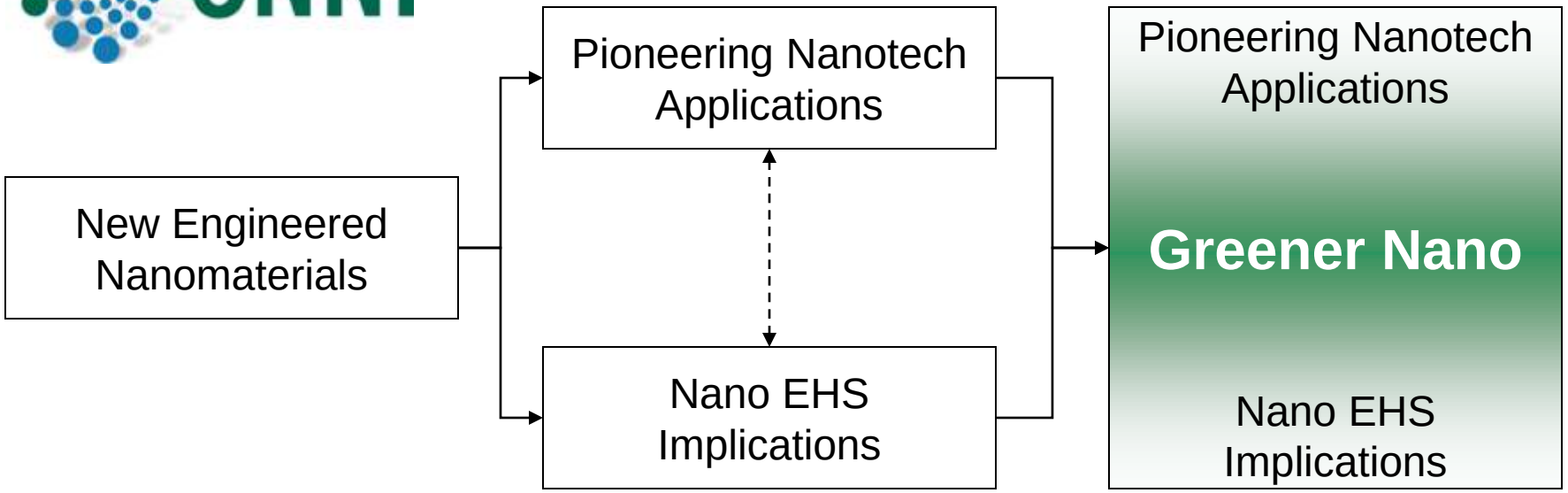
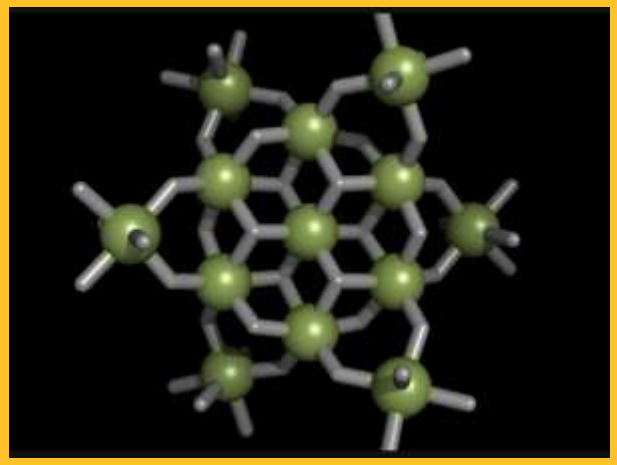
Coupling Applications and Implications:
An integrative and prioritizing approach



SNNI = Nine interdisciplinary teams at four institutions
80 researchers
chemistry, materials, toxicology, engineering

adapted from Hutchison, J.E. *ACS Nano* **2008**, *2*, 395-402

Center for Sustainable Materials Chemistry

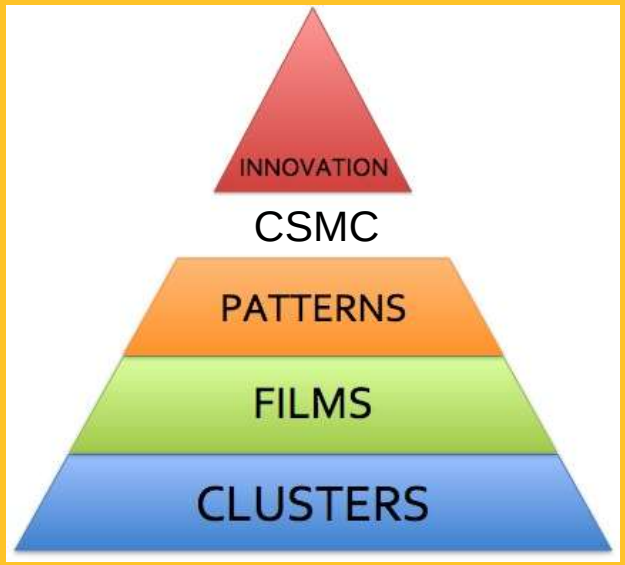


Conduct curiosity-driven and use-inspired research
to enhance the green chemistry toolbox
with new methods and new techniques
that will advance the scientific enterprise
and transform the next generation of products

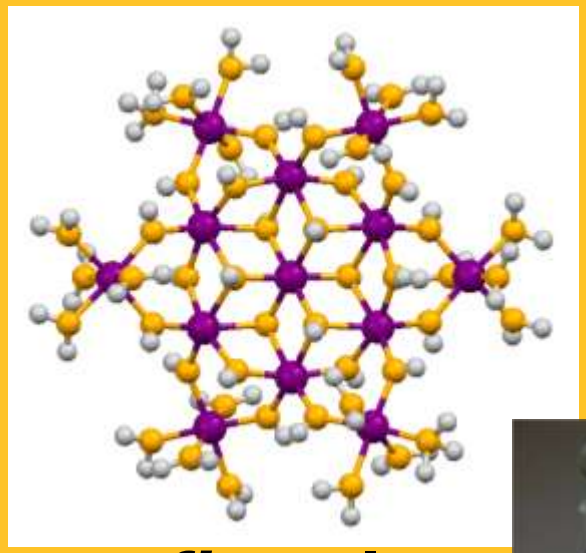
Industrial and National Lab Partners

Research Focus

- Clusters
  - First technique for synthesizing chemically labile metal clusters
  - New inorganic clusters without bulky ligands
- Films
  - High-quality inorganic films from water
  - Living films
  - High-fidelity sub-10-nm patterning
  - Tunability and high performance
- *Ferecrystals*- a new class of solid
  - Designed structures at the atomic scale
  - Abrupt structural interfaces
  - Unique and tunable properties



Research Examples



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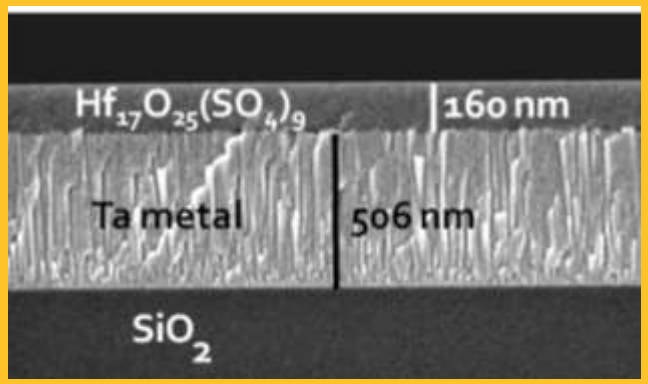


The highest quality obtained by directed assembly

Innovation

- Workshops – NCIIA Lens of the Market 1-day w/ breakout
  - Follow-up with Innovation Lab – 2-day intensive workshop aimed at selecting options for potential market innovations
- Webinars – 3 per year (coordinated by NCIIA)
  - First webinar - Intellectual Property and Tech, 2/2012
  - Webinars are recorded and posted on the web: http://www.venturewell.org/csmc-webinars/
- Commercialization

Innovation

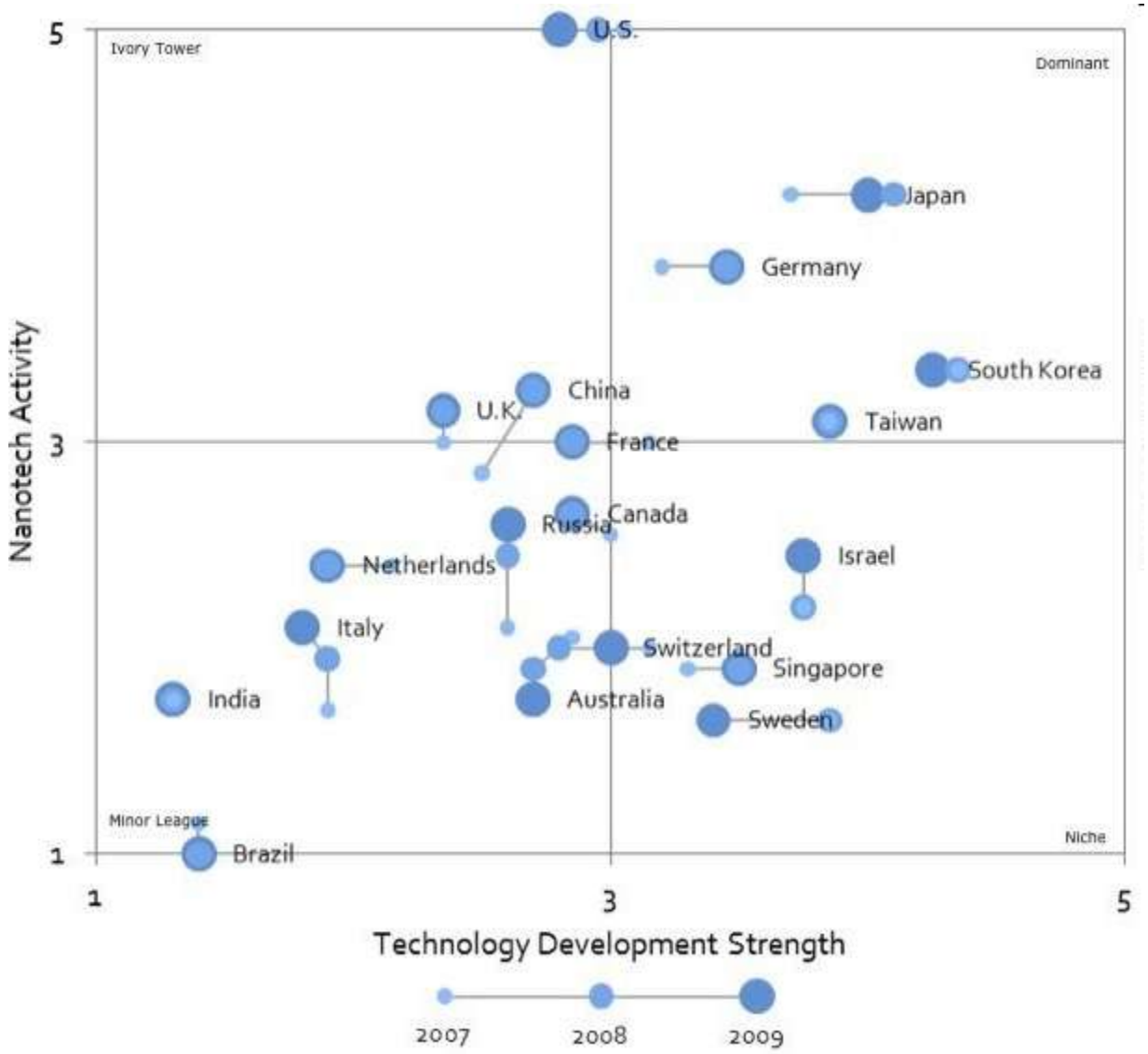
Phase-I

Series A
April 2011

Phase-II

Seed Funding
Dec 2011

The US' Challenge: Commercialization and Opportunity Retention



"U.S crosses into 'Ivory Tower' territory"

