Nanotechnology in the SBIR/STTR Programs at NSF

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Industrial Innovation and Partnerships Division
Engineering Directorate
National Science Foundation

Nanoscale Science and Engineering Grantees Conference

National Science Foundation

Arlington , VA

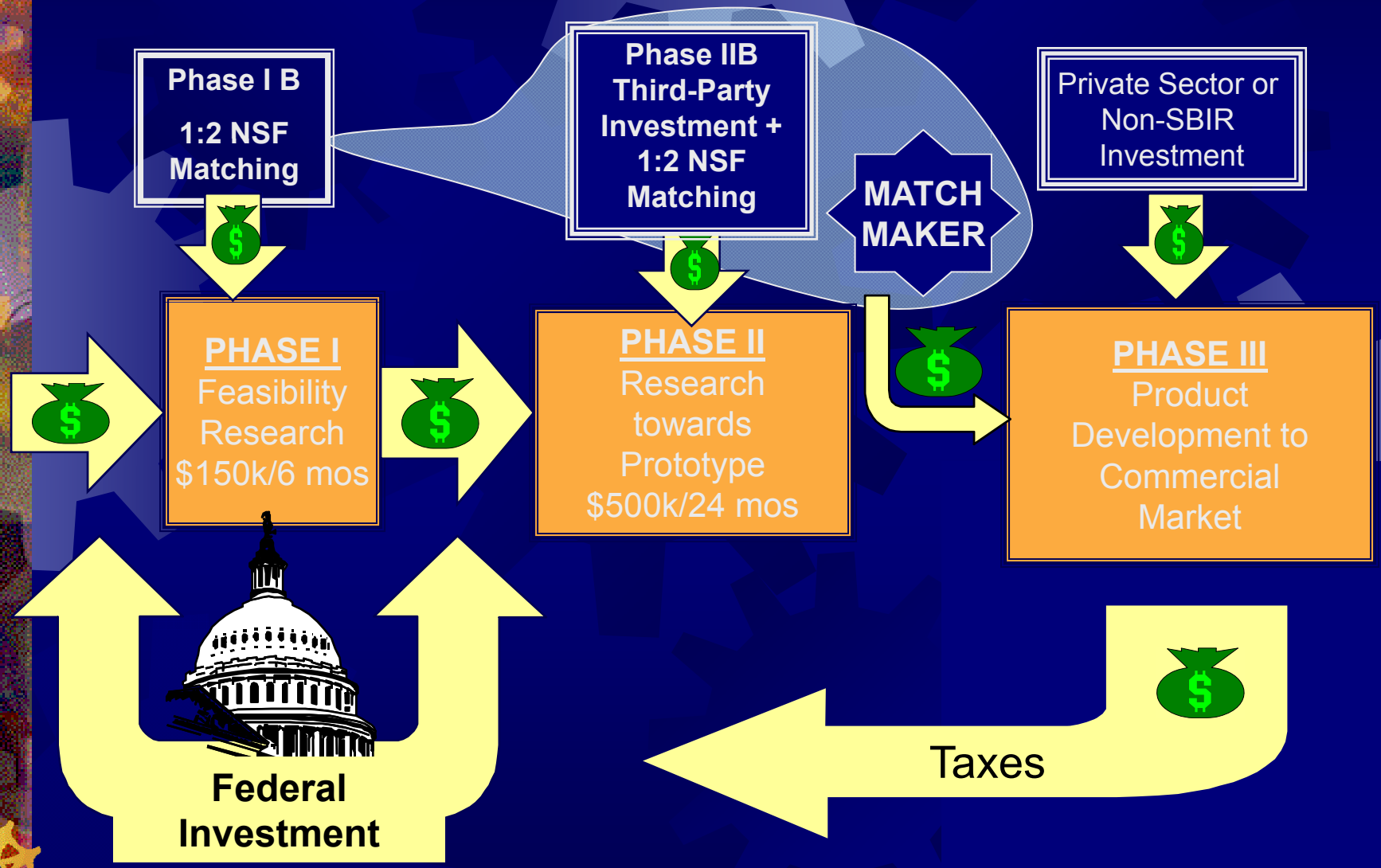
December 7th, 2010

SBIR/STTR Funding Criteria

- Project must be innovative
- Must demonstrate high commercial potential and /or societal benefit
- SBIR program supports high risk* component
-

** From the market viewpoint*

NSF SBIR/STTR Innovation Model



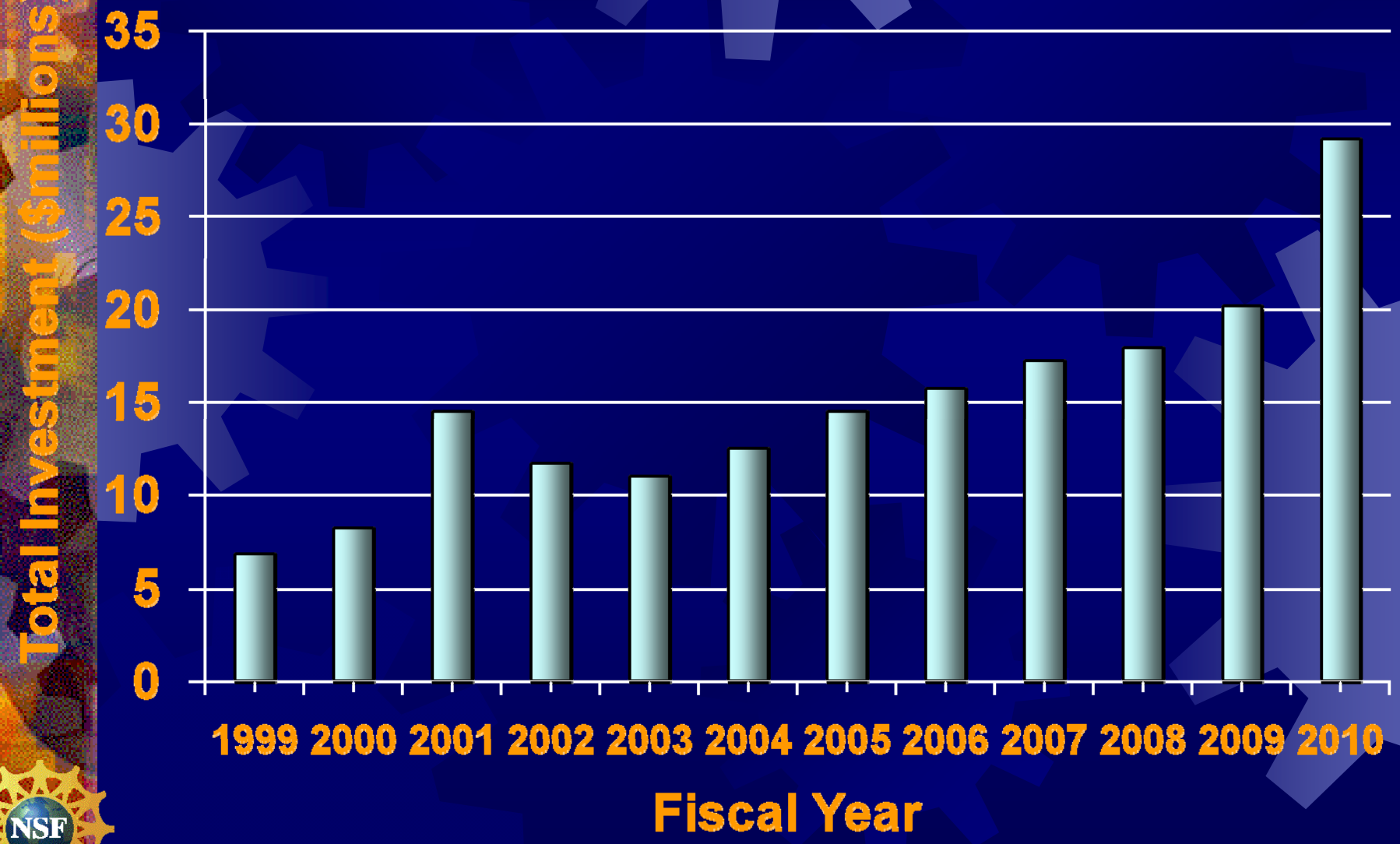
Technologies Supported in SBIR/STTR Program at NSF

- Nanotechnology, Advanced Materials & Manufacturing
- Biotechnology and Chemical Technologies
- Information and Communication Technologies
- Education Applications

