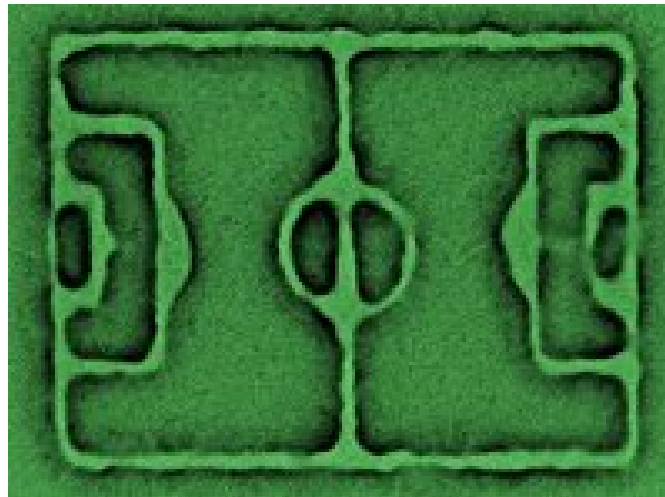

Everyday Use of Nanotechnologies

Patti Glaza
Vice President - Publisher

Smallest Soccer/Football Field

Dr Stefan Trellenkamp, from the University of Kaiserslautern.
Pitch made by using an electron beam to engrave lines onto a piece of acrylic glass. 380x500 nanometers



"The only problem is that I really don't know what to do with it. I can't put it on show as no one can see it,"

Small Times – 5th Year Anniversary

- Delivering knowledge to drive the commercialization of micro and nanotechnologies
- Small Times Magazine
 - 27,000 qualified subscribers
 - Global circulation - +7,000
- SmallTimes.com & ST Direct
 - Daily & breaking news
- Small Times NanoCon International
 - Sept. 20-22 Las Vegas



2006 State-of-the-technologies

- It's all about global nano infrastructure
 - Facilities – tools - software
- Government funding still key
- Manufacturing becoming critical – MEMS is leading the way
- Verticals taking hold – but common lingo still missing
- IP battles are on the “RIM”
- Environmental/health concerns
- Still don't know what nano means....

NNCO Definition of Nano

Nanotechnology is the understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications.

Integration of multiple disciplines, technologies, materials, and processes to enable the creation, assembly, measurement, or manipulation of things at the nano and molecular scales.

Nano – making some categories

Nature	Man-made: unintentional	Man-made: intentional
Forest Fires	Incinerators	Semiconductors
Volcanoes	Jet engines	Metal oxides
Clay deposits	Welding fumes	Nanotubes

Distribution of particle sizes created

Controlled size & shape

Nanoparticles

They're all different

Engineered nanoparticles appear in a variety of shapes, and their size, shape and composition affect how they behave. Buckyballs, carbon nanotubes, quantum dots, dendrimers and nanoshells are all nanoparticles, but they look and function quite differently.

Each has special properties that make them attractive for specific applications. Quantum dots, for instance, emit light in various colors. Their fluorescent properties can be used as cancer cell markers. Carbon nanotubes can conduct electricity and be semiconductors, making them attractive materials for electronics. Dendrimers can serve as drug delivery devices by ferrying medicine in their branch-like structures.

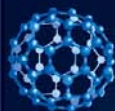
But often nanoparticles need to be "dressed up" in order to be useful. Nanotubes, for instance, need to have molecules attached to keep them from sticking together or to get them to disperse evenly. Dendrimers, quantum dots and nanoshells won't latch onto cells unless they have antibodies or other biological molecules attached to them.

Adding a molecule onto or into a nanoparticle changes its properties. Nanoparticles whose charged surface makes them toxic, for instance, may become benign once a molecule is wrapped around them. Alternatively, contaminants or other matter may stick onto some nanoparticles, turning them into potentially harmful materials.

Research by Candace Stuart
Illustration by Mike Roeder

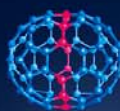
Nanoparticles

Buckyball



C60

Sixty carbon atoms bond to make a typical buckyball, or C60. But a buckyball can be elongated by adding more atoms, such as C70. And the hollow spheres can also hold metallic atoms; those are known as a metallofullerenes.

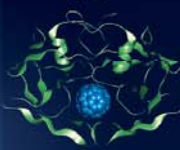


C70



Buckyball metallofullerene

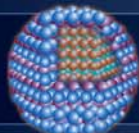
USES



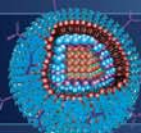
Buckyball docked in HIV

Buckyballs have been considered as possible HIV inhibitors because they fit within the virus, disrupting its reproductive process.