- Lux Research

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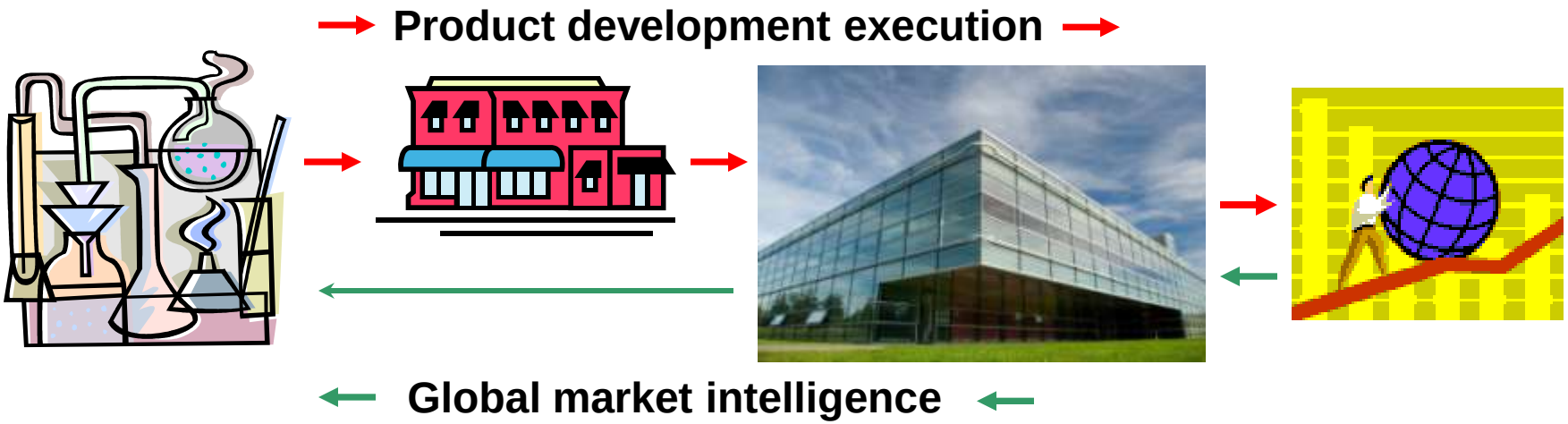


Organizational roles/needs in technology commercialization:

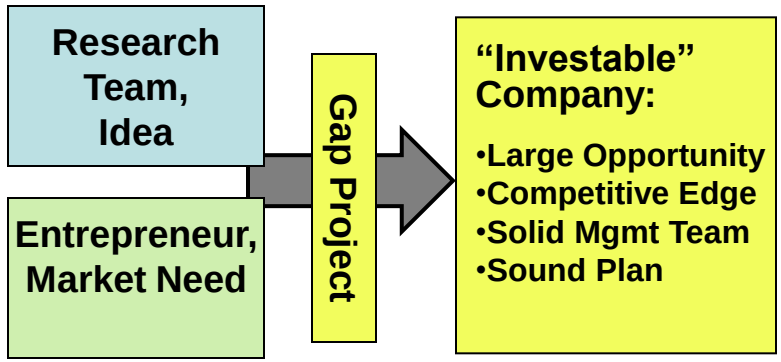
Research Institutions: scientific discovery, fundamental invention, talent development, shared user facilities. **Need:** public and philanthropic funding, enabling regulatory/legal environment

Startup companies: pioneering technology and market development of small - but disruptive – first opportunities. **Need:** equity/royalty licenses, large company customers/partners, high-risk (early stage) capital, minimal regulatory/legal burdens

Large companies: Manufacturing scale-up and global business development. **Need:** large & profitable “mainstream” markets, low-risk technology options

The ONAMI Commercialization Gap Fund Concept

Technology Stage	Company Stage	Funding Source
Research Result	(NA)	NNI Grants
Proven Prototype	***Formation***	***Gap Grants (state + federal)***
Products, Sales	Development	Early Stage Investors
Product Line Expansion	Growth	Various (private)



Federal/state partnerships in "gap" (aka "valley of death") funding for new ventures commercializing NNI technology could accelerate commercialization by 2-4 years and also ensure proper focus on economic returns and job creation.

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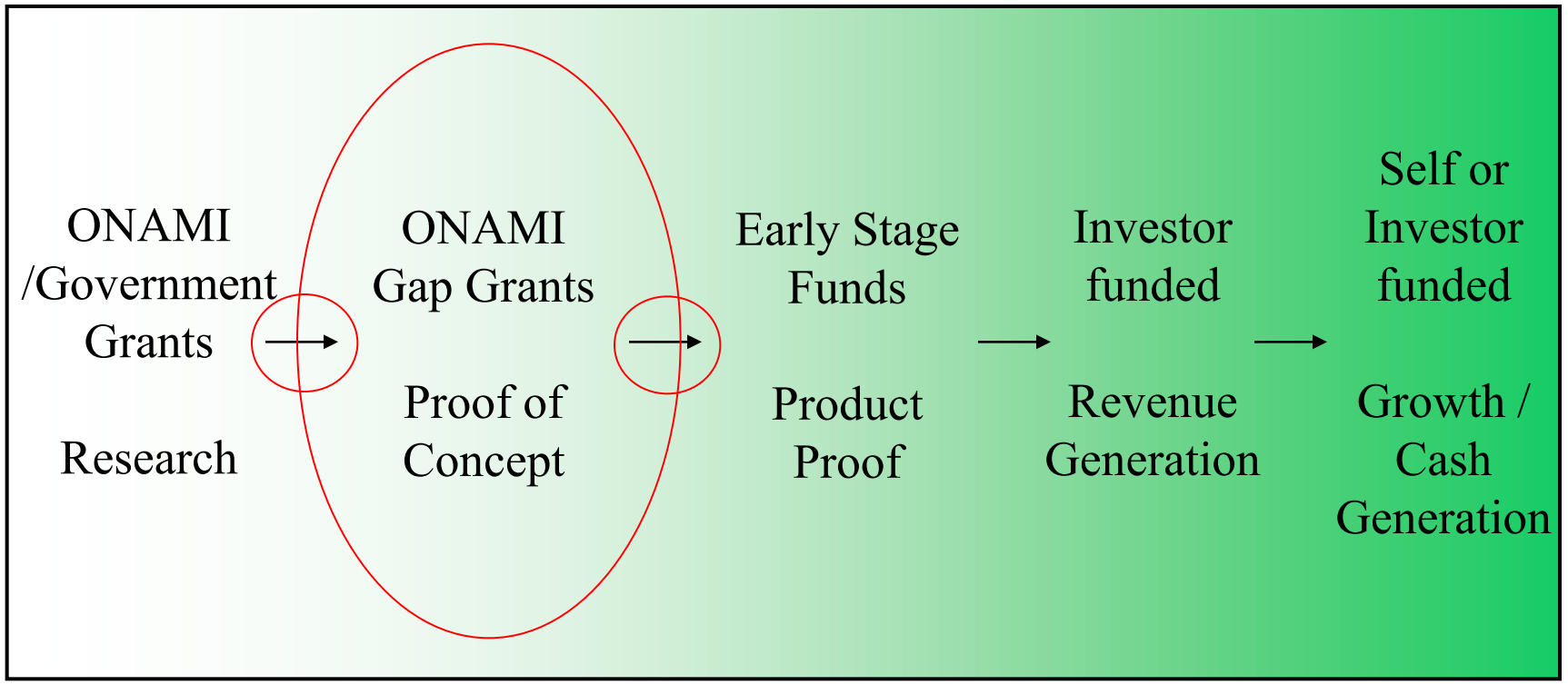
Review: ONAMI's Role in Technology Commercialization



Focus on interfaces and operations

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Two Paths Into the ONAMI Fund

- Company/entrepreneur will commercialize university IP, obtains exclusive license option and engages research team/facilities
- Company brings own IP, will utilize shared facilities and/or research team

ONAMI Entrepreneurs In Residence

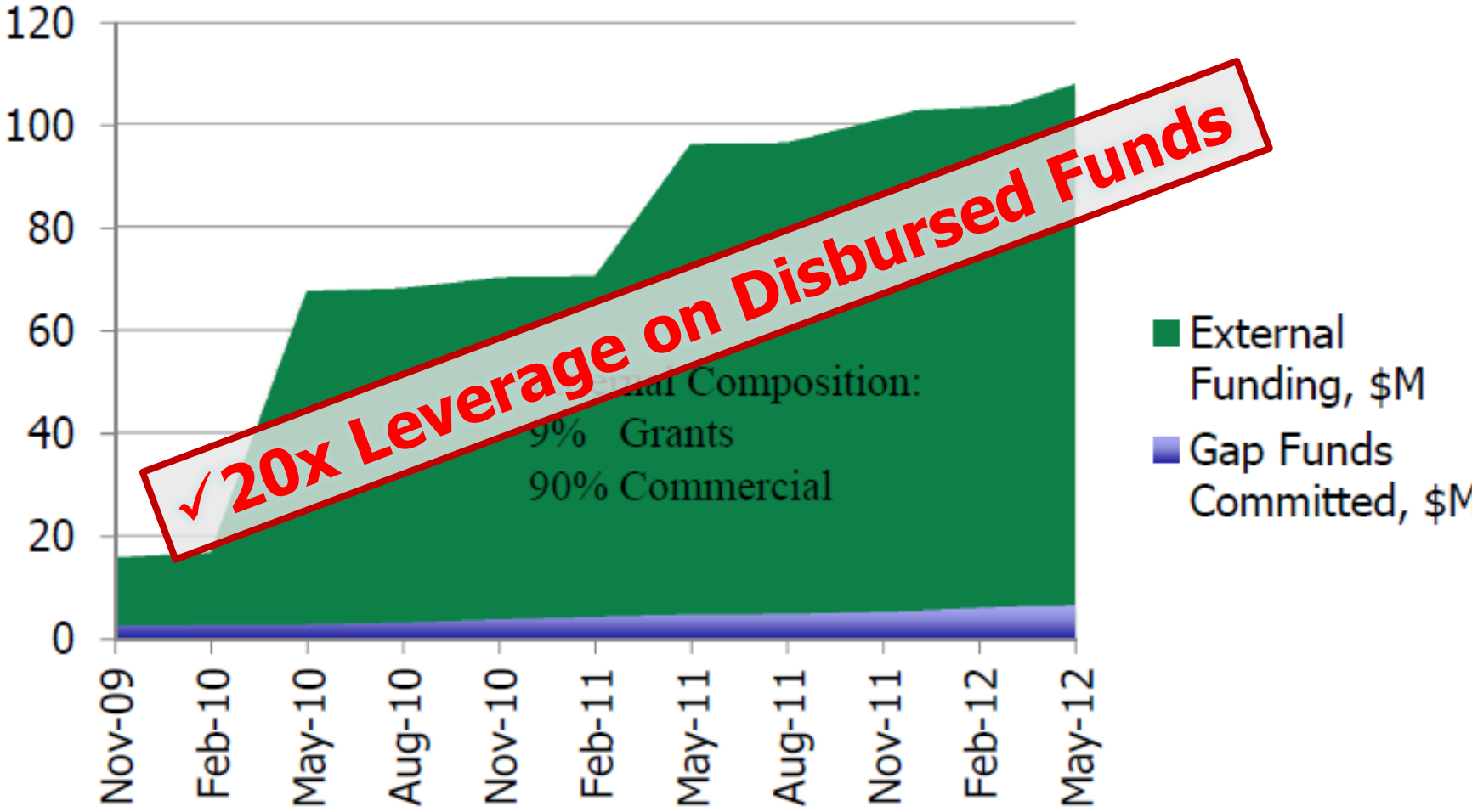
Team, Network, Market and Sales assistance from veteran CEOs

- Augie Sick asick@onami.us
  - *Chemistry, nanomaterials, life science tools*

- Michael Tippie mtippie@onami.u
  - *Biomedical, pharma, nanomedicine*

- John Brewer jbrewer@onami.us
  - *Semiconductors, electronics, optics*

Gap Company Funding History



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Water

Crystal Clear Technologies
MTek Energy Solutions
Puralytics
ZAPS Technologies

Bio and Health Care

Cascade Prodrug
DesignMedix
Floragenex
Flash Sensor
Home Dialysis Plus
Northwest Medical Isotopes
NemaMetrix
PDX Pharma

115 FTE

Energy

Applied Exergy
Energy Storage Systems
Mtek
NWUAV
Perpetua Power
Trillium FiberFuels

Advanced Materials

Amorphyx
CNXLs
CSD Nano
Dune Sciences
Inpria
Microflow CVO
OnTo Technology
Pacific Light Technologies
QE Chemical
Voxtel Nano

$112M leverage to date, more pending

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A Green Nano Startup Portfolio

SNNI	Green Nano-Material	Green Nano-Manufacture	Green Nano Application
Safer Design	DUNE SCIENCES	OnTo Technology	
Reduce e-impact		Crystal Clear Technologies	PERPETUA Power Source Technologies
Waste Reduction		VOXTELNANO	ZAPS TECHNOLOGIES
Process Safety		CSD Nano	ESS Energy Storage Systems
Materials Efficiency	Amorphyx™	inpria	PLT
Energy/H2O Efficiency			Puralytics

ONAMI Gap Fund Portfolio Highlights

- **Inpria**
- **Amorphyx**
- **Pacific Light Technologies**
- **ZAPS Technologies**
- **Perpetua Power Source Technologies**
- **Puralytics**
- **CSD Nano**
- **Voxtel Nano**
- **Microflow**
- **Dune Sciences**