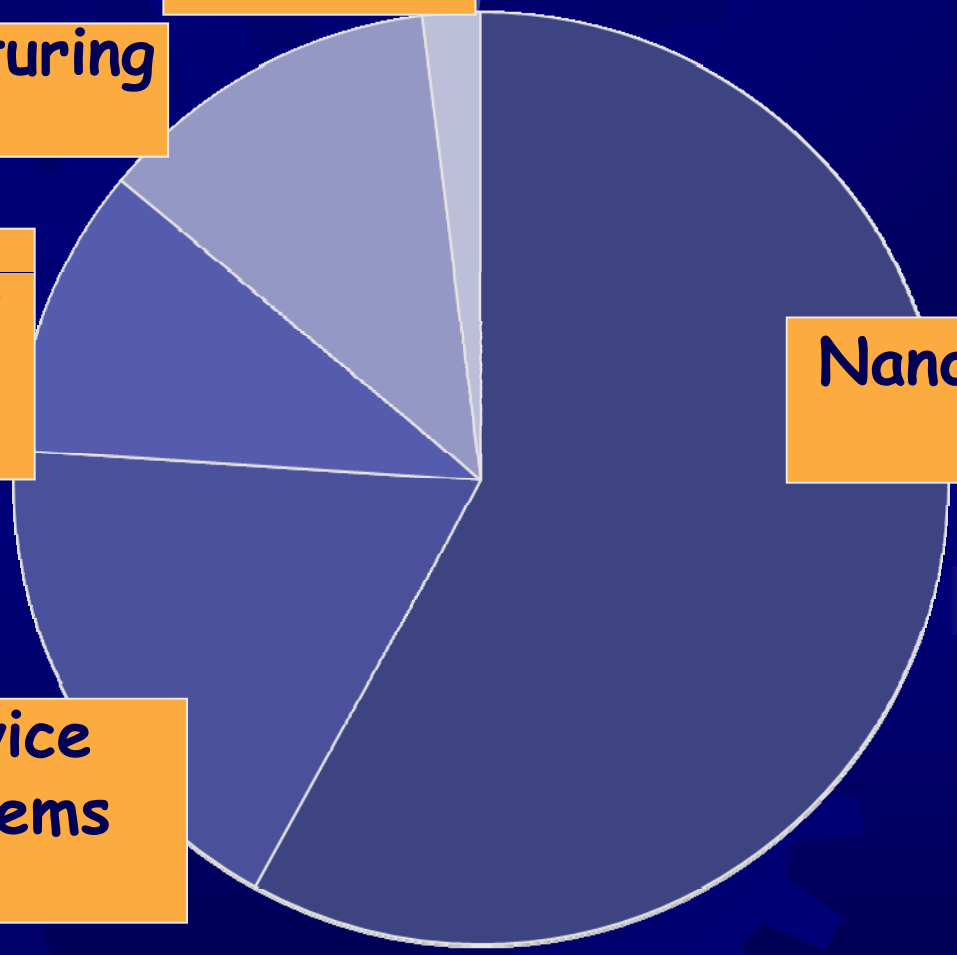
Nanotechnology Thrusts in SBIR/STTR at NSF

- Nanomaterials
- Nanomanufacturing
- Nanoelectronics and Active Nanostructures
- Nanotechnology for Biological and Medical Applications
- Instrumentation for Nanotechnology

NSF SBIR/STTR Investment in Nanotechnology



NSF SBIR/STTR Investment in Nanotechnology (FY 2010)



Examples of Nanotechnology Applications

- Selected examples of nanotechnology applications funded by SBIR/STTR program at NSF through FY 2008

Nano - composites

0848645 – Advanced Polymer Matrix Composites Based on Nanofiber Fused Microfiber (*Nf²-M*) Architecture

Performance Polymer Solutions, Inc

Impact

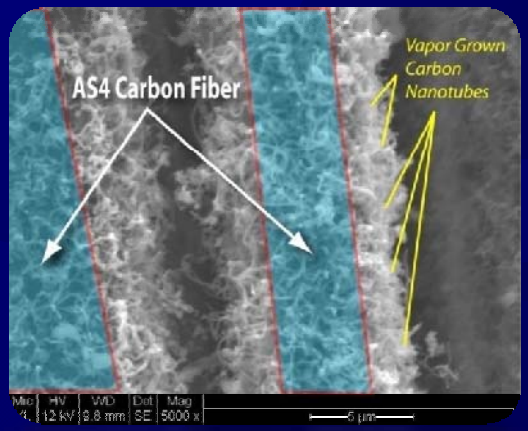
- Aerospace applications call for materials that provide weight reduction while maintaining performance
- *Nf²-M* reinforcements provide significant performance increases in composite parts
- 25X increase in composite electrical conductivity
- 5X increase in composite thermal conductivity
- Structural, thermal, electrical aerospace applications (de-icing, lightning strike, numerous structural applications)

Novelty

- Carbon nanotubes grown from the surface of continuous fibers
- Low cost, easily scaleable, continuous process
- No modification to existing composite manufacturing infrastructure
- Successfully demonstrated on carbon, glass, alumina, quartz, silicon carbide fiber

Lineage

- P²SI owns IP, *U.S. Patent 7,338,684*
- Related Work:
  - N68335-10-C-0176
  - N68335-07-C-0152
  - N00015-09-1-0925



Company Mission

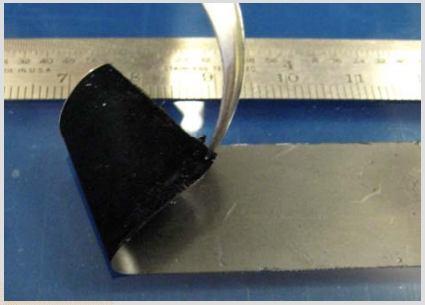
- Utilizing our patented *Nf²-M* process, our mission is to introduce a new platform of reinforcement materials for the aerospace industry that demonstrate significant increases in composite mechanical, thermal, and electrical performance.
- Team: Dr. Jason Lincoln (PI), P²SI
  Dr. David Curliss, P²SI
  Mr. Zach McHale, P²SI

Dry Thermal Adhesive Tape Based on Carbon Nanotubes

Atlas Nanotechnologies
PI: Yang Zhao - yzhao@atlasnanotechnologies.com

IMPACT

- **Enables smaller, more complex and higher power density electrical and mechanical devices**
- **High thermal conductance** without messy grease



NOVELTY

Double-Sided Flexible CNT Tape

Strongly adheres two surfaces together without residue via **nano scale Van der Waals forces**

LINEAGE

- **Progression from 1cm² to 100cm² CNT (wafer level) tapes through the use of a custom built production scale furnace**
- **Scalable production of Single and Double sided flexible CNT tapes**
- **Greater CNT array adhesion than the gecko foot**
- **10x lower thermal interface resistance than off-the-shelf thermal greases**

ABOUT ATLAS

Our mission is to bring to market adhesive tape products based on CNTs that provide enhanced thermal and electrical conductivity in a reusable adhesive tape

Scientific Team:

- Dr. Ali Kashani, Chief Operations and Scientific Officer
- Yang Zhao, Chief Technology Officer
- Jay Longson, VP of Research
- Plus additional Nanotechnology experts

Commercialization Team:

- Rob Steir, Todd Smith, Stew Sando (combined 70 years of business experience)

STTR Phase II
Grant Number
Company
PI

Metal Oxide Nanofibers for Filter and Catalyst Support Structures

0822914
MemPro Ceramics Corporation
Dr. Gary Carlson

PO Box 250, Akron, OH 44309
Ph.: 303.386.5471 Email: carlson@mempro.com
www.mempro.com www.noxfox.com

Impact

Market Factors

- Increased catalyst efficiency
- Expanded thermal stability
- Allows OEMs and catalyst suppliers to expand current product offerings and market sectors

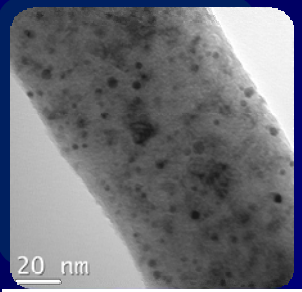
Societal Factors

- Increase chemical production efficiencies
- Pollution reduction and control
- Enhanced particulate removal from industrial and motor vehicle emissions

Novelty

Technology Synopsis

- Catalyst support media
- Various ceramic materials
- Produced by electrospinning followed by calcination



Al_2O_3/Pd Nanofiber

Material Advantages

- Favorable catalyst particle size and dispersion
- Enhanced thermal stability
- Lightweight

Lineage

Technology Origins

- Co-developed by MemPro and the University of Akron
- **1993** Initial technology development
- **2001** Investigations into ceramic nanofiber production
- **2005** Patent issued on the use of catalysts within nanofibers
- **2005** MemPro acquires license from University of Akron
- **2007** Production of ceramic nanofibers with noble metals
- **2009** Patent pending – CCN for engine exhaust treatment

Company Mission

Innovation Vision

- Develop an array of cost effective, environmentally sound materials into various products or sold as nanofiber materials to OEMs and/or catalyst product manufacturers

NOXFOX MaxoSurface nCATfiber

The Innovation Team

- Collaboration between MemPro Ceramics Corporation and the University of Akron (Akron, OH)

