Spin-off Companies at Northwestern University (NU)

Entrepreneurship and translation of innovation at research institutions

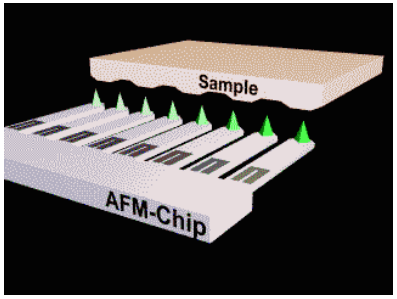
Presenter: **Vinayak Dravid**

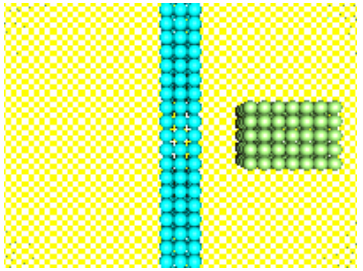
Professor, Materials Science & Engineering

Director, NU*ANCE Center*

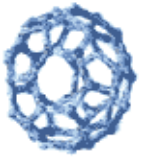
Emergence of Modern Nanotechnology:
Gathering of a Perfect Storm

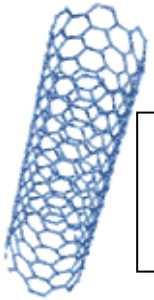
Tools and techniques to "see" nanoscale"





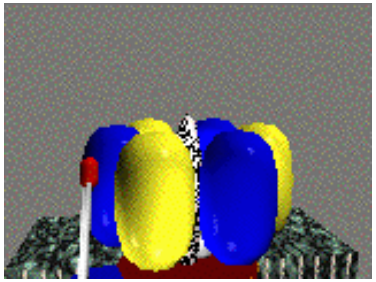
Computational tools and methods to "predict" nano-behavior





Synthesis and fabrication approaches to "make" nanostructures

Improved understanding/recognition of biological tools/structures



➔ ***Interdisciplinary R &D Ambiance:***
Creativity and Innovation
➔ ***Recognition of Potential Business & Economic Opportunities:***
Corporate Technology Drivers and Government Investment

Emerging Role of Research Institutions

Traditional/Old:

*Generate and Transmit Knowledge through **Research, Teaching, Service***

Emerging paradigm:

Knowledge ➔ Analysis ➔ Synthesis ➔ Creativity ➔ Dissemination

- *Regional, National and Global Engagement*
- *Coupling (balancing) scholarship with innovation & entrepreneurship*

Ivory Towers ➔ Economic Engine

Northwestern (IIN) Innovation Strategy

Excellence in Nanotechnology Research & Education

+

Regional, Societal, Industrial and Global Outreach

+

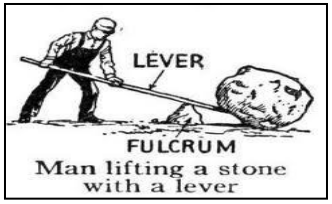
Engagement with Corporate Partners

+

Leveraging Top Business School (Kellogg)

+

Coalition and synergy among all stakeholders

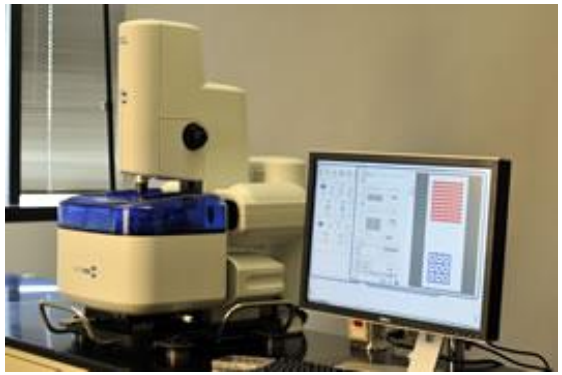


Out-of-the-box initiatives

Entrepreneurship in Nanotechnology at NU:
The First decade of NNI

- 16 start-up companies launched
- IIN technologies commercialized in
  - *Medical Diagnostics*
  - *Advanced Nanolithography and Metrology*
  - *Nanomaterials*

Nanosphere
Verigene test cartridge



NanoInk
NLP 2000 System

NanoIntegris
Metallic IsoNanotubes

Mechanisms and Programs:
Facilitating Commercialization and Entrepreneurship

Small Business Evaluation and Entrepreneur's (SBEE) Program

- *Unique collaboration with the NU Kellogg School of Management*
- *16 start-ups launched to date with over $500M of VC investment*

Nanotechnology Corporate Partners (NCP) Program

- *Identify industries whose R&D align with and benefit from the NU's nanotechnology research*
- *Build and maintain professional relationships and productive collaborations with corporate partners*
- *20 partner companies*

Small Business Evaluation and Entrepreneur's (SBEE) Program

- *Partnership between the Kellogg School of Management and the International Institute for Nanotechnology*
- *New technologies developed by NU researchers are presented to Kellogg students at open forums*

Kellogg MBA students:

- *assess the viability of commercialization*
- *choose projects with best promise for success*
- *work with the inventor to develop a business plan*
- *formally present plan to potential investors or at business plan competitions*

Nanotechnology Corporate Partners (NCP) Program

Partners span broad range of high-tech fields

NU Nanotech Businesses Launched

Over $500M venture capital invested!