The World Needs Solid State Lighting

Worldwide Electricity Consumption

Lighting: 27%
4.7B KWh in 2009

Photo Source:
NASA

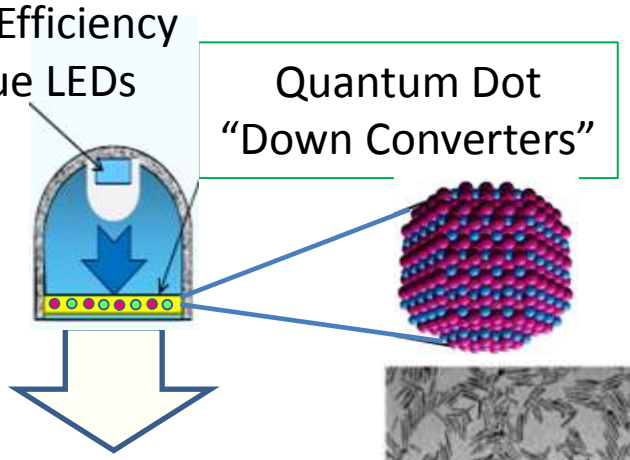
Solid State Lighting Will:

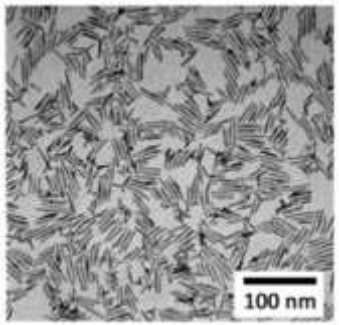
- Save a cumulative 5T kWh of electricity WW in the next decade,
- Remove the need for 500 power plants from the grid
- Reduce cumulative tons of CO2 emissions by 8B tons (equal to the emissions from all of the passenger cars in the world)

Source: Canaccord Genuity

Pacific Light Technology

efficient lighting through engineered nanomaterials





SSL Bulbs Today Reduce Electricity Usage by:

- 80% vs. Filament Bulbs (But initial price is 2-3x too high)
- 10-20% vs. Florescent (Not sufficient)

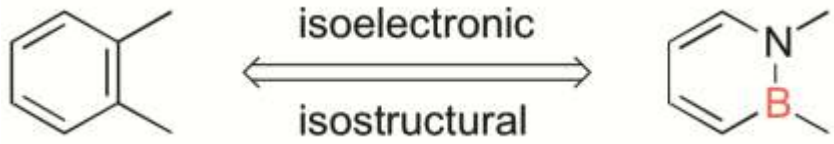
PLT's High Efficiency QD Down Converters Will:

- Reduce Cost by Reducing Number of LEDs (20-50%)
- Reduce SSL "Florescent" Electricity Usage by another 20-50%
- Improve Stability of Color (no objectionable CFL color "shifts")

QE Chemicals, Inc.

- **Start-up specialty chemical building blocks business – Azaborines as phenyl alternative**
- **U. of Oregon inventor and CSO Liu is co-founder. CEO Upson is co-founder; was VP of catalog chemicals business**
- **NIH grant ($254K) to show if Azaborine in place of phenyl in Acetaminophen can reduce/eliminate liver toxicity**
- **ONAMI ($74.5K) grant to scale-up and cost-engineer**
- **Early interest from AstraZeneca, GlaxoSmithKline, and academics**
- **Contact: Donald A. Upson, 541-913-3921**

Business Opportunity: Azaborine Building Blocks as Tools to understand Structure-Activity, and Likely to be Active



Phenyl **Azaborine → Different Properties**

- **99% of Drugs Contain Phenyl – "Privileged" Building Block**
- **Current Discovery is limited by current building blocks**
- **Azaborines similar to phenyl, likely to produce <u>active</u> analogs, with novel properties. This is the VALUE to Customers.**

"….I routinely looked for novel building blocks, regardless of the cost, to add to the diversity or expand the Structure-Activity Relationships…"

Dr. Joseph Salvino, Med Chem Professor, Drexel Medical, July 11, 2012

QE Chemicals, Inc.

- **Financial Projection**
  - 2018, Revenues projected at ~$30M+
    - Building Blocks => $18-36M, **Plus**
    - Custom Synthesis, Libraries, Co-Marketing => $5-10M
  - Licensing => **Potential for big payoff** (e.g., acetaminophen)

- **Milestones**
  - June 2012: Began lab work on grant objectives
  - 4Q12: Sign licensing agreement with U. of Oregon
  - 2013: Gain follow-on grant funding from NIH and ONAMI
  - April, 2013: First sales
  - 1Q14: Pass $1M in cumulative sales of building blocks

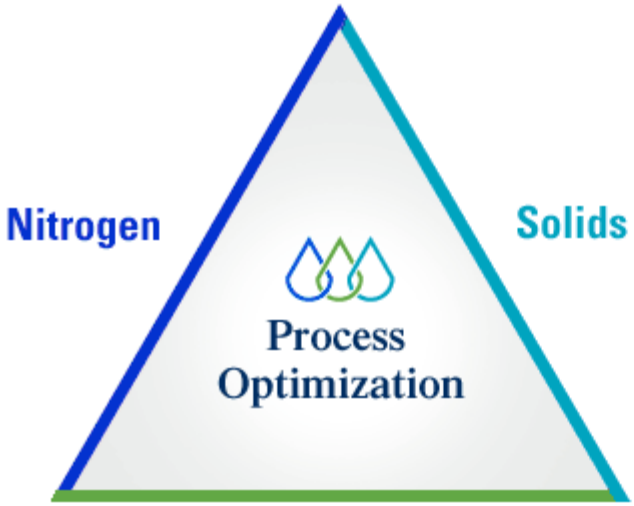
ZAPS TECHNOLOGIES

1 Machine - 100s of Parameters

LiquID™

Millions of Tests a Day

Optical Triangulation	Parameters



Ammonia	Flow
NO3	Turbidity
E.coli	Temp
Color	DBP
SUVA	CHLa
UVT	CHLb
TOC	cBOD
FDOM	BOD
TSS	COD

One machine provides a wealth of accurate, reliable real time information relevant for process optimization. Understanding nitrogen input can help systems predict and manage sludge microbe behavior, while observing efficiency in real time through oxygen demand and solids removal provides a basis for efficiency measurement and improvement.

ZAPS TECHNOLOGIES

LiquID™ features

Tri-Optical:
The LiquID™ made by ZAPS Technologies, Inc. is the only early warning system that can apply a variety of analytical techniques; absorption, fluorescence and reflectance measurements, with the same machine. The LiquID™ uses novel flow-cell and optical arrangements to manage the light more efficiently than any other optical detection system. This patented innovation together with its unique analytical capabilities makes the LiquID™ a powerful event detection system.

Multi-Parameter:
LiquID™ optically monitors diverse processes from drinking water to waste and industrial fluids. ZAPS Technologies' patented Multi-Parameter Technology™ allows for real-time measurement of numerous fluid quality indicators in a single station.

Real-Time Detection, Analysis and Control:
The LiquID™ system is accessible via a web-based user interface allowing for a comprehensive view of the entire region. A layered Observation system such as Regional, System, Site, Machine, Parameter, diagnostic, calibration and even control activities can be observed and acted upon from anywhere in the world.

Award-Winning Power Pucks®

Life-long, renewable battery for powering Wireless Sensor Networks

- Renewable energy from waste heat
- Eliminates batteries
- Like a battery – constant voltage
- Easy installation

2009 FLC Award
National
Excellence in Technology Transfer

R&D 100
2009 R&D 100 Award

2008 FLC Award
Far West Region
Outstanding Partnership & Commercialization Success

Contact Information

Perpetua Power Source Technologies, Inc.
Nicholas Fowler, Chairman & CEO

4314 SW Research Way
Corvallis, OR 97333 USA

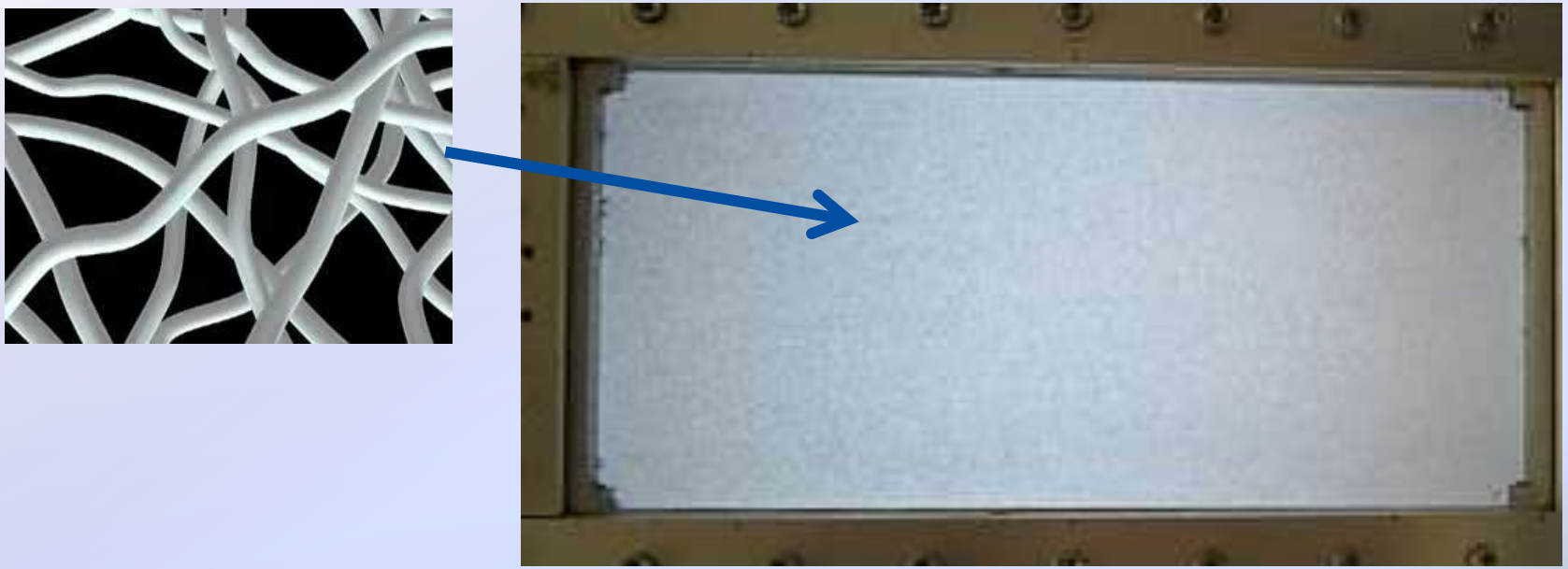
Telephone:	541.223.3112
Fax:	253.399.0373
Email:	nff@perpetuapower.com
Web site:	www.perpetuapower.com

Perpetua Power Puck®

Renewable energy solutions for wireless sensors.