Dr. Gary Carlson, PE
Principal Investigator

Dr. George Chase
The University of Akron
Department of Chemical Engineering
Co-Principal Investigator

Nanocomposite Foil for Bonding

Reactive Nanotechnologies, Inc

Joining Configuration

NanoBond® Joining of Electronic Components

- Enables direct solder attach between silicon and thermal management components without exposing them to reflow temperatures
- High thermal conductivity: 4-8X improvement over current commercial solutions
- Lower residual stress
- Bond dissimilar materials

Nano-instrumentation

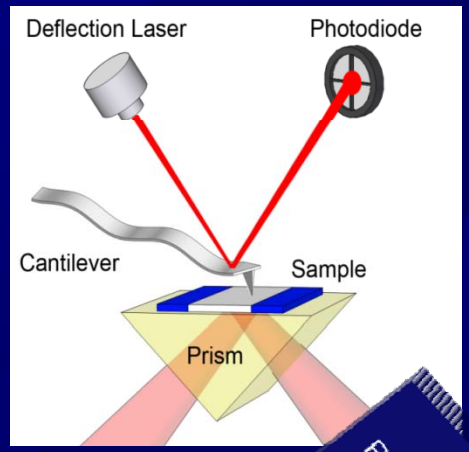
NSF Grant # 0750512 - Nanoscale Chemical Imaging
Anasys Instruments - Kevin Kjoller

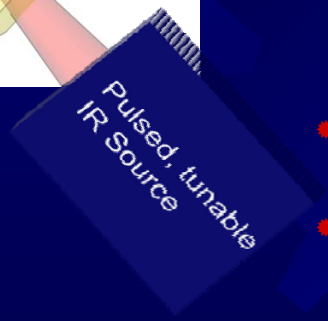
Impact (Market/Societal)

- Adds chemical measurements to the SPM capabilities
- Provides high resolution spectroscopic imaging to the FTIR and IR microscope users
- Primary markets
  - Polymers
  - Life Sciences

Technology

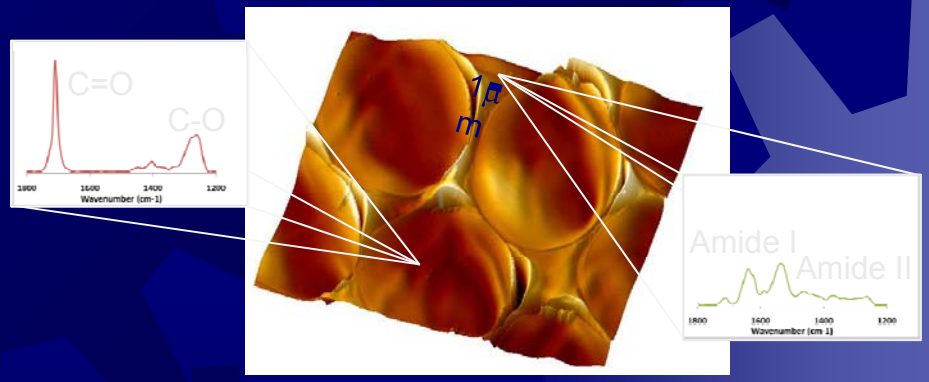
- Initially invented by A. Dazzi
- Developed and Patented by Anasys Instruments





Novelty

- Breaks the diffraction limit for IR microspectroscopy providing spatial resolution up to 100 nm
- Provides topography, chemical, mechanical and thermal measurements in an integrated SPM system
- IR spectra directly comparable to FTIR absorption spectra allowing usage of the vast FTIR libraries

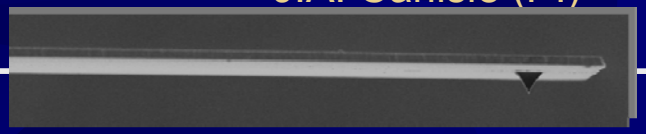


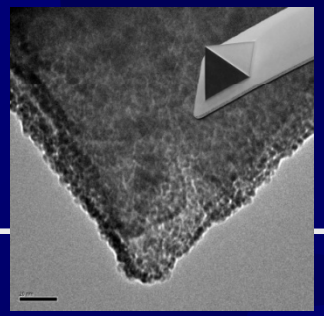
Company / Mission

- Quantitative nanoscale property measurements based on probe technologies
- Proprietary IP and technology breakthroughs
- Team:
  - Kevin Kjoller: VP / Product Development
  - Craig Prater: CTO

Phase II STTR: Diamond Nanoprobes for Atomic Force Microscopy

Advanced Diamond Technologies, Inc.
J.A. Carlisle (PI)



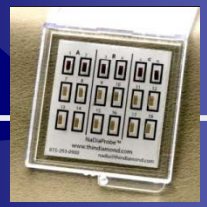


Impact

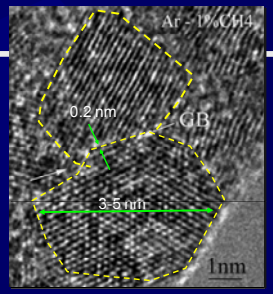
- Enables new industrial applications for AFM (advanced metrology, nanomanufactoring
- Enables new scientific applications, including advanced nanotribology and nanomechanics experiments
- Enables new applications that take advantage of molded diamond structures
- Provides outstanding training for personnel micro/nanofabrication, advanced materials, and nanotechnology

Novelty

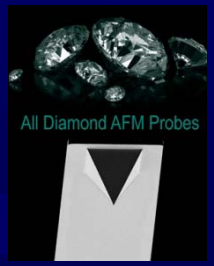
- First diamond MEMS devices made with high yields that meet specifications (frequencies, force constants)
- First successful production of monolithic diamond AFM probes, *NaDiaProbes*™, suitable for use in a broad variety of AFM instruments.
- First direct comparisons of dimensional stability between probes made of different materials, using known theories of contact mechanics.



Lineage



- Ultrananocrystalline diamond (UNCD®) originally developed at Argonne National Laboratory.
- ADT founded in 2003 to commercialize the technology (first ANL spinout).
- ADT today: 17 employees, selling three product families (wafers, seals, probes)



Company Mission

- TEAM: ADT, Uni. of Pennsylvania (R. Carpick), Uni. Of Wisconsin (K. Turner), several grad. students and posdocs
- Develop UNCD-enabled Microdevices leveraging process improvements developed with NSF's SBIR support
- Overcome technical barriers as needed to bring a NaDiaProbe product line to market for general purpose contact and dynamic mode imaging.
- Refine the understanding of tip/substrate nanoscale processes and interactions and correlate with probe fabrication processes and performance.

Visit ADT on the web at www.thindiamond.com

Environmental nanotechnology

Water Purification Technology for the Removal of Chemical & Biological Contaminants

Crystal Clear Technologies, Inc.

Lisa M. Farmen

IMPACT

- Industrial: Removes metal contaminants without generating a waste stream.
- Societal: Technology can purify enough water for one person for a year for $1.00

LINEAGE:

- Funding from Siemens for field test
- Validation samples at Dow Water
- MOU with CDI for OEM manufacturing
- Sandia Nat'l. Labs – filter testing
- CRADA – NUS, NRL, UO
- Licensing with Ga Tech/NUS
- ONAMI Gap Grant $225K

NOVELTY

NMX™ nano-coated filter media can be recharged, with a "double sticky tape" ligand and accumulate numerous layers of metal before the media exhausts.

COMPANY MISSION

To commercialize low cost water purification products at a cost affordable to the majority of the world's population.

Grant Number: 0646557

A Quality Monitor for Enabling Water Recycling in Semiconductors

Uncopiers, Inc. – Dr. Bingrong He

- A new to the world in-liquid particle detector for monitoring UPW quality.
- Yield ensuring metrology for IC Manufacturing.
- Facilitates water conservation by enabling water recycling.
- Advances state of the art in sub-100nm particle detection
- Broader impact: applications to Pharmaceutical Manufacturing, Bio-technology, and Corrosion Monitoring in Nuclear Power Plants.

Sub-100 nm particle detection is accomplished by the following technical features:

1. Control of phase-nucleation, bubble formation, at an in-liquid particle.
2. High frequency pulse-echo protocol to infer bubble and hence the particle presence.
3. Non-contact, *in situ* processing via acoustics.

- ACIM Technology is being pioneered at Uncopiers, Inc.
- ACIM constructively controls microcavitation.
- ACIM is singularly energy efficient.
- ACIM uses only silent sound and clean water.
- ACIM is environmentally sound.

- Uncopiers, Inc. is located in Manhattan Kansas.
- Uncopiers was founded in November 1999.
- Uncopiers prime purpose is to commercialize its ACIM technology.
- Uncopiers is its team of invaluable ten.
- Uncopiers facilities have been uniquely designed to explore and harness ACIM.