Nanosphere, Inc. (2000, Mirkin)

- Develops commercial diagnostic systems

NanoInk, Inc. (2001, Mirkin)

- Commercializes nanolithography systems

Integrated Microdevices (2001, Liu)

- Rapid prototyping of bioMEMS and polymer MEMS

Ohmx Corporation (2003, Meade)

- Produces point-of-care electronic pathogen detection devices

Acumen Pharmaceuticals Inc. (2004, Klein)

- Developing the first therapeutics and molecular diagnostic tools for Alzheimer's disease and other memory-related disorders, business plan led to collaboration with a major pharmacuetical company

Nanodisc (launched 2003, Sligar)

- Enabling the biochemistry of membrane-associated molecules for drug discovery and novel therapeutic applications

NU Nanotech Businesses Launched

Over $500M venture capital invested!

Nanotope (2005, Stupp)

- Utilizes self-assembling amphiphilic molecules for drug discovery and novel therapeutic tissue regeneration

Polyera (2005, Marks)

- Provides solutions and supplier of materials technology for the printed electronics industry using organic electronic materials

SilenTech (2006, Sontheimer)

- Treating disease by silencing disease genes through modification and control of RNAi

PreDx (2006, Meade)

- Creating bioactivatable contrast agents for imaging diagnostics

NanoIntegris (2007, Hersam)

- Supplier of single wall carbon nanotubes that are have uniform diameter and/or electronic type

NU Nanotech Businesses Launched

Over $500M venture capital invested!

American Bio-optics (2007, Backman)

- Detection of cancerous cells with LED probes

SAMDITech (2007, Mrksich)

- High-throughput biomarker screening for in vitro nanodiagnostics

NanoSonix (2008, Dravid)

- Offers a solution to the industry problem of finding small yet critical microchip defects buried underneath the surface

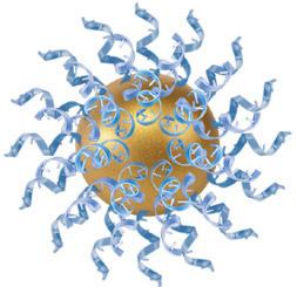
Citrics BioMedical (2009, Ameer)

- Tissue regeneration/replacement via devices that support tissue growth and drug eluting capabilities

AuraSense, LLC (2009, Mirkin)

- Develops theranostics based on gold nanoparticle technology

Nanosphere



History

- Founded in 2000, now ~120 employees
- Based upon discoveries at Northwestern University by Professors Robert Letsinger and Chad Mirkin
- Technology based on functionalization of gold nanoparticles with oligonucleotides (DNA or RNA) or antibodies that can be used to detect nucleic acid or protein targets
- IPO in 2007 raised $110M, listed on NASDAQ

Focus Areas

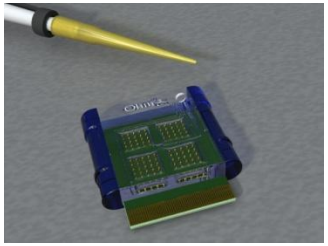
- Direct detection of nucleic acid diagnostics
- High-sensitivity protein diagnostics
- Research applications
- Biosecurity
- Food and animal
- Industrial sensors

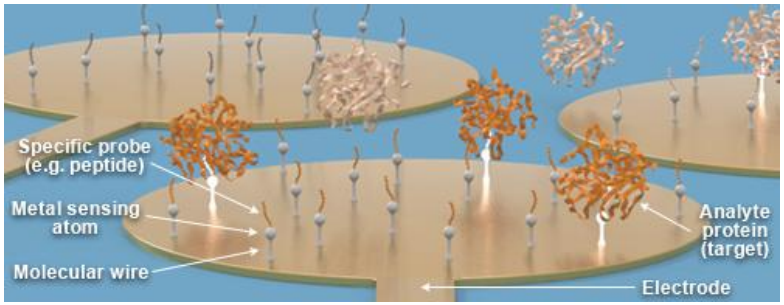
Verigene® System with Test Cartridge

Ohmx™ Powering Protein Detection

- Founded 2005, currently 8 employees
- Raised ~$5M in financing
- Offers consumer diagnostic devices that monitor chronic diseases *remotely* on a device that requires only a single drop of blood for analysis
- Developing tests for chronic disease monitoring, including cardiac, cancer and metabolic markers, electrolytes, metabolites, lipids and blood gases
- Unique features: bioelectronic detection, lack of reagents, low sample volume, speed, small size, low cost (similar to a blood glucose meter) and testing capability near the patient