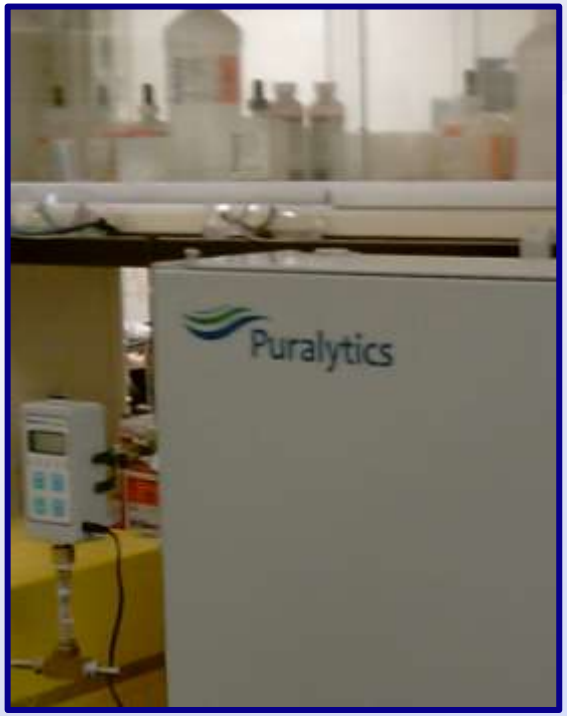
Destroying Contaminants with Light

LEDs excite a nanotechnology coated mesh which destroys germs and chemicals



4 Patent Apps Filed, 3 Grants, Field tests successful

Puralytics Solution



Shield 500 – world's first solid state water purification system

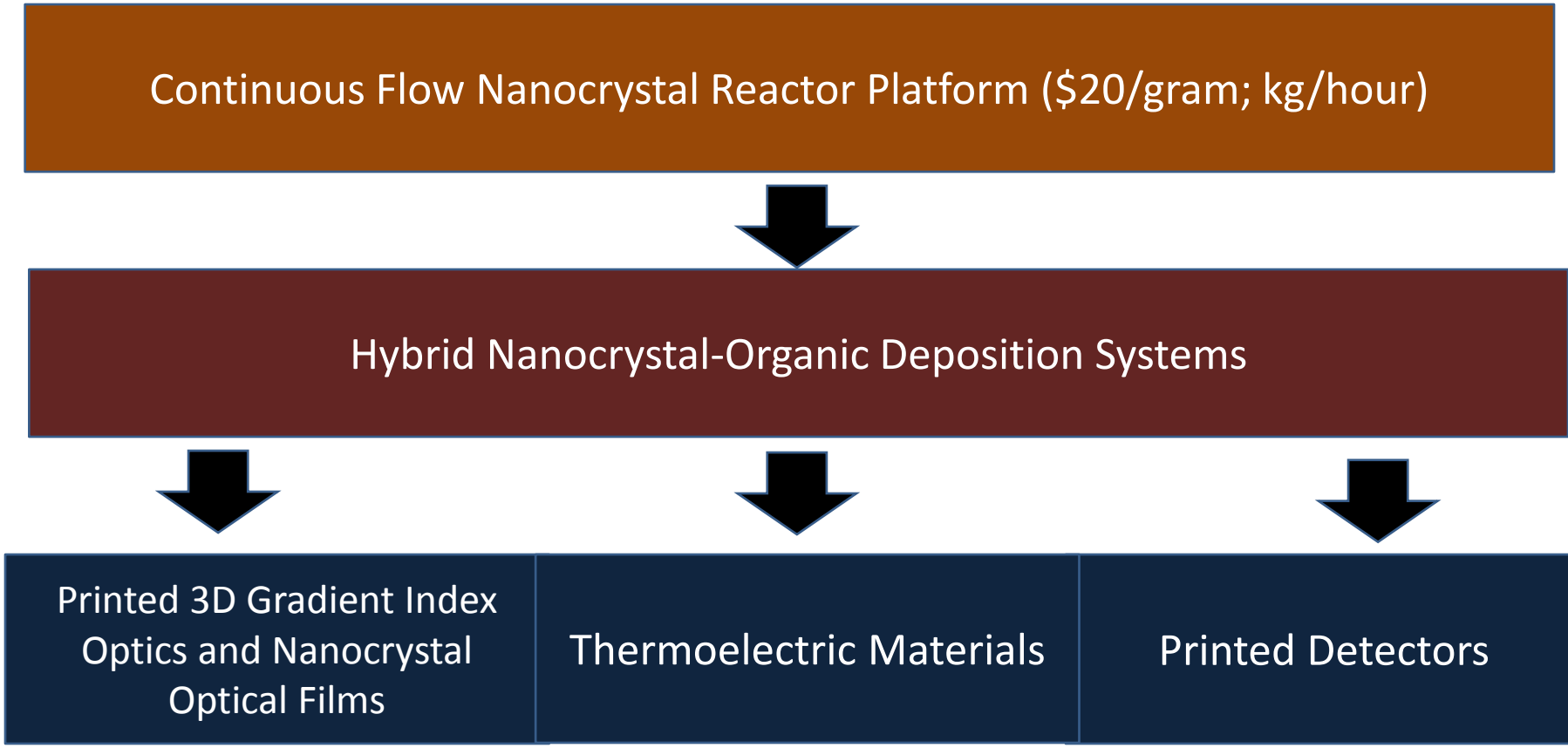
- Novel LED-activated nanotechnology coated mesh for water purification
  - **Green:**
    - Water and electricity reduced
    - Contaminants destroyed
  - **Lean:**
    - Operating Expenses reduced 80%
    - 18 Month Payback
  - **Mean:**
    - Eliminates contaminants competitive systems can't

CLEAN TECH OPEN 2010 WINNER

VoxtelNano

- **Located in Eugene, OR**
- **Wholly-owned subsidiary of Voxtel Inc. (Beaverton, OR)**
- **Nanocrystals and Nanocrystal Device Development**
  Wet Laboratories & Nanocrystal Flow Reactors
- **Located at CAMCOR Analytical Facilities**
  - **Nanofabrication Facility**
    - FEI Helios dual-beam focused ion beam (DB-FIB)
    - photolithography
    - e-beam lithography
  - **Bio-Optics Facility**
    Bio-Rad confocal microscope
  - **Microanalytical Facility**
    FEI Quanta scanning electron microscope (SEM)
  - **Surface Analytical Facility**
    ION-TOF time-of-flight secondary ion mass spectrometer (SIMS)
  - **X-Ray Diffraction Lab**
    Bruker D8 Discover thin film X-ray diffractometer
  - **High-Resolution Lab**
    FEI Titan transmission electron microscope (TEM), 0.5 Å
- **7 employees, 4 PhD**
  - **Core team from Hewlett Packard (Corvallis, Oregon)**

Product Technology Focus

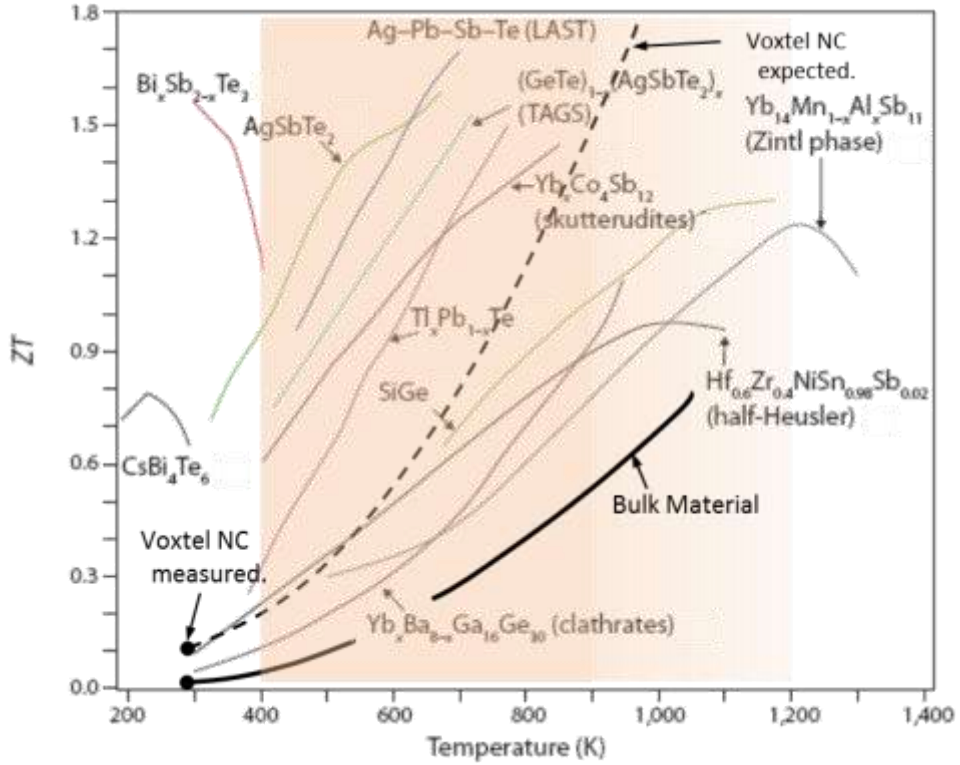


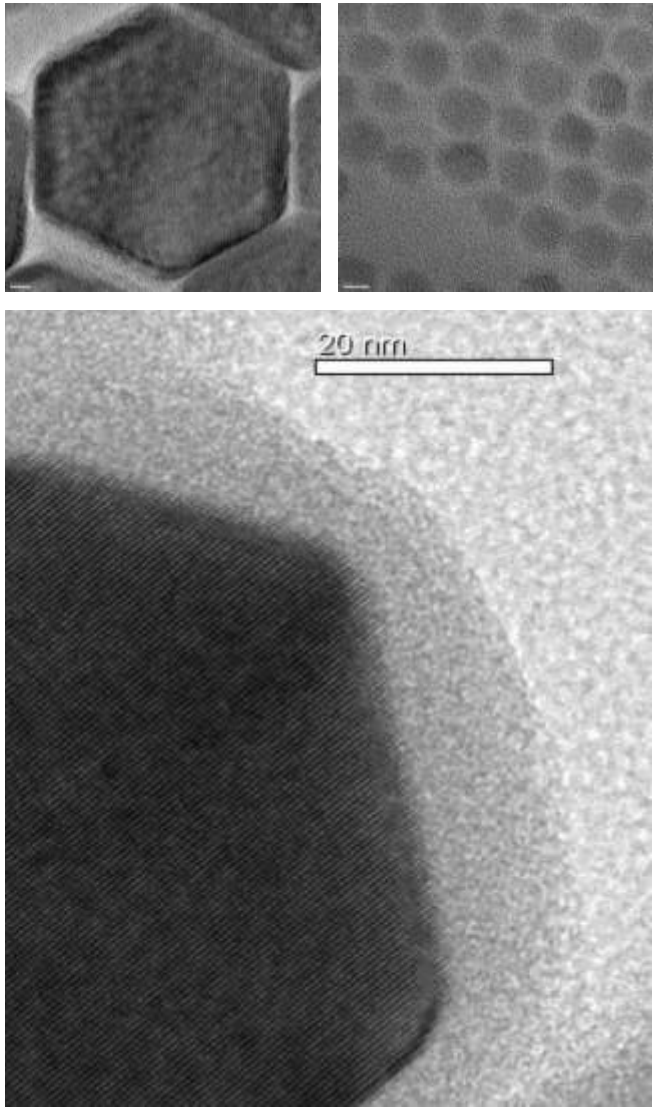
We develop functional hybrid organic-inorganic materials and the methods to synthesize and deposit them

Products & Services

High Temp High *ZT* Thermoelectric Materials

- Good TE materials have a ZT value ~1.
- Thermoelectrics with ZT > 1 have low lattice thermal conductivity and high electrical conductivity.
- Voxtel uses multiphase composites on the nanometer scale, delivering high electrical and low thermal conductivity.





nano.voxtel-inc.com

Products & Services

Photodetectors and Detector Arrays

- InGaAs (InAlAs/InP) PIN and APDs
- Silicon

Photoreceivers and Rangefinders

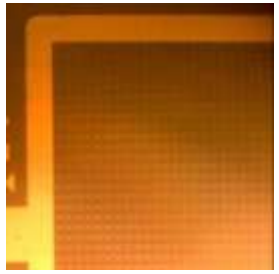
- InGaAs PIN and APDs
- Integrated uLRF Receivers
- uLRF ROICs

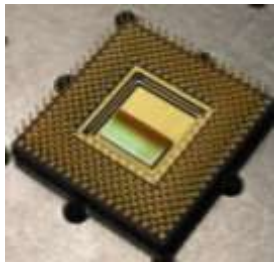
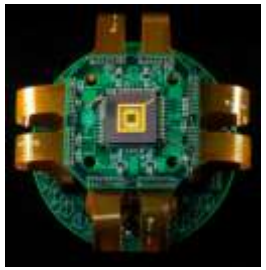
Readout Integrated Circuits (ROICs) & Focal Plane Arrays

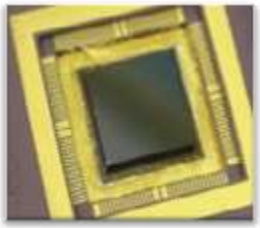
- Radiation Hard Silicon Imagers
- Wavefront Sensors
- Active/Passive Imagers
- LIDAR/LADAR sensors

Photon Counting Detectors and Instruments

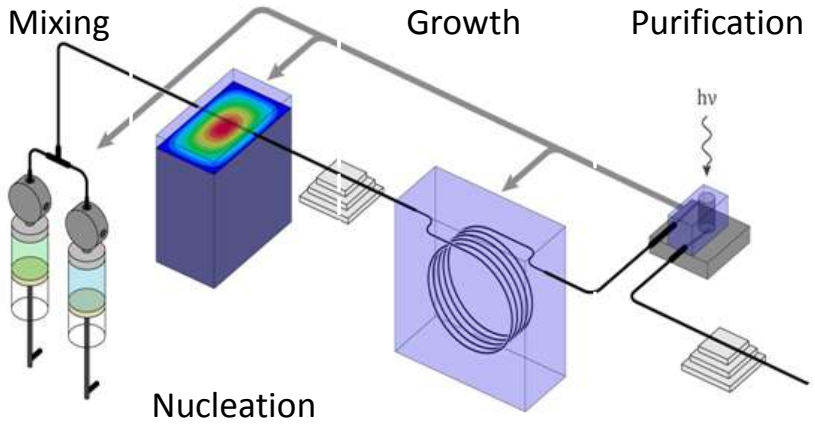
- InGaAs linear mode and Geiger mode (GM) APD
- Silicon GmAPD and SiPM
- Time-of-flight (TOF) ROICs and electronics
- Photon Counting and TOF ROICs





Microwave Flow Cell Reactor for High Precision Nanoparticle Synthesis



Zoned / Modular Reactor enabling:

- Process Control / Monitoring at each zone
- New chemistries not available to batch processes
- Increased scientific understanding of each step in nanoparticle synthesis (nucleation, growth, ligand exchange)

- Green Aspects
  - Reduced Waste
  - Increased Yield
  - Elimination of Heavy Metals (Pb, Hg, Cd)
- Business Aspects
  - Reduced Cost
  - Increased Process Control (Particles of known size, shape and chemistry)
- Green Performance and Business Success are compatible.