Uncopiers was founded to realize the platform promise of ACIM

ACIM – Acoustic Coaxing Induced Microcavitation

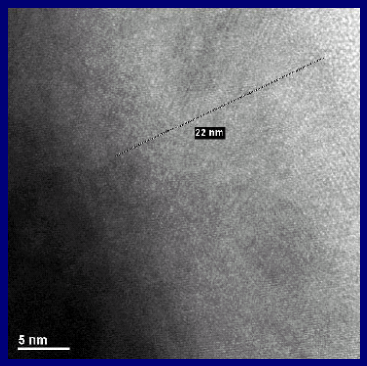
Nano - coatings

Atomic Layer Deposition

ALD NanoSolutions, Inc.

STTR Phase II: Novel Nanocoated Ferromagnetic Materials

γ-Al_2O_3 growing epitaxially to iron particle surface



Goals:

- Use Particle-ALD™ to Deposit Nanothick Films on Fine Particles
- Develop Pilot Scale Production Capabilities for Particle-ALD™
- Develop Link to Consumer Products for Nanocoated Fine particles through use of Strategic Partners

Technical Objectives:

- Develop Atomic Layer Deposition (ALD) chemistry for placing conformal, pinhole-free, and nanothick alumina films on individual primary particles
- Produce Kilograms of nanocoated fine iron powders using a scaleable fluidized bed process
- Characterize the product: film thickness, composition, crystallinity, particle size distribution, surface area, oxidation resistance, magnetic moment

Commercialization Strategy:

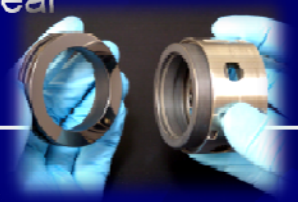
- Work with Strategic Partners to Design materials for the Aerospace, Elecronic, and Automotive Industries
- Using Facilities proven during Phase II, provide materials for Consumer Product Development
- License or Manufacture coated particles designed through Phase II to Strategic Partners as needs dictate

Ultrananocrystalline Diamond as Wear Resistant and Protective Coating for Mechanical Shaft Seal Applications

Advanced Diamond Technologies, Inc.

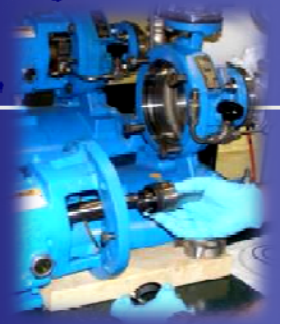
Impact

- John Crane offers largest product line with UNCD®
- Advanced Diamond Technologies, Inc. (ADT) selling UNCD seals to direct users (www.diamondseals.com)
- Reduced energy consumption, wear



Novelty

- Reduction in seal face friction by 75%
- Multiples of decrease in wear from SiC in accelerated wear testing with hot-water (250F, 150 psig).
- Smooth diamond suitable for use with conventional mating ring



Lineage

- UNCD resulted from 10+ years of R&D at DOE's Argonne National Laboratory (ANL)
- Advanced Diamond Technologies, Inc. spun out of ANL in 2003, and is exclusive commercial source of UNCD.
- Other products in market or development include UNCD wafers, AFM probes, supported by NSF SBIR programs

Company Mission

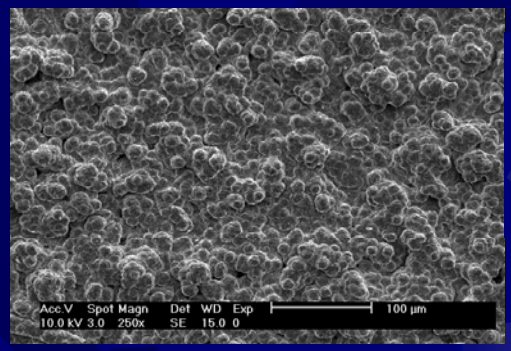
- TEAM: ADT (prime), ANL, John Crane NA
- Product-oriented company focused on thin, smooth diamond
- *We solve hard problems*™

ADVANCED DIAMOND TECHNOLOGIES, INC.

Nanocomposite Temperature-Adaptive Solid Lubricant Coating for Cutting Tools

Nanomech, Inc

- Novel composite coating for cutting tools comprising:
  - NanoTuff™ hard coating made of cubic boron nitride and titanium nitride (cBN-TiN)
  - Nanoparticles-based temperature adaptive solid lubricant coating made of zinc oxide and molybdenum disulphide (ZnO, MoS_2)
- Solid lubricant is temperature-adaptive and self-replenishing
  - Lubricant resides in reservoirs created by micro-structured surface of the NanoTuff™ hard coating



- Target applications:
  - Hard turning – manufacturers want to move from grinding of hardened steels to hard turning, thus lowering costs and increasing productivity
  - Dry machining – growing need to reduce or eliminate use of cutting fluids due to cost and environmental impact of fluids

EXPERTS IN
- RARE EARTH MAGNETS
- MAGNET DESIGN
- MAGNET SYSTEMS

National Science Foundation
WHERE DISCOVERIES BEGIN

SBIR Phase II Title: "Fe-nanoparticle Coating of Anisotropic Magnet Powder for Nanocomposite Permanent Magnets with Enhanced $(BH)_{max}$"

Company Name: Electron Energy Corporation (Landisville, PA)

PI Name: Jinfang Liu

Impact (Market/Societal)

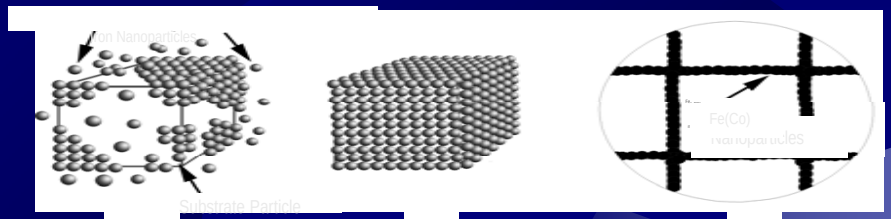
If the proposed technology can approach the theoretical performance potential of double the current state of the art rare earth magnets, it would have a dramatic impact on permanent magnet markets and applications.

If successfully implemented into practice, the proposed technology could lead to the development of a new class of high performance nanocomposite magnets with much higher maximum energy product, $(BH)_{max}$ or magnetic strength.

This technology could have a significant impact in many devices in which the actuation or sensing is based on a magnetic field produced by permanent magnets. The applications include consumer electronics, renewable energy, electric vehicles, medical and military applications, etc.

Novelty (Technical)

The objective of this project is the synthesis of composite magnet powders coated with Fe or Fe-based nanoparticles for the development of permanent magnets with superior magnetic properties. A sketch of the morphology of the (nano)composite powders and consolidated nanocomposite magnets is shown below.



(a) Partial nanoparticle coating

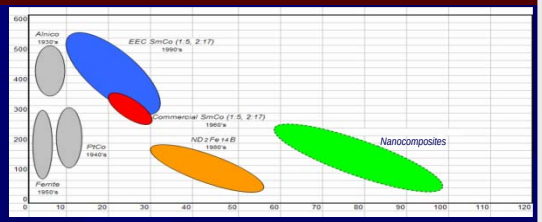
(b) Complete & uniform coating

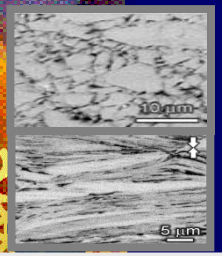
(c) Morphology of the composite powders consolidated into a permanent magnet

Lineage (Origins of the Technology)

1990s: Theoretical prediction that two phase nanocomposite magnets consisting of
- hard magnetic phase
- soft magnetic phase

may exhibit a maximum energy product $(BH)_{max}$ twice the value of the current magnets.





Current SBIR data: Back scattered electron SEM micrographs of composite magnets with different morphologies, consisting of a hard magnetic phase (rare earth –based intermetallic compound) surrounded by a soft magnetic phase (Fe nanoparticles).

Company Mission (Include the Team)

Company Mission: to be specialists in rare earth magnets and magnet systems, providing innovative solutions for precise technical challenges.

Project partner: University of Delaware, Department of Physics and Astronomy, Prof. George Hadjipanayis's Group.

EEC Key Personnel

- Dr. Jinfang Liu, V.P. of Technology and Engineering, plays a leadership role in magnet material's development as well as magnet applications development for the company.
- Dr. Melania Marinescu, Manager of Process Technology, focuses on the improvement of magnetic performance of the current permanent magnets through process and chemistry optimizations and the development of new (nano)composite magnets.
- Peter C. Dent, V.P. of New Business Development, is responsible for leading the product introduction to the market and product licensing programs.