Quantum dots



Coated quantum dot



Quantum dot with antibody

USES

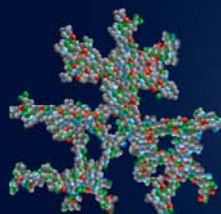
Quantum Dot Corp.
Quantum dot cancer marker

Quantum dots are nanocrystals that can be used in optical and electronic applications. Evident Technologies' quantum dots can be used to make solar cells. Quantum Dot Corp. provides optical tags for studying cancer cells.

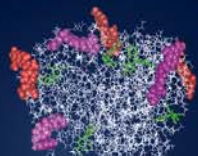


Evident Technologies
Solar cell

Dendrimers



Dendrimer



University of Michigan
Dendrimer drug delivery systems



Starpharma
Dendrimer HIV inhibitor

Branch-shaped dendrimers have numerous biotech applications. University of Michigan researchers have demonstrated dendrimer-based drug delivery systems while Starpharma is testing a dendrimer product that blocks HIV receptors.

Nanoshells



Nanoshell



Nanoshell with antibodies

Nanoshells invented at Rice University have been shown to kill cancer cells. Nanoshells coated with antibodies latch onto cancer cells and heat up when exposed to near infrared light, cooking the tumor cells. Near infrared penetrates but does not harm flesh.



Nanoshells with cancer cells

Carbon nanotubes



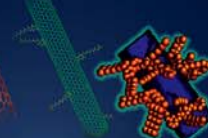
Metallic



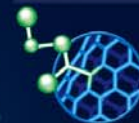
Semiconductor



Multiwall



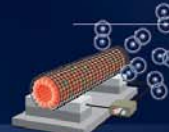
Functionalized



Polymer attachment

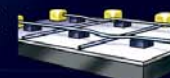
Carbon nanotubes can be metallic or semiconducting, depending on how their chickenwire-like lattice rolls into a tube. They also can form tubes within tubes, making them multiwall nanotubes. Nanotubes can be "functionalized" by adding or attaching molecules to their surface.

USES



Sensor

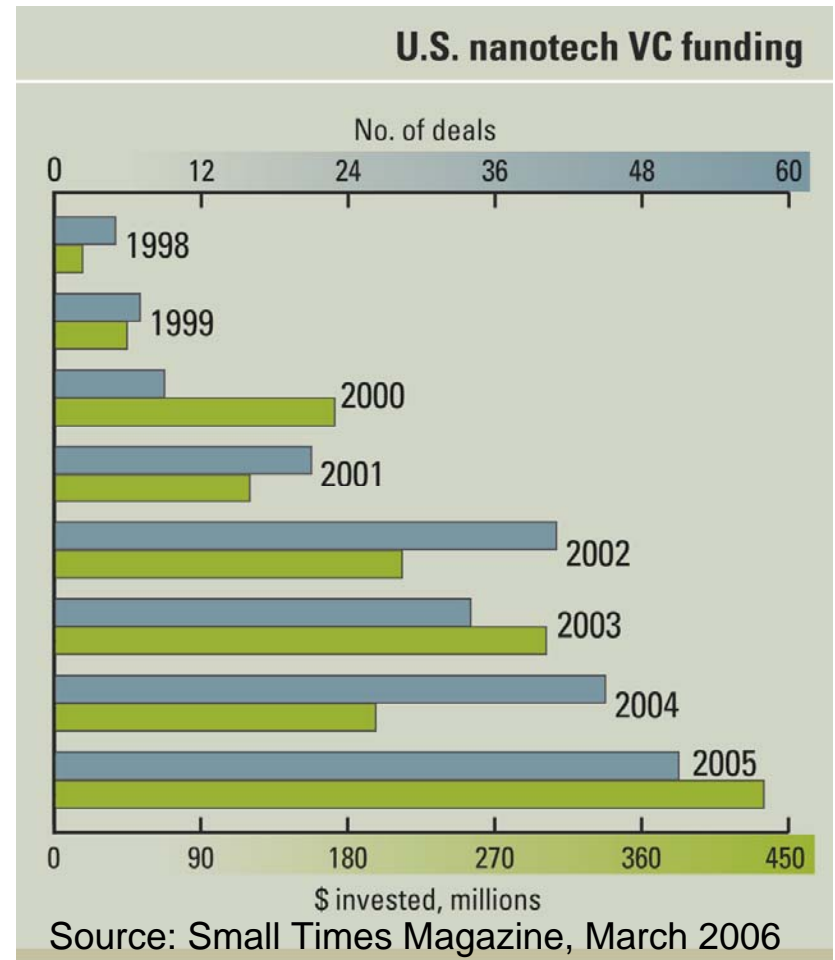
Several companies are making products based on carbon nanotubes. Nanomix markets sensors that detect hydrogen. Nantero is developing carbon nanotube-based semiconductor devices such as switches.



Nantero
Switch