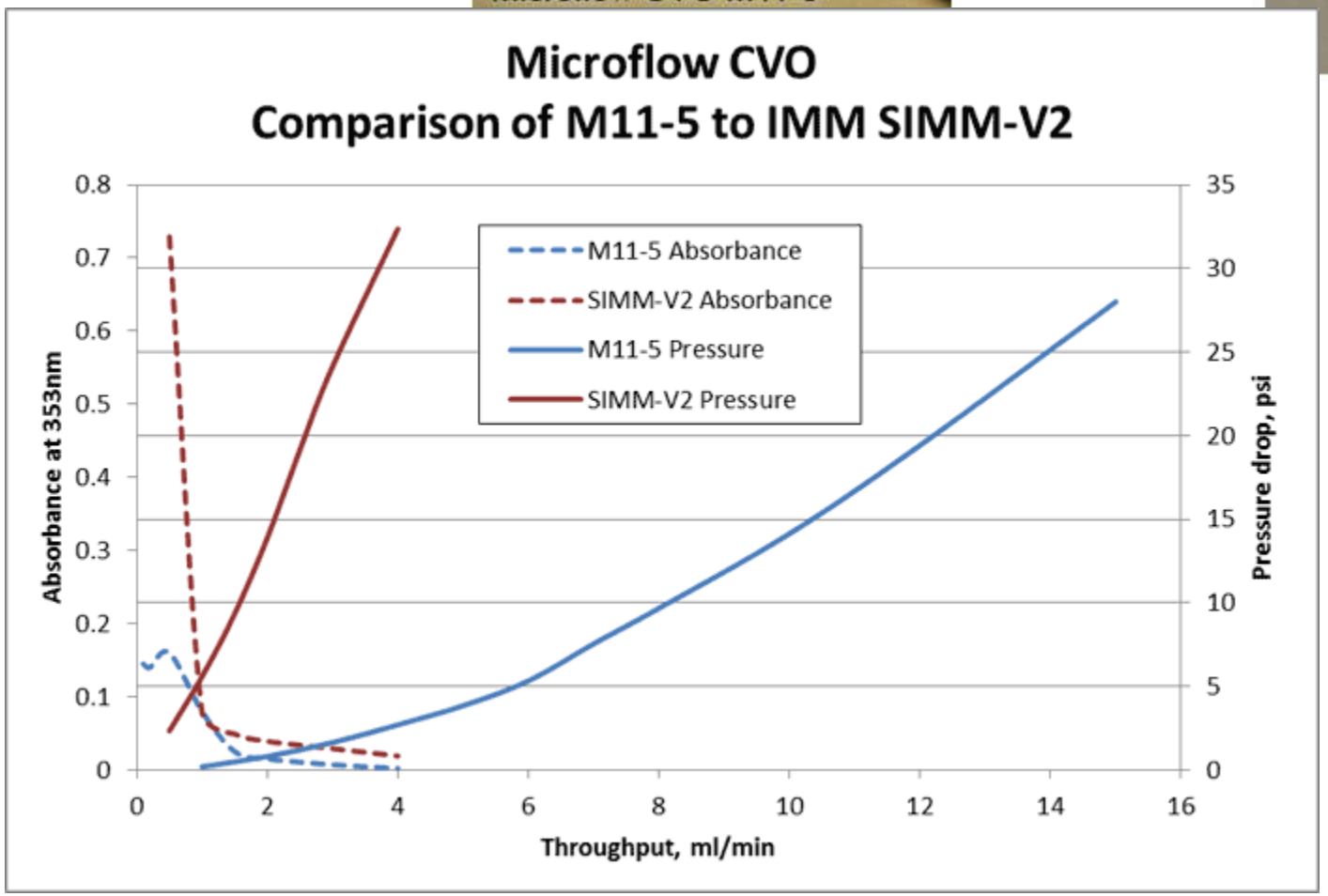
Oregon State University OSU

VOXTELNANO

microflowcvo

http://microflowcvo.com/

- Better Mixing
- Lower Cost
- Customizable
- Scalable

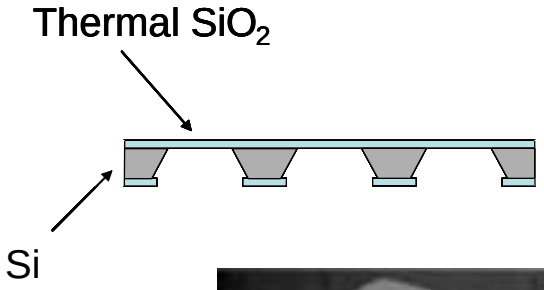


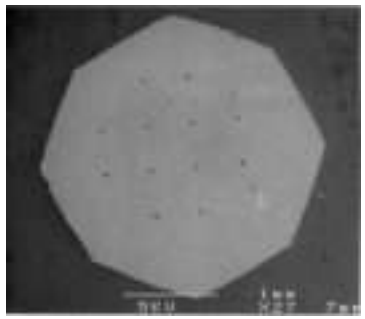
On-going efforts to streamline analysis

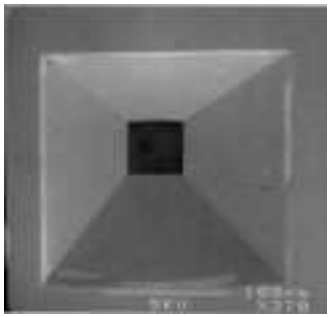
Avoiding artifacts and streamlining sample preparation – custom TEM grids

Speeding the analysis of large numbers of particles[1]

New tools (SAXS) and new analysis methods (image processing)







[1]Woehrle et al. "Analysis of Nanoparticle Transmission Electron Microscopy Data Using a Public- Domain Image-Processing Program, Image" *Turk. J. Chem.* **2006,** *30*, 1-13.

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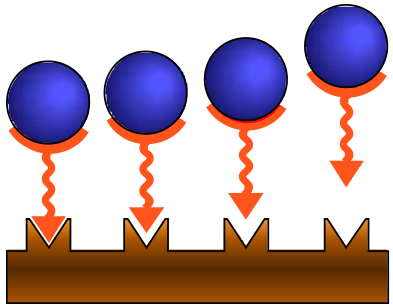
...improving life one grain at a time.

Functional Nanoparticles • Smart Grids™ Electron Microscopy
Biofuel Catalysis • Nanoparticle Waste Remediation

Dune Sciences

Nanoparticle Capture for
Visualization and Surface Functionalization



Nanoparticle Adhesion

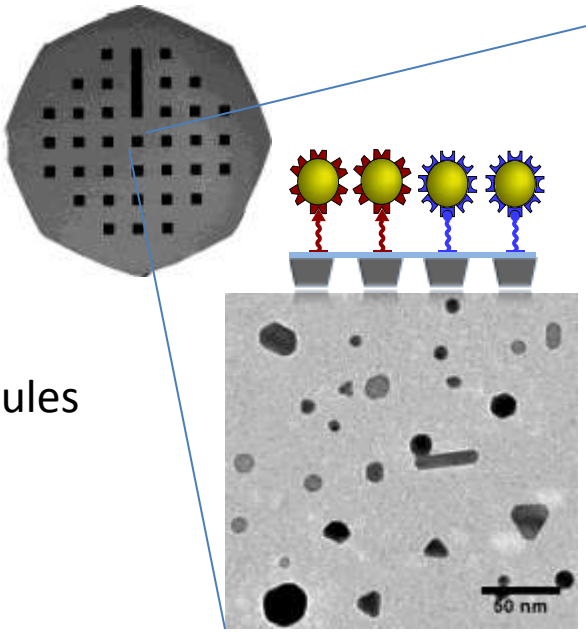
Durable anti-microbial coatings.

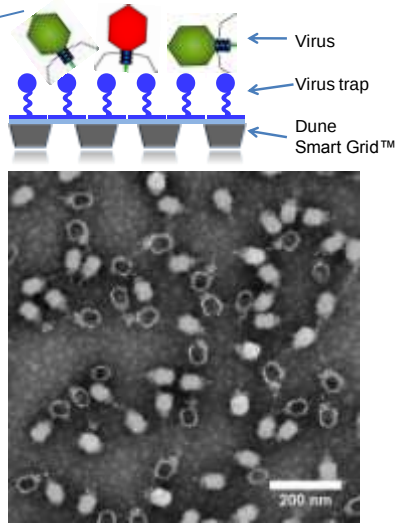
LinkedON™ Technology

- Permanent bonding of nanoparticles to surfaces.
- Reduces environmental impact and footprint.

Smart Grids™

- New standards for nano-particle metrology.
- Better understanding of nanomaterial risks.
- Enhanced imaging of biomolecules for research and diagnostics.





Lab on a Grid™ DUNE SCIENCES SMART GRIDS

DUNE SCIENCES

Acknowledgements

- Air Force Research Laboratory
- Army Research Laboratory
- Naval Research Laboratory
- National Science Foundation
- Jim Hutchison - University of Oregon
- Doug Keszler - Oregon State University
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- Dave Johnson - University of Oregon
- Andrew Grenville – Inpria
- John Brewer, Amorphyx
- John Miller - Dune Sciences
- Mark Owen - Puralytics
- Chih-hung Chang - CSD Nano
- George Williams - Voxtel
- Ron Nelson - Pacific Light Technologies
- Matt Johnen – ZAPS Technologies
- Nick Fowler – Perpetua Power Source Technologies
- Todd Miller - Microflow

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Backup slides

Principles for greener nanoscience

Green Chemistry Principles

P1. Prevent waste

P2. Atom economy

P3. Less hazardous chemical synthesis

P4. Designing safer chemicals

P5. Safer solvents/reaction media

P6. Design for energy efficiency

P7. Renewable feedstocks

P8. Reduce derivatives

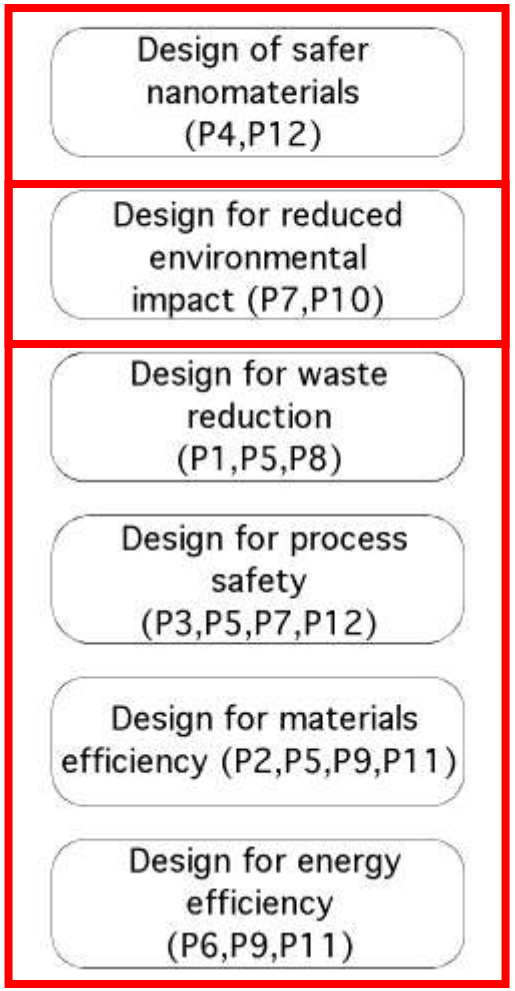
P9. Catalysis

P10. Design for degradation/Design for end of life

P11. Real-time monitoring and process control

P12. Inherently safer chemistry

Designing Greener Nanomaterial and Nanomaterial Production Methods



McKenzie and Hutchison "Green nanoscience," *Chemistry Today,* **2004**, 30.
Dahl, J.A.; Maddux, B. L. S.; Hutchison, J. E. *Chem. Rev.* **2007**, *107,* 2228

Green chemistry: a proactive approach to safer design, production and application of nanomaterials

Green chemistry is the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products

- Greener solution must meet or exceed functional needs
- Risk = f (Hazard, Exposure)

Design for reduced hazard and exposure at the molecular level – inherent safety

More efficient and safer processes

Early feedback and intervention – get the technology right the first time

The ONAMI Gap Fund Portfolio, August 2012

http://www.onami.us/Commercialization/currentProjects.php

Thrust Area and Project Host Campus	**MECS** (microtech-based energy and chemical systems)	**Green Nano** (materials and processes)	**Solid State** (batteries, printed electronics, green electronic materials)	**Nanoscale Metrology**	**Nano Bio-Tech**
OSU	Home Dialysis Plus ABP Mtek Energy Trillium Fiberfuels Apex Drive Labs NWUAV Mtek desal Applied Exergy	Inpria Nanobits CNXL Voxtel Nano CSD Nano Microflow CVO Amorphyx	Peregrine/Promat OnTo Technology *Inspired Light* *e1NA*	ZAPS Technologies	Northwest Medical Isotopes
PSU/ OHSU		Puralytics	Pacific Light Tech. Energy Storage Systems	Flash Sensor	DesignMedix PDX Pharma
UO		Crystal Clear Technologies Dune Sciences	Perpetua Power *Voxtel Optics*	NemaMetrics	Floragenex QE Chemical Cascade Prodrug