ISO 9001:2000

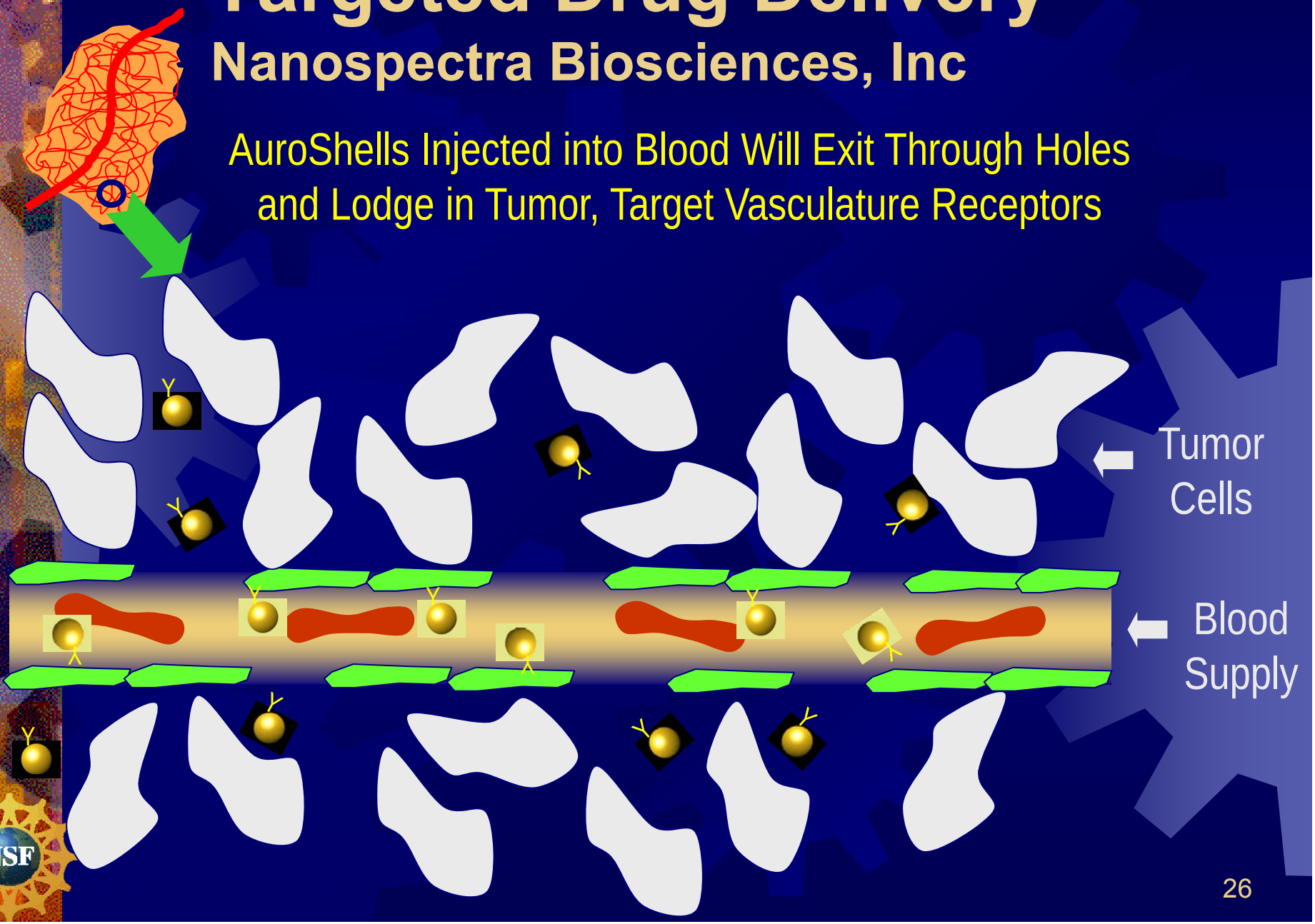
This research was sponsored by the NASA Glenn Research Center under the SBIR Program.

Nano - biotechnology

Targeted Drug Delivery

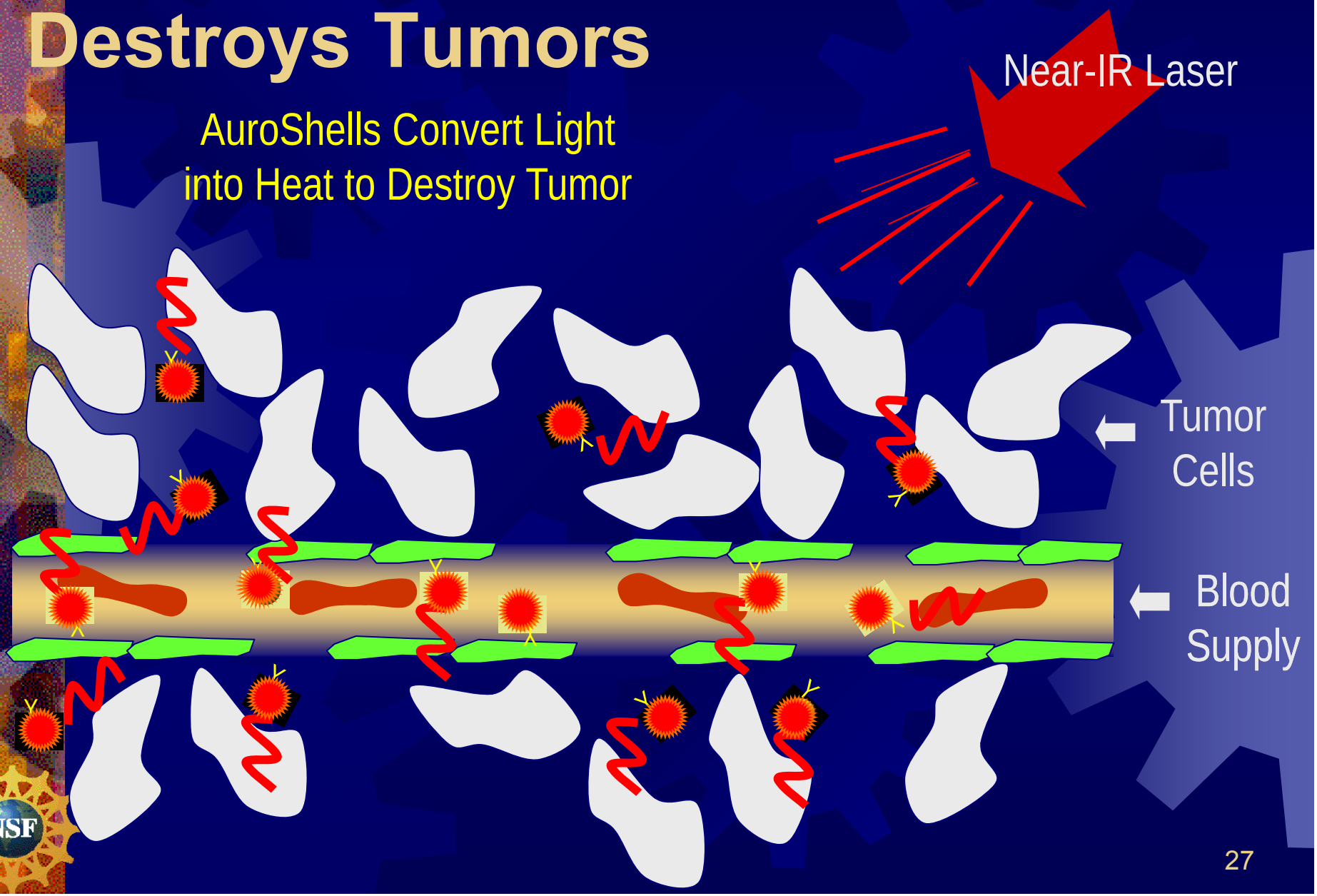
Nanospectra Biosciences, Inc

AuroShells Injected into Blood Will Exit Through Holes and Lodge in Tumor, Target Vasculature Receptors



AuroLase™ Therapy Thermally Destroys Tumors

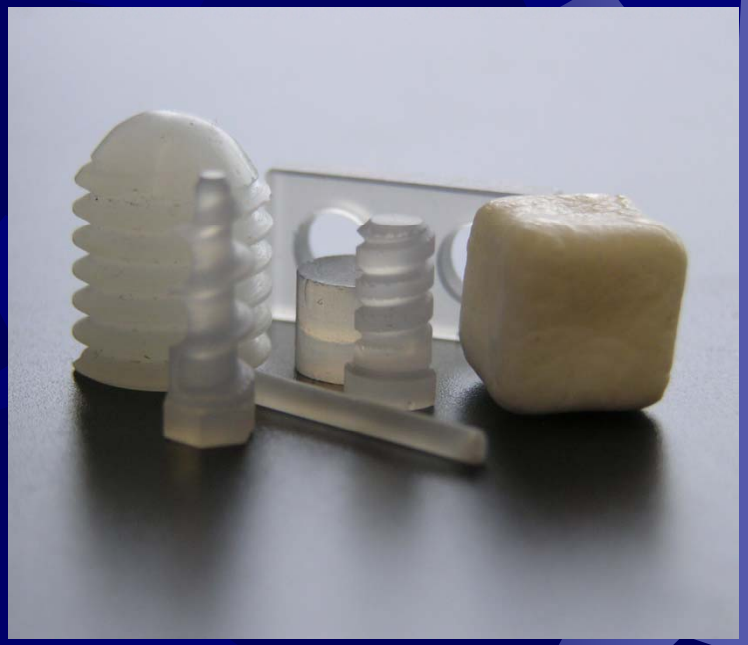
AuroShells Convert Light into Heat to Destroy Tumor