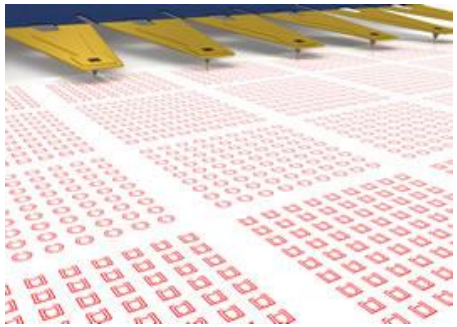
Biosensor chip/cartridge





Handheld biosensor reader

NANOINK INC

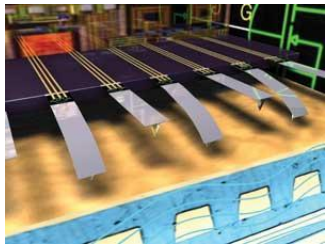


- Founded in 2002, now ~70 employees
- Raised over $60M in venture capital
- Specialize in nanometer-scale manufacturing and applications development for the life sciences, engineering, pharmaceutical, and education industries
- Technology based on Dip Pen Nanolithography® (DPN®) – the patented and proprietary nanofabrication technology
- Enables rapid and easy micro-and nanoscale fabrication from a variety of materials on a range of substrates
- Low cost, easy to use, and scalable

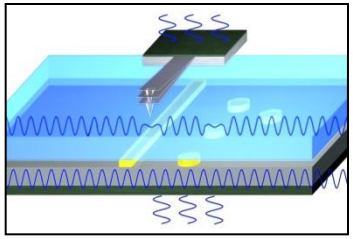
NanoIntegris

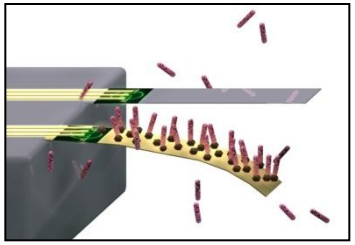
- Founded in 2007, currently 7 employees
- Received 2 SBIR grants in 2009
- Supplier of high performance nanomaterials for information technology, biotechnology, and energy technology
- Commercializes a technology for separating carbon nanotubes and other nanomaterials by their optical and electronic properties
- Based upon discoveries developed by the Mark Hersam Research Group at Northwestern University
- Employs a technique known as density gradient ultracentrifugation (DGU)
  - *Outstanding output purity, scalability, versatility, and cost effectiveness*

NANOSONIX

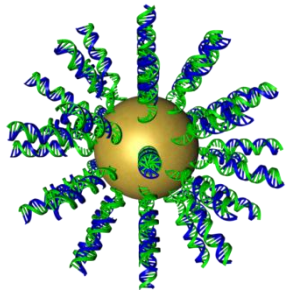


- Founded in 2008, currently 6 employees
- Funding from SBIR, DOD, DOE grants and angel investors
- Commercializing of IP developed by Dravid research group of IIN at Northwestern.
  - **Scanning Near Field Ultrasound Holography** (SNFUH):
    - *Combining SPM and ultrasound source and holographic detection*
  - **MOSFET Embedded Micro-Cantilevers**
    - *All-electronic signal transduction for sensing cantilever deflection, opening up the potential for massively parallel, high throughout analysis*
- *Non-destructive semiconductor metrology*
- *Enabling non-invasive biological imaging, signal pathways and monitoring*





AuraSense™



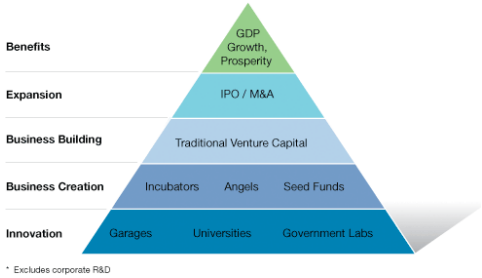
- Founded in 2009, currently 7 employees
- Raised $2.5M in seed funding
- Technology invented at Mirkin and Thaxton labs at NU
- AuraSense's novel nanoparticles are highly useful and versatile as therapeutics and intracellular assays
- Most powerful applications of AuraSense technology:
  - Efficient, carrier-free transfection of genetic material into cells to regulate protein expression
  - Effective mimic of HDL or "good cholesterol"
  - Quantification of genetic and small molecule activity in live cells
- Multiple successful partnerships ongoing with major pharmaceutical manufacturers

Summary & Future Prospects

- **Innovation, Creativity and Entrepreneurship:**
  - ✓ *Translating scientific excellence to economic opportunities*

- **Filling the <u>Gap</u>:** Inserting nanotechnology innovation
  - ✓ *NCP program*
  - ✓ *Industry and global collaborations*

- **Systems, Processes and Mechanisms:**
  - ✓ *Local (Kellogg), regional and global partnerships*
  - ✓ *Facilitating entrepreneurship and innovation culture*



Leveraging scientific and technology output (NSEC/IIN) with NNI investment
➔ *job creation, retention and diversification of economy*