$112M leverage to date, more pending

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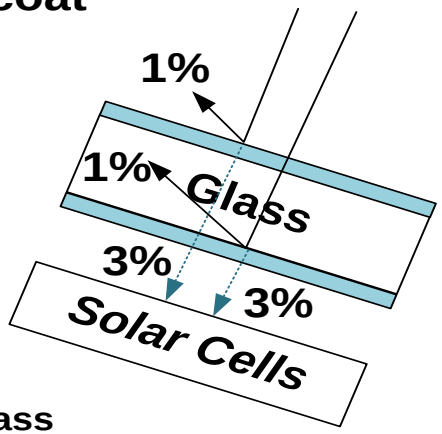
ARC* Moth-eye Structure

CSD Nano Inc

* Moth-eye structure (<100nm) with polymer hard coat

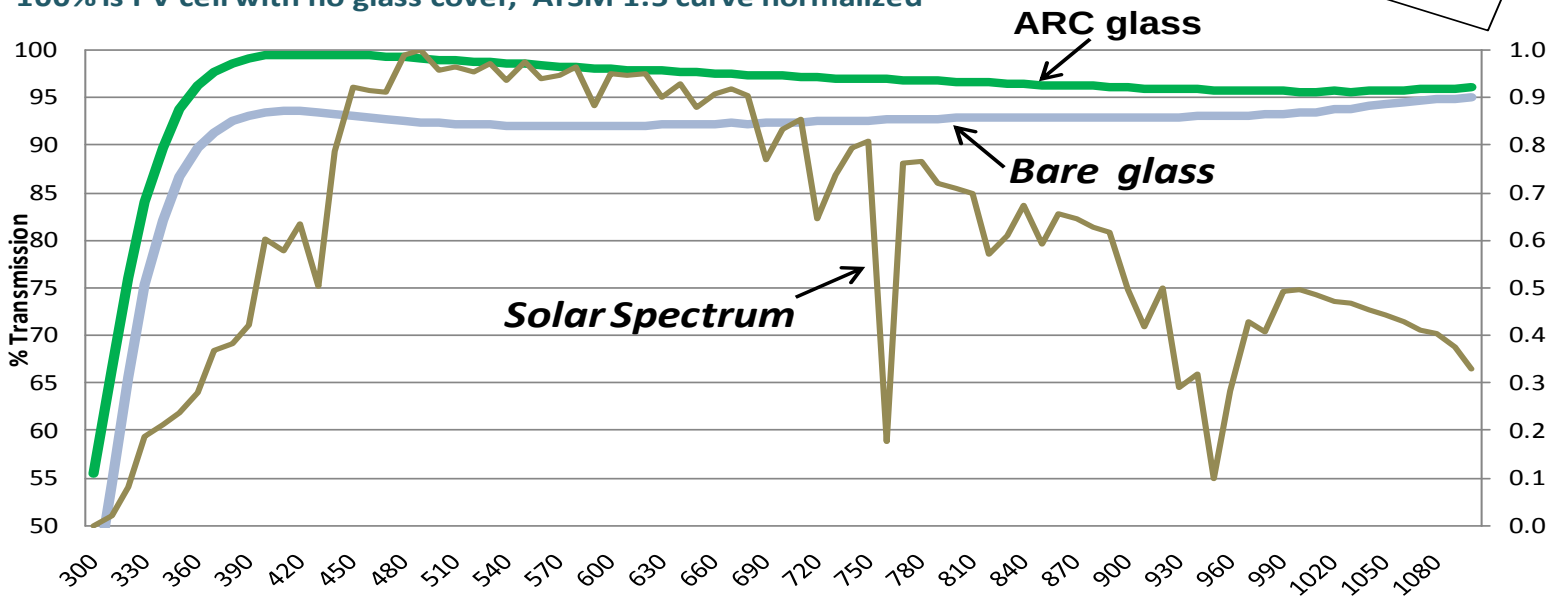
* Average 5.85% increase across 400nm-750nm
  (3rd party measured, 12 Eagle 2000 solar cover glass)

* Excellent broadband and angle of incidence performance without extra film layers



Percent Transmission (%T)

100% is PV cell with no glass cover, ATSM 1.5 curve normalized

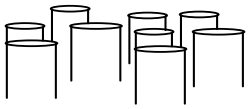


info@csdnano.com

ARC* Moth-eye Structure

CSD Nano Inc

Moth-eye Structure



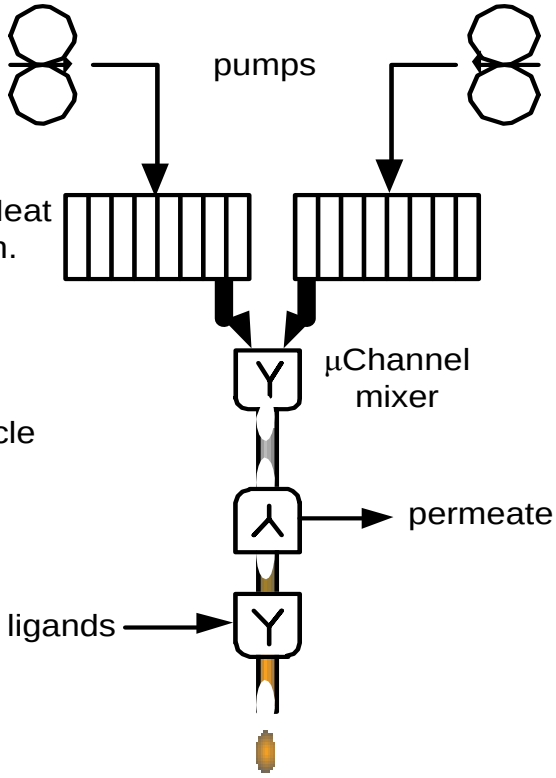
Synthesis + Deposition

SiO_2 Stochastic Tapered Structure

Molecule

Nanoparticle

Homegenous Nanoparticle film



substrate

*** Anti-Reflective Coating**

info@csdnano.com

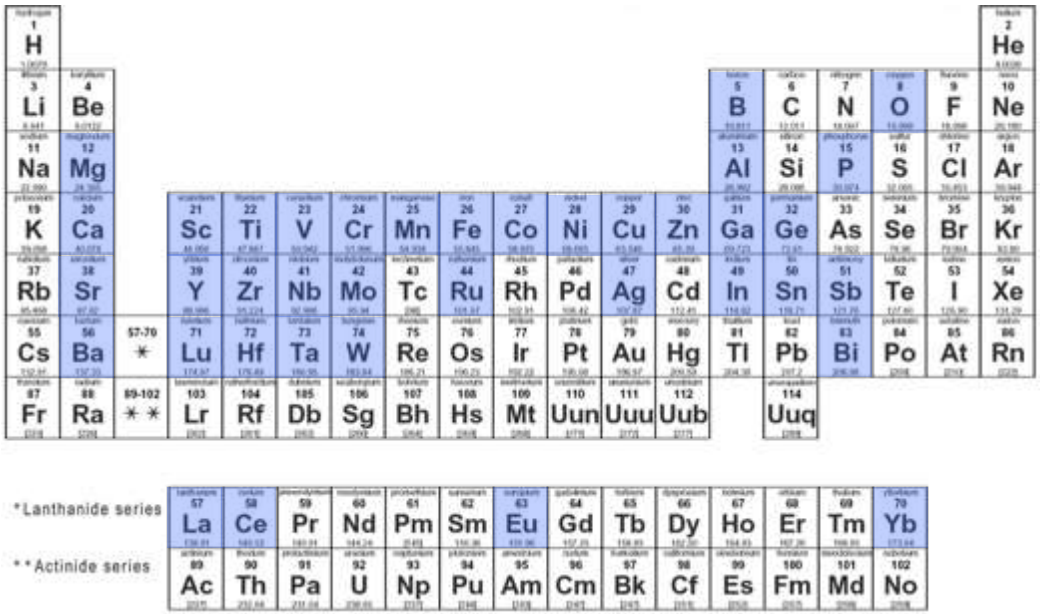
solutions for electronic thin films

Company Introduction

Andrew Grenville
agrenville@inpria.com

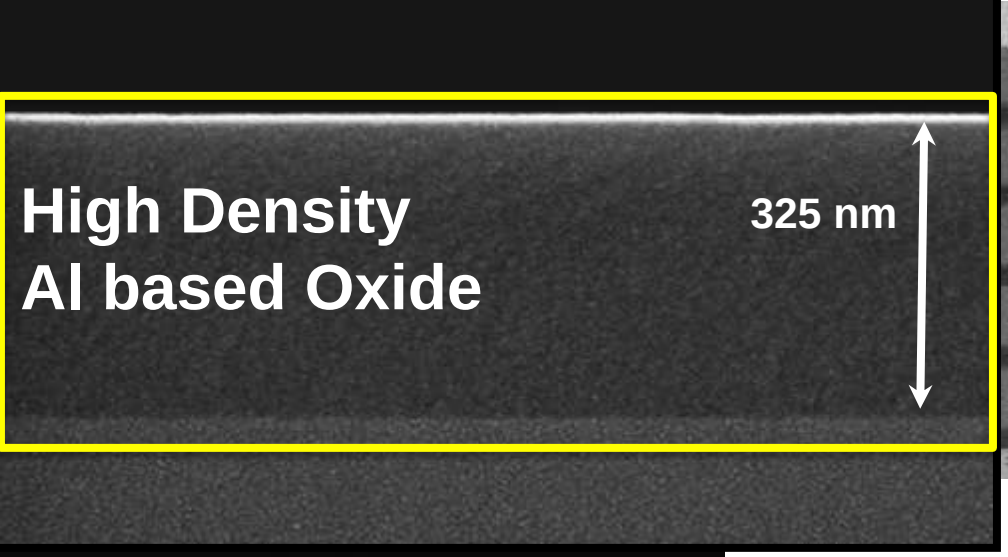
Metal oxide thin film

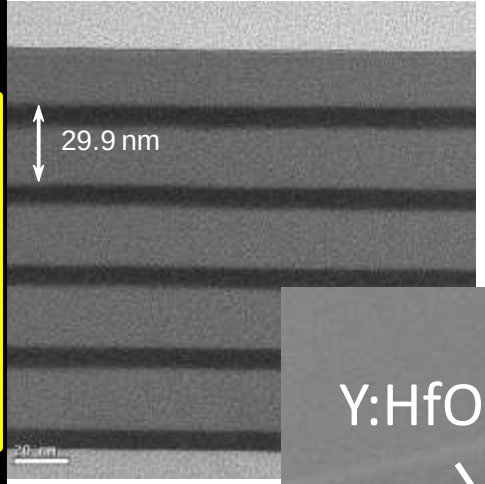
Vacuum quality metal oxide thin films from solution

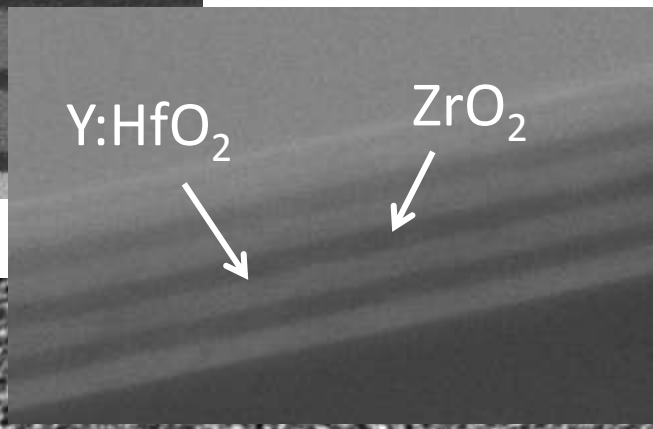


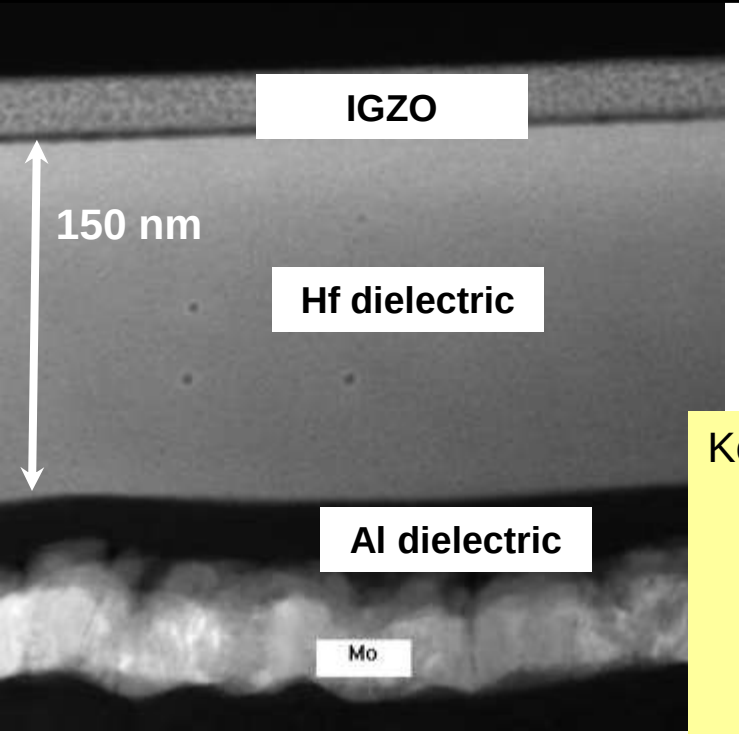
Platform accesses large range of metal oxides