Synthetic Bone Material -NanOss™

Angstrom Medica

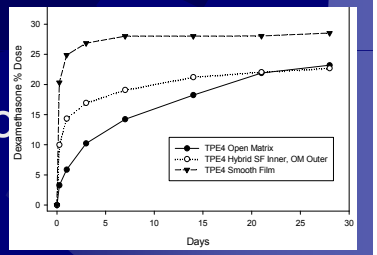
- Structural Medical Devices
  - Osteoconductive
  - Remodels into Bone Over Time
- Injectable Cement
  - Endothermic, Rapid-setting
  - Structural, Weight-bearing
- Bioactive Coatings
  - Micron Thicknesses
  - Can Act as a Carrier



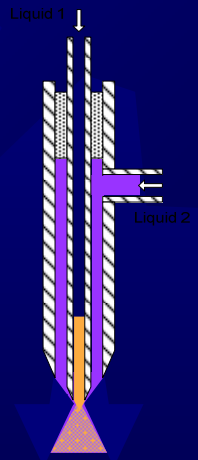
#0620563
Nanocomposite Coating on Coronary Stents
Nanocopoeia, Inc.
Robert Hoerr, MD, PhD

- Drug and medical devices combinations a growing trend
  - Coronary stents first blockbuster example
  - Broad market opportunities
- Modify the body's response to implanted devices

- Drug/polymer combinations
- Non-line-of-sight coatings on complex structures
- Able to engineer/control drug release profiles



- ElectroNanospray™ technology
  - U Minnesota
  - David Pui, Daren Chen inventors
  - Nanocopoeia improvements
  - World-wide exclusive license



- Bring novel drug delivery applications to market that solve clinical challenges
- Drug coatings to improve therapeutic performance of medical device implants, including stents

STTR Grant Number : 0620572
"Antibacterially-Active Nanoparticles"
Nanopharma Technologies, Inc.
Drs. Edward Turos, Seyoung Jang

Impact (Market/Societal)

Antibiotics → *Nanobiotics*

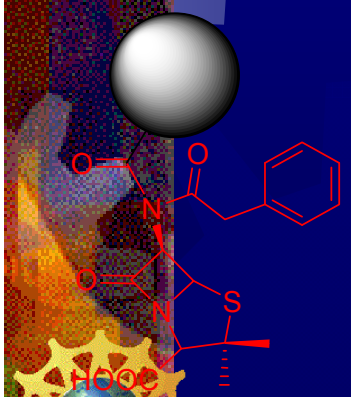
Platform Technologies for Biodefense and Nanoscience

Novelty (Technical)

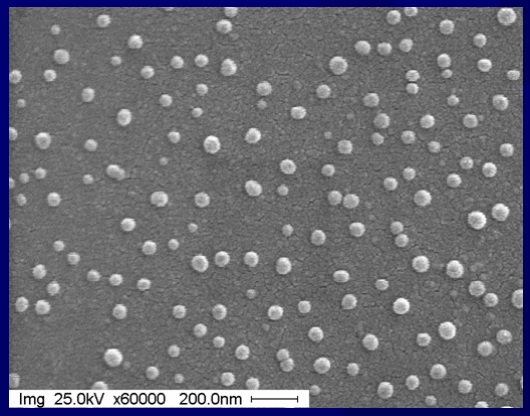
Pen G-nanoparticles

* Infectious Diseases (MRSA) Treatment
* Target delivery and rejuvenation

Lineage (Origins of the Technology)



MRSA MIC = 2 µg/mL



Scanning Electron Microscope Image

Company Mission

Development of

Nanoparticle Drug Delivery Platform

for delivery of water-insoluble drugs

to greatly enhance the efficiency and enzyme stability of antibiotic agents

providing *a potential means to clinically overcome resistance* that the infectious agent has acquired to an antibiotic such as penicillin.

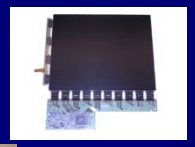
Nano - electronics

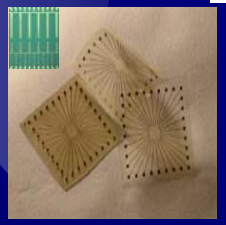
Thin Film Transistors: Silicon Nanowires

Nanosys, Inc

High Performance, large area nano-structured macro-electronics substrate technology

TFT Backplane Drivers – Integrated Edge Electronics





Beam-Steering Antennas

- **Eliminates high-temperature steps required for semiconductor deposition**
- **Dramatically reduces manufacturing cost, time and complexity**
- **Deposition on virtually any substrate material possible**

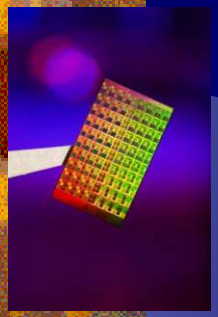
A variety of application areas:

- **Portable & large-area flat panel displays**
- **Low-cost RFID and smart cards**
- **Electronically steerable phased-array RF antennas**

RFID Tags

IIP-0848490
Ultralow κ Interlayer Dielectrics for 22nm Node and Beyond
Dendritech, Inc. PI: Petar Dvornic

Impact



Target: Ultralow K <2 interlayer dielectrics to enable "next gen" chips (ITRS Roadmap)

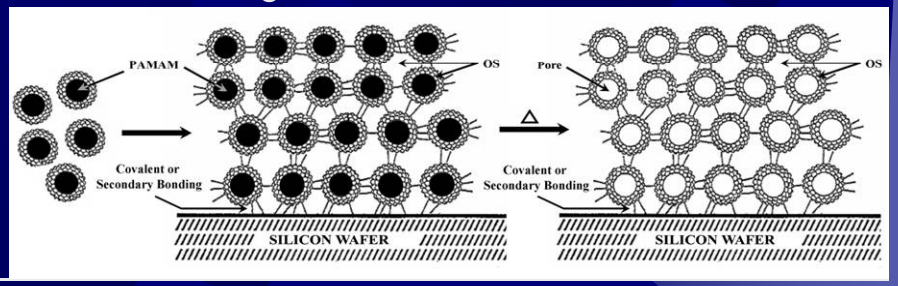
Minimizing "crosstalk" between chip layers permits faster, smaller semiconductors for device computing power and miniaturization

Ultralow K ILD forecast >$150MM in 2012

Novelty

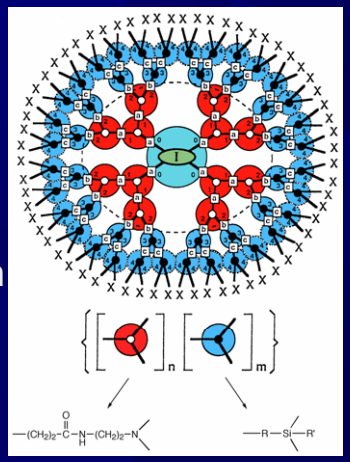
PAMAMOS dendrimers form covalently crosslinked honeycomb networks by spin-on and cure

Closed-cell nanoporosity (2-4 nm) introduced upon thermal degradation to form insulator



Lineage

- Dendrimers, a new class of polymer architecture were invented in late 1970's-1980's
- Commercial production of PAMAM (polyamidoamine) dendrimers begins at Dendritech (1990's)
- Patented invention of the first silicon-containing dendrimers (PAMAMOS) in 1990's-2000's



Company Mission

-Commercial supply of PAMAM dendrimers for enhanced value in customer products

-Custom-built plant for reliable supply of PAMAM dendrimers since 1994

-6 patents on PAMAMOS dendrimers

Team: Dr. Petar Dvornic, PI
Dr. Steven Kaganove, R&D
Emery Scheibert, Manufacturing
Mark Kaiser, Market Development

NSF SBIR Phase II Grant IIP- 0822652

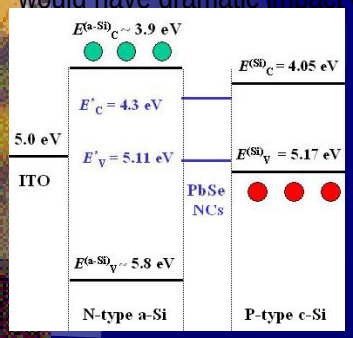
High-Efficiency Nanocomposite Photovoltaics and Solar Cells

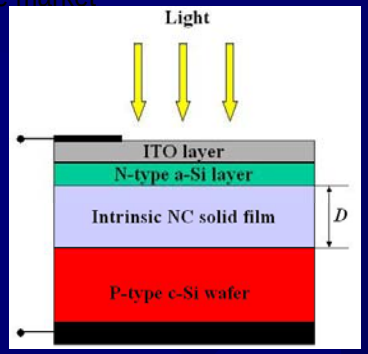
ANTEOS, Inc.