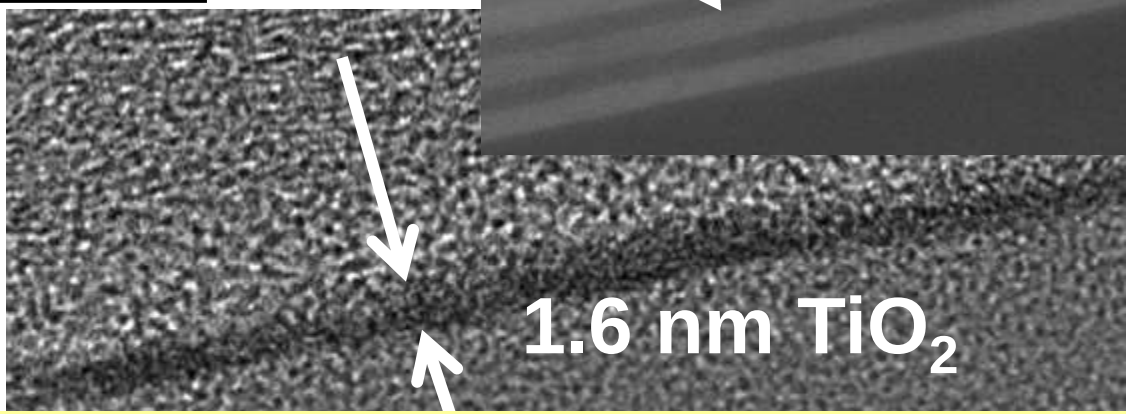
inpria









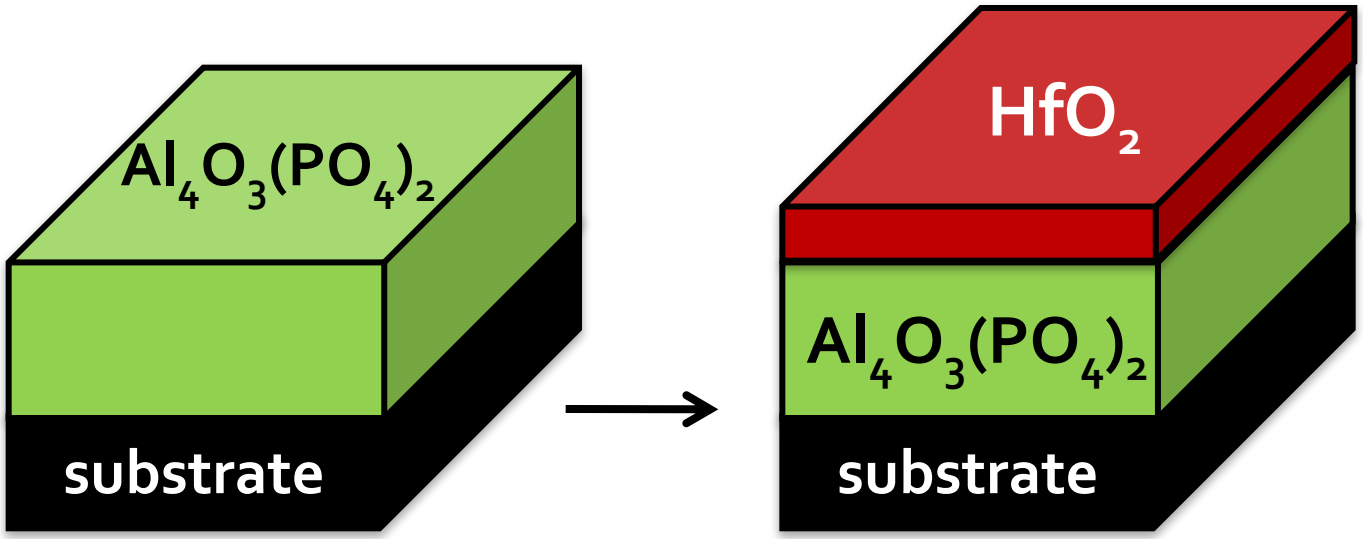


Key attributes

- Fully dense films, atomically smooth surfaces without cracking
- Directly imageable
- Widely tunable optical properties
- Film thickness ~1 - 100nm per coat
- Planarizes over nanoscale, conformal at micron scale
- Deposition by spin coating; path to large area coating
- Anneal at moderate temperatures (200C – 450C)

inpria

Digital Control of Index of Refraction via Sequential Solution Processing

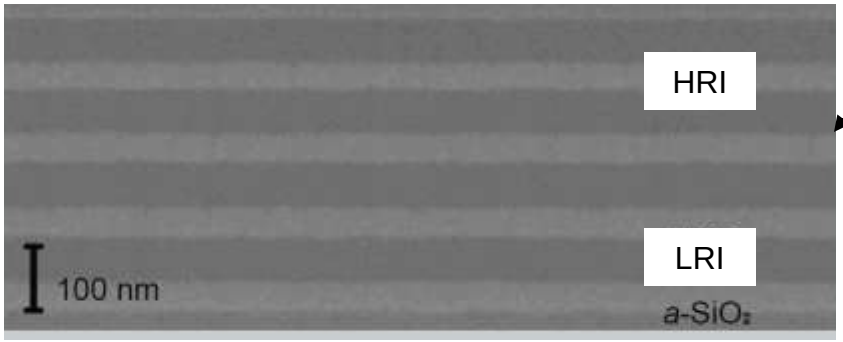


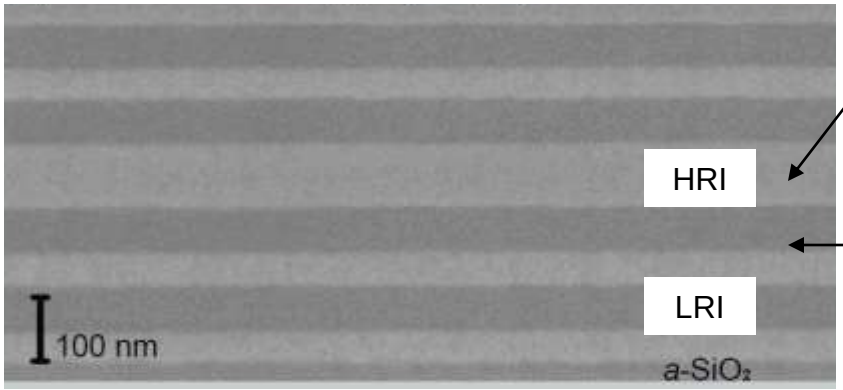
Individual layers added one by one with control of composition

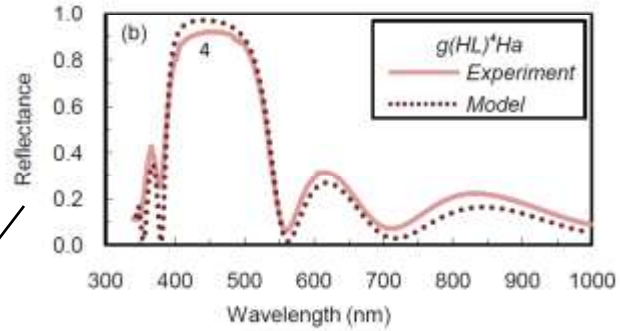
Inorganic Optical Coatings by Solution

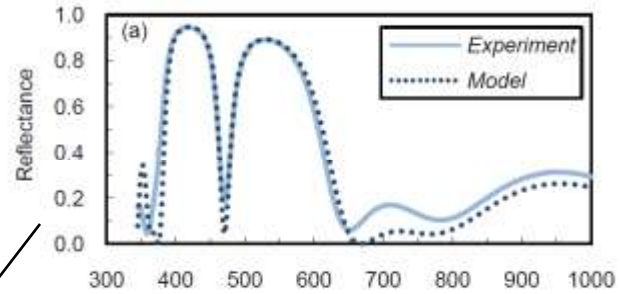
HRI: n = 2.26 (@ 500nm)

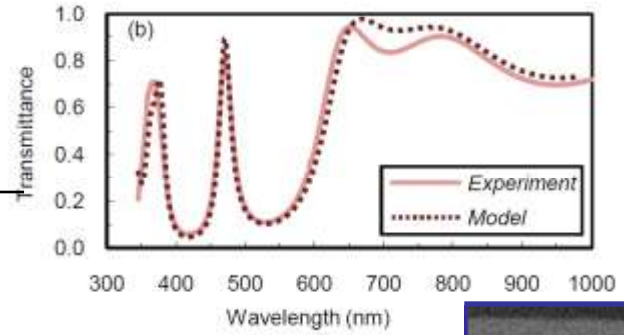
LRI: n = 1.50 (@ 500nm)

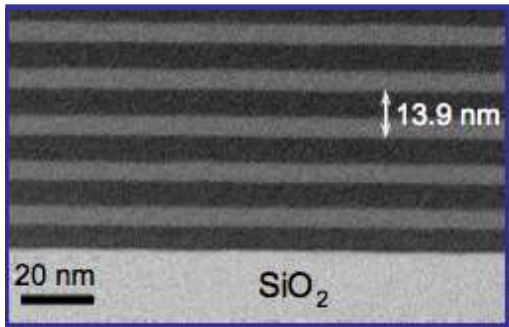










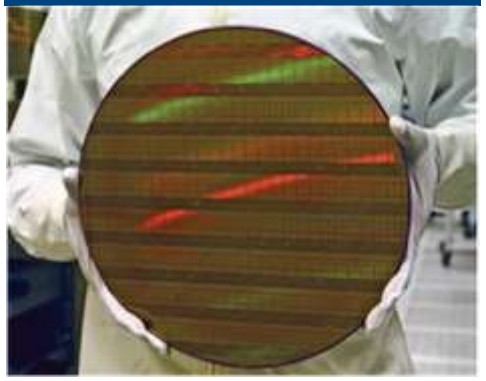


Note: maximum processing temperature was 300C; multilayer film stack deposited entirely by solution process (spin coating)

Applications

Display Backplane TFT Materials

Lithography Materials



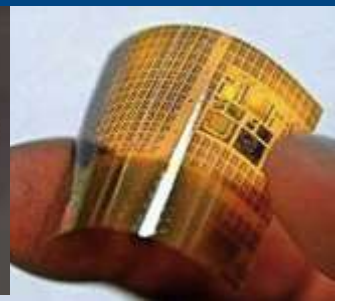
Inpria

Materials And Processes

Thin Film PV

Window Coatings

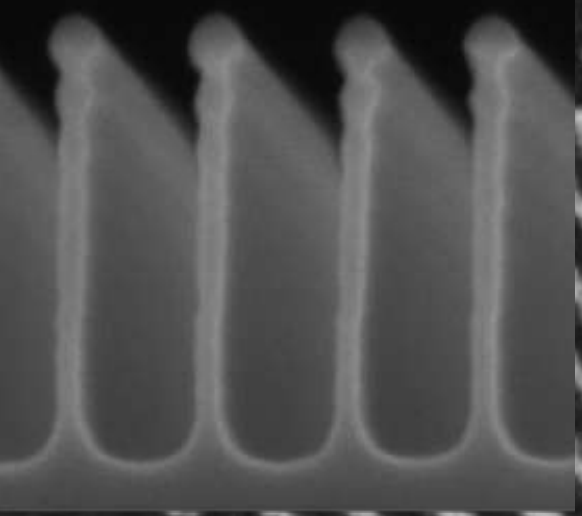
Printed Electronics & Lighting



Inpria

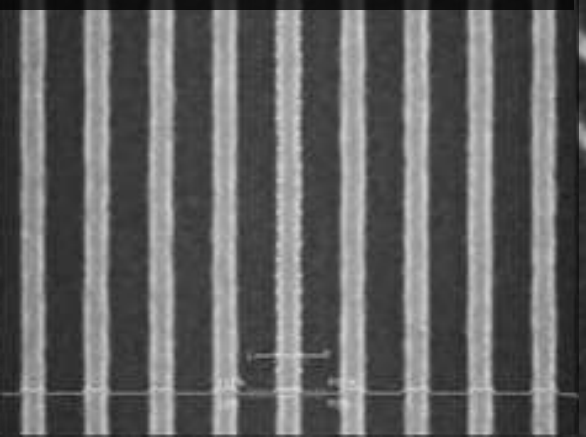
Resist for Semiconductor Lithography

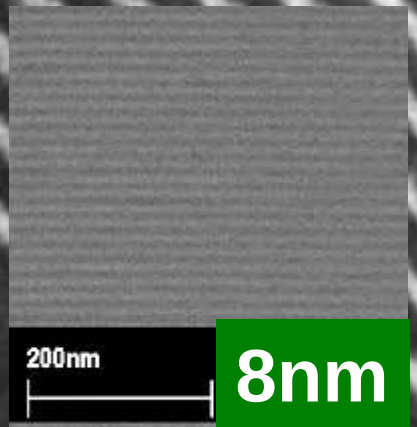
15nm Etched Si Fins



15 nm

1.6 nm Linewidth Roughness





8nm

Key Attributes

- High resolution
- High etch selectivity
- High EUV absorbance
- Low LWR

Amorphyx Overview

- **Breakthroughs in manufacture and use of amorphous metals**
- **Revolutionize manufacturing of flat-panel display backplanes while enabling the future of flexible displays**

Replaces complex Thin Film Transistor with simpler Amorphous Metal Electrode Thin Film Diode

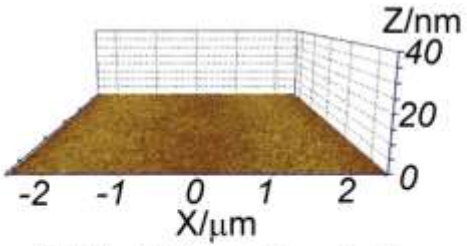
Roughly 3x capacity increase in TFT Array manufacturing facilities using existing tooling

- License AMTFD Process into FPDs
- Develop Reference Plant for Flexible

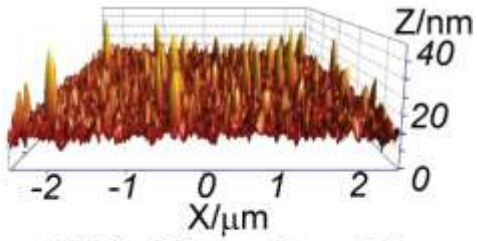
Convert $Bs in annual FPD industry losses into profits by redefining backplane manufacturing throughput

Generation 8 glass panel patterned with six backplanes for 52” Samsung televisions. Previous generation glass panels are seen to lower left.

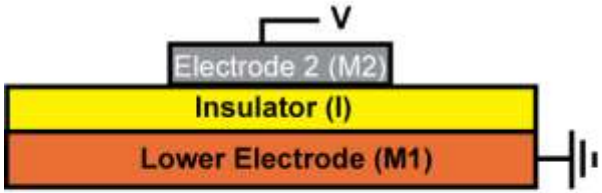
AMTF Metal-Insulator-Metal Diodes



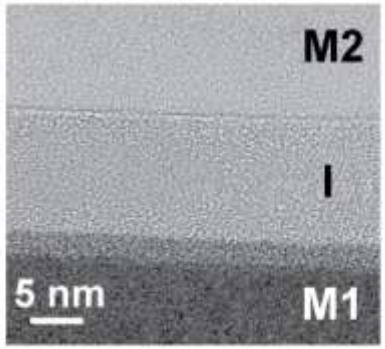
AFM of amorphous metal electrode surface



AFM of crystalline metal electrode surface



AMTFD Schematic



AMTFD Structure

Amorphous metal thin films:
Device control through material properties

An ultra-smooth surface eliminates localized “eddy currents” that modulate MIM diode “on resistance” at a given forward-bias voltage

Flat Panel Display Benefits

- improved gray-level performance
- improved brightness uniformity
- increased backplane glass yields
- lower power consumption

Development Status

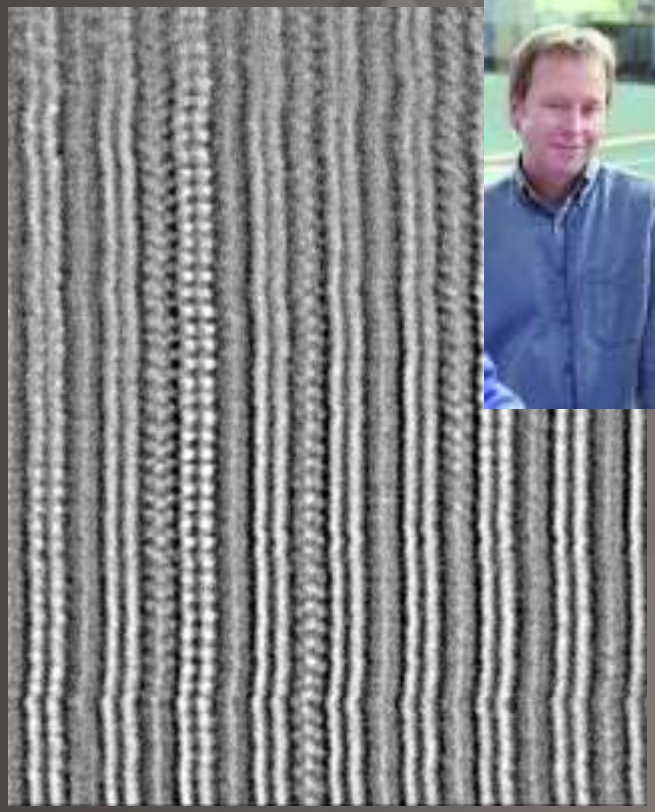
- AMTFDs operating 1nA-10μA produced on 1” glass substrates using ALD
- Validated ability to engineer I-V characteristics with insulator thickness, electrode materials
- Initiated development of CVD process

Amorphyx

Center for Green Materials Chemistry

An NSF Center for Chemical Innovation

New Materials - Unprecedented Performance



Doug Keszler
Oregon State University
Dave Johnson
University of Oregon

$21.5M Awarded from NSF Oct. 2011!!

CSMC Mission

Conduct curiosity-driven and use-inspired research
to enhance the green chemistry toolbox
with new methods and new techniques
that will advance the scientific enterprise
and transform the next generation of products

Prepare students to implement sustainable chemistry

University Partners

Project-oriented Research Thrusts

Clusters
Darren Johnson (UO)
Bill Casey (UCD)
Jim Hutchison (UO)
Mark Asta (UCB)
Paul Cheong (OSU)
Scott McIndoe(U. Victoria, Canada)

Solution Films & Patterns
Doug Keszler (OSU)
Cathy Page (UO)
Rick Garfunkel (Rutgers)
Greg Herman (OSU)
Deidre Olynick (LBL)

Ferecrystals
Dave Johnson (UO)
Janet Tate (OSU)
Ian Anderson (NIST)
Paul Zschak (Argonne Nat'l Lab)

Cross-cutting research

Sophia Hayes (WUSTL)
Shannon Boettcher (UO)
Mark Lonergan (UO)
George Nazin (UO)

John Wager (OSU)
John Conley (OSU)
Thomas Proffen (Los Alamos Nat'l Lab)
Mas Subramanian (OSU)

The "High Tech Extension" Concept

Nanoscience facilities and equipment can best benefit technology development when they are conveniently located and easy to use by businesses. **Such access is especially important to the small and medium enterprises (SMEs) that are critical for early stage commercialization.** State and regional economic development field staff can serve as "high tech extension" agents.

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ONAMI Shared User Facilities

Center for Materials Characterization (CAMCOR)

CAMCOR is a full-service, comprehensive materials characterization center at the University of Oregon (UO) open to outside clients. Benefit from capabilities, access to analytical experts, priority for time critical data, and remote access from your office. Equipment includes: Transmission electron microscope (TEM), Field emission Scanning electron microscope (SEM), SEM/FIB nanofabrication, Electron Microprobe Analysis (EPMA), X-ray photoelectron spectrometer (XPS), Time-of-Flight Secondary Ion Mass Spectrometer (ToF-SIMS), Single crystal and powder diffractometers, and more.

CAMCOR is located in the Lorry Lokey Science Complex, University of Oregon

View inside the CAMCOR Surface analytical laboratory and the X-ray photoelectron spectrometer (XPS)

Center for Electron Microscopy and Nanofabrication (CEMN)

The CEMN at Portland State University (PSU) provides researchers and industry with state-of-the-art facilities for characterization and fabrication of nanoscale materials and devices. Equipment includes: Transmission electron microscope (TEM), Field emission Scanning electron microscope (SEM), SEM/FIB nanofabrication, thin film deposition and sample preparation.

CEMN is located in the heart of Portland

Transmission electron micrograph of virus particles.

Microproducts Breakthrough institute (MBI)

The MBI is a microsystems fabrication facility located on the Hewlett Packard (HP) campus in Corvallis. Through miniaturization, microtechnology has the potential to revolutionize many products. The MBI uses microfabrication methods to support researchers and industry to invent and prototype products for energy, environmental, medical and defense applications. Applications include, blood processing, fuel injection, DNA sample preparation, nanomaterial deposition, and microchannel heat exchangers.

The MBI is managed by Oregon State University and located on the HP Corvallis campus.

ESI laser machining tool at the MBI facility.

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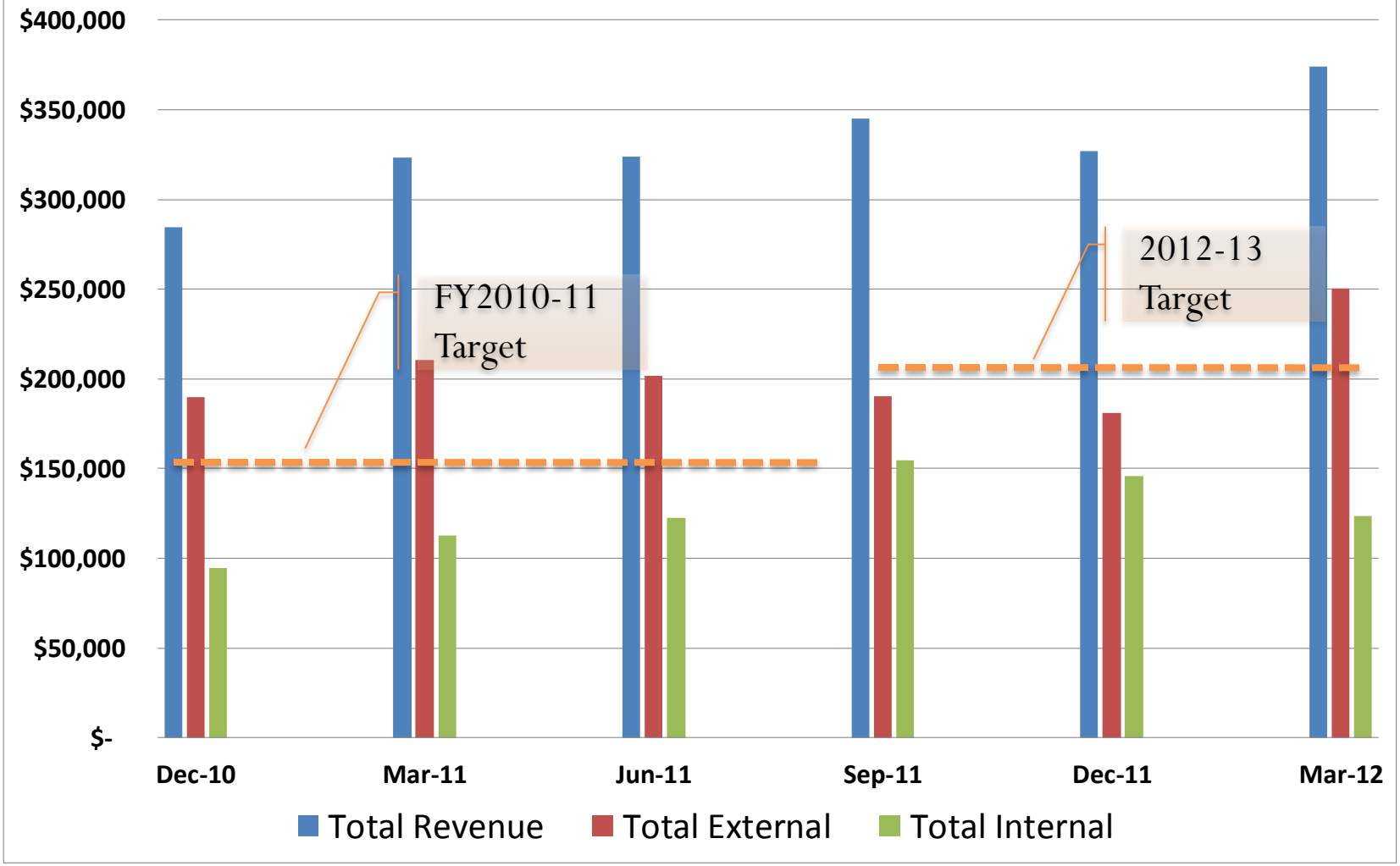
Combined Shared User Facility Revenue



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Symitree LLC.
Sales, Marketing and Technical Services