PI - Dr. Valery Rupasov

Impact (Market/Societal)

- Projected revenue of the market of solar cells - $23.1B
- Thin-film amorphous silicon (TFAS) solar cells capture 20% of the market.
- Increasing power efficiency from 6-7.5% up to 10% would have dramatic impact on the market

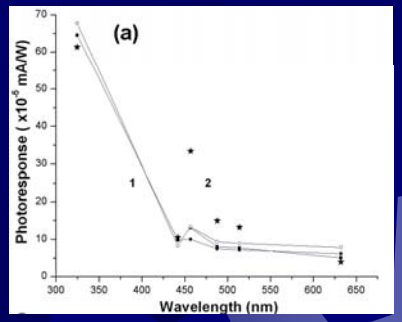


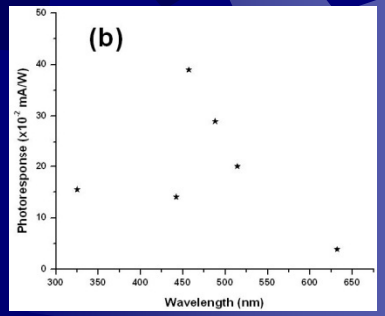


Novelty (Technical)

Power efficiency of low-cost and mature TFAS solar cells is increased by

- Using the effect of Multiple Exciton Generation (MEG) in quantum-confined semiconductor nanocrystals embedded into amorphous Si p-n junction and
- Fast separation of the electron-hole pairs in built-in electric field of the p-n junction





Lineage (Origins of the Technology)

- Demonstration of Multiple Exciton Generation (MEG) in semiconductor nanocrystals (LANL, NREL)
- Patent pending invention of company president, Dr. S. Krivoshlykov, who proposed to incorporate the semiconductor nanocrystals into amorphous silicon p-n junction (Patent Application: 11/439,626)

Company Mission (Team)

Mission: Development of the emerging nano-technology and manufacturing of the nanocrystal solar cells

Team: Dr. Sergei Krivoshlykov (project management, technology development & commercialization) Dr. Valery Rupasov (theoretical estimates)

Seeking: Equity Investment & Partnership for product manufacturing and marketing.

Photovoltaics : Nanoparticle co-sensitizers for increased efficiency.

Konarka, Inc

From Light to Power

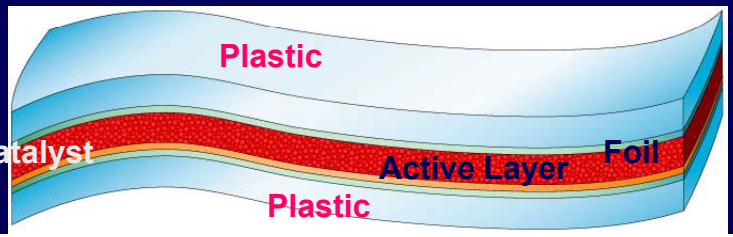
Polymer photovoltaic products in a variety of form factors for commercial, industrial, military and consumer applications

- **Uses photoactive dyes & conducting polymers**
- **High-speed manufacturing processes**
- **Low temperature environment**
- **Uses low cost materials**
- **Highly scaleable**

- **Mass customization from a single source**
- **World solar PV market: CAGR > 35%**
- **20+ patents pending**

Schematic of Dye Sensitized Titania Cell

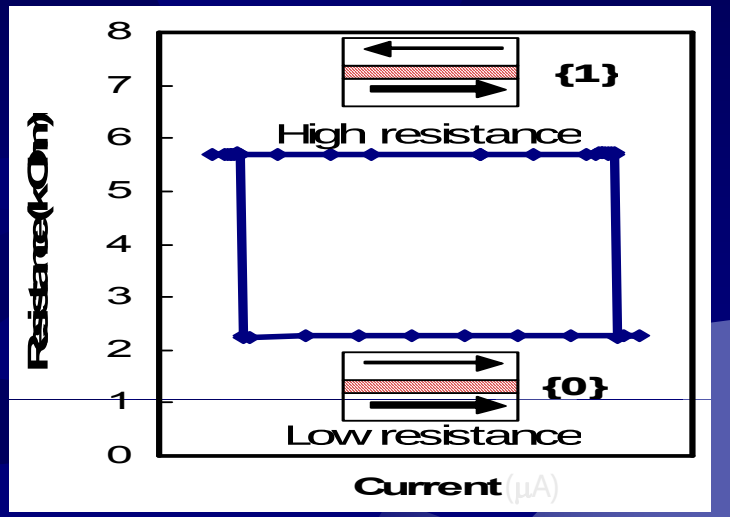
Total thickness 0.01 inch



Spintronics Non-volatile Memory

Grandis, Inc

- **Spin Transfer Torque RAM (STT-RAM)**
  - Fast: less than 10ns read/write
  - Non-volatile memory: >10 year lifetime
  - Scalable: beyond 65nm
  - Low Power
  - Multiple bits per cell capable
  - Compatible with semiconductor processes



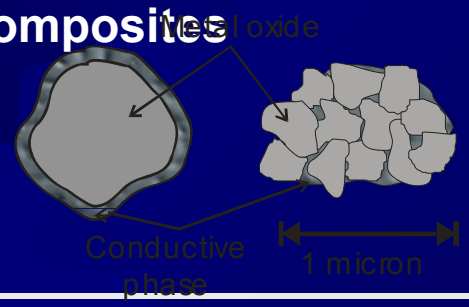
- **SBIR PHASE II Grant**
  - Allows Grandis to continue materials research to enable an advanced demo chip to accelerate commercialization.

T/J Technologies, Inc.

Lithium Ion Batteries

Technology:

High Rate, High Capacity Anodes for Rechargeable Li Batteries Based on Metal Oxide Nano Composites



Outside Investment

NASA Contract: $2,200,000
Acquired by A123 Company

Goals:

- Reduce irreversible capacity to <15%
- >300 mAh/g reversible capacity
- >10C at 80% rated capacity and 80% DOD
- Achieve projected material costs of <$10/kg

Commercialization Strategy:

- System payoff:
  30-50% reduction in large format lithium-ion battery size
- Develop a cost-competitive battery suitable for HEV, UPS, military and aerospace applications
- Strategic Partnerships for joint development of new materials:
  materials production and battery manufacturing

Lithium Reservoir Nanocarbons for Lithium Ion Batteries
Applied Sciences, Inc

IMPACT

- Enables Long-Range HEVs and EVs
- Supports Alternative Energy Use
- Reduces Emissions
- Reduces Dependence Upon Foreign Oil
- Creates Domestic Manufacturing Jobs

NOVELTY

- High Capacity Anodes for Li-Ion Battery
- Safe Performing Battery

LINEAGE

- Technology
  - Carbon Nanofiber – GM, ASI, PPI
  - Anode – ASI, PPI, GM, Others
- Funding Source
  - NSF → GM → Ohio Fund → A123
  - $M Secured

COMPANY MISSION

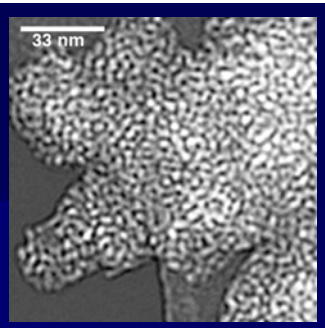
- High Performance Li-Ion Battery → Chevy Volt
- Insertion in 2011 at 30 k lb/yr
- $8 M investment for 400 k lb/yr demand in 2013
- Revenues of $26 M by 2013
- ROI > 45% in 2013

Nano - manufacturing

IIP-0822808
Automotive Nanocomposites

Claytec, Inc.

PI: Joel Dulebohn, Ph.D.

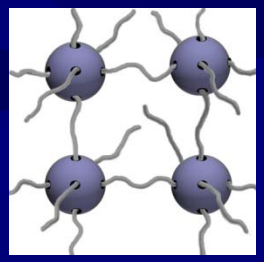


Impact

- *Stronger, stiffer, lighter* and *cheaper* plastics
- Lighter automobiles with improved fuel efficiency
- Reduction in CO_2 emissions
- Enhanced barrier properties, improved durability
- Recyclable plastics for a longer life cycle
- Represents a highly competitive new niche in the $66 B global polymer additives industry

Novelty

- *Porous frameworks* allow for particle networking
- *Low cost, non-toxic* synthetic silicate nanoparticles
- Dispersible *without* the need for surface modifiers



Lineage

Michigan State University

- NSF – funded basic research on metal oxides with intracrystal porosity and high surface areas (1992-2004)
- International patent applications (2004-2008)

Claytec, Inc.

- NSF-SBIR Phase I (January 2007)
- Licensing of patents (2004 – 2008)
- NSF-Phase II (2008-2010)

Company Mission

Thomas J. Pinnavaia – President

Joel Dulebohn, Ph.D. – Operations Manager

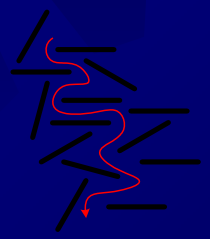
SeongSu Kim, Ph.D. – Senior Scientist

Claytec, Inc. solves challenging chemical and material problems through innovative porous metal oxide chemistry. Our mission includes the development of porous nanoparticles for advanced applications in automotive, green energy (wind turbines), electrical cables, and catalytic bio-fuel production.

Supercritical Fluid Processing of Polymer/Clay Nanocomposites

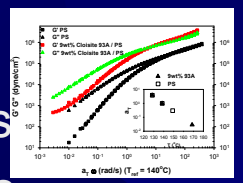
nanoScience Engineering Corporation
Steve Horsch

Impact

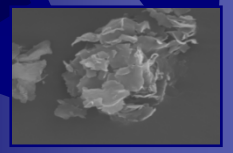


- Create jobs
- Create wealth for investors
- Increase shelf-life of perishables
- Introduce high performance nanocomposites in products

Novelty



- Green, economical process
- Highly dispersed nanofillers
- Improved mechanical, thermal properties
- Improved barrier properties



Lineage

- Joint Development Agreements

Ford MASCO CHRYSLER

- Raised $500,000 venture capital/investors
- Collaboration with WSU/Clemson

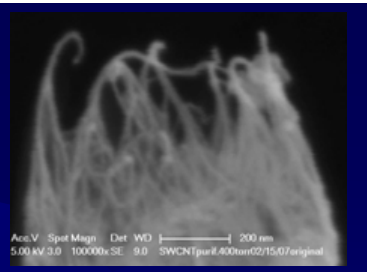
NSF

Company Mission

- Value: Highly dispersed nanofillers at a competitive price
- Team: Experienced entrepreneurs and Research Scientists
- Exit Strategy: IPO, Strategic Partnership, or Sale

SBIR Phase IIB: Commercial Combustion Synthesis of Homogeneous Lots of Carbon Nanotubes (IIP-0522093)

Henning Richter, hrichter@nano-c.com



Impact

- Large-scale manufacture of single-walled carbon nanotubes (SWCNT)
  - Energy generation and storage
  - Electronics and sensors
  - Improvement of polymer properties
  - Filtration and separation

Novelty

- Selective combustion synthesis of (SWCNT) or fullerenes
- Exothermic, scalable, reproducible
- Length control
- Hydrogen formation

Lineage

- Founded in 2001 to commercialize MIT technology
  - license for fullerene synthesis in Japan
- Development contracts in place
- 5+ patents, >10 pending and in-licensed
- $7 MM invested between '01 and '09
- $2.9 MM NIST ATP award

Company Mission

- Leading manufacturer of fullerenic materials and derivatives, licensor
- Experienced technical and business team
- Capture downstream value by internal and collaborative application work
- Major development effort in SWCNT dispersions and their use for transparent conducting films

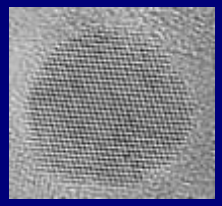
Silicon Nanoparticles Manufaturing

Innovalight, Inc

Continuous Flow Reactor & Size-Selection Scheme for Use in High Throughput Manufacture of Si Nanoparticles

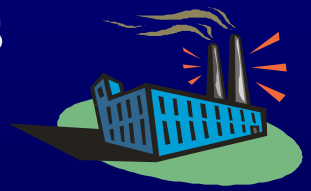
Technical Objectives:

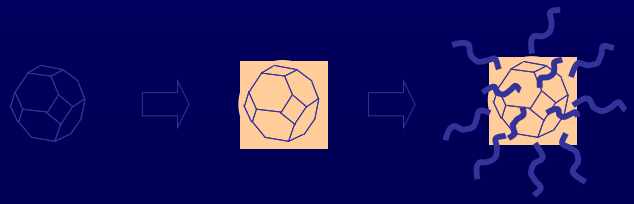
- High quantum yields
- Tunable emission
- Defect-free particles



Goals:

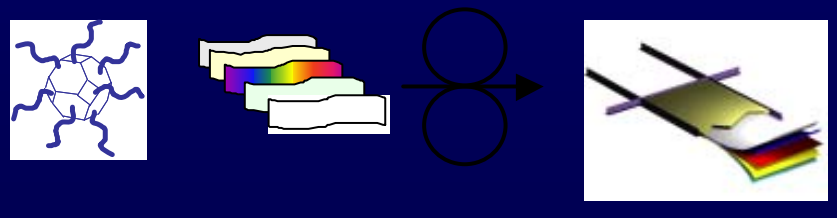
- Si nanomanufacturing system
- Process parameters
- 5 grams/hour





Commercialization Strategy:

- IP portfolio
- Cell phones, exit lighting (short term)
- Solid-State Lighting

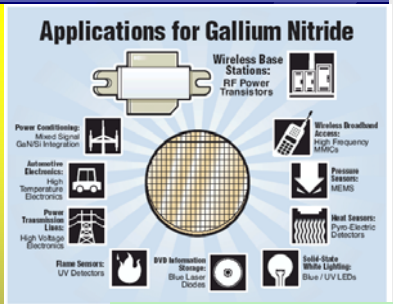


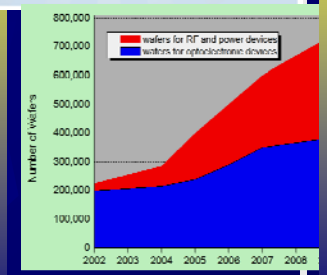
Gentle Atomic Level Chemical Mechanical Smoothening (CMS) of Gallium Nitride Substrates

Sinmat, inc

Impact

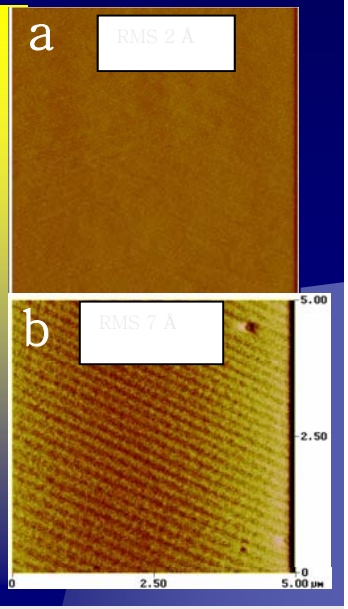
- Increasing demand for WBG devices for RF, power & opto-electronic applications
- GaN components sales > $7.2 Billion by 2009
- Great potential for energy saving devices
- Creation of new hi-tech R&D and manufacturing jobs





Novelty

- Novel polishing process (chemistry, particles, etc.) for bulk GaN & GaN films on various substrates
- Atomic level polishing
- High removal rate
- Uniform, low defect polish over large area: high yield/low cost
- Scalable > 2" substrates
- Good reproducibility



Lineage

- Idea conceived and developed at Sinmat Inc.
- Patent applications in preparation
- Selective results have been published
- Collaborations with University of Florida (UF) for film deposition, device fabrication, testing and data analysis
- Several companies interested in Sinmat's process, and supplying substrates for evaluation of GaN polishing process

Sinmat Inc.'s Mission & Goals

- Establish a leadership position in providing value-driven semiconductor solutions to industry on planarization technologies
- Establish strategic industrial partnerships for R&D, marketing, sales, & services
- Build up Intellectual Property portfolio (5 licensed patents & several pending applications)
- Teams: Sinmat scientists (9 PhDs); UF (Profs. Pearton & Abernathy); Advisors & Consultants

Summary

- In FY 2010 the NSF SBIR/STTR program made over 140 nano-related grants and over 40 supplemental grants to small companies totaling $ 29 MM.
- Across the whole Federal government SBIR/STTR programs accounted for close to $100 MM in nano-related grants (FY 08).

NSF SBIR/STTR Home Page

www.nsf.gov/eng/iip/sbir

Thank You

James Rudd

tjrudd@nsf.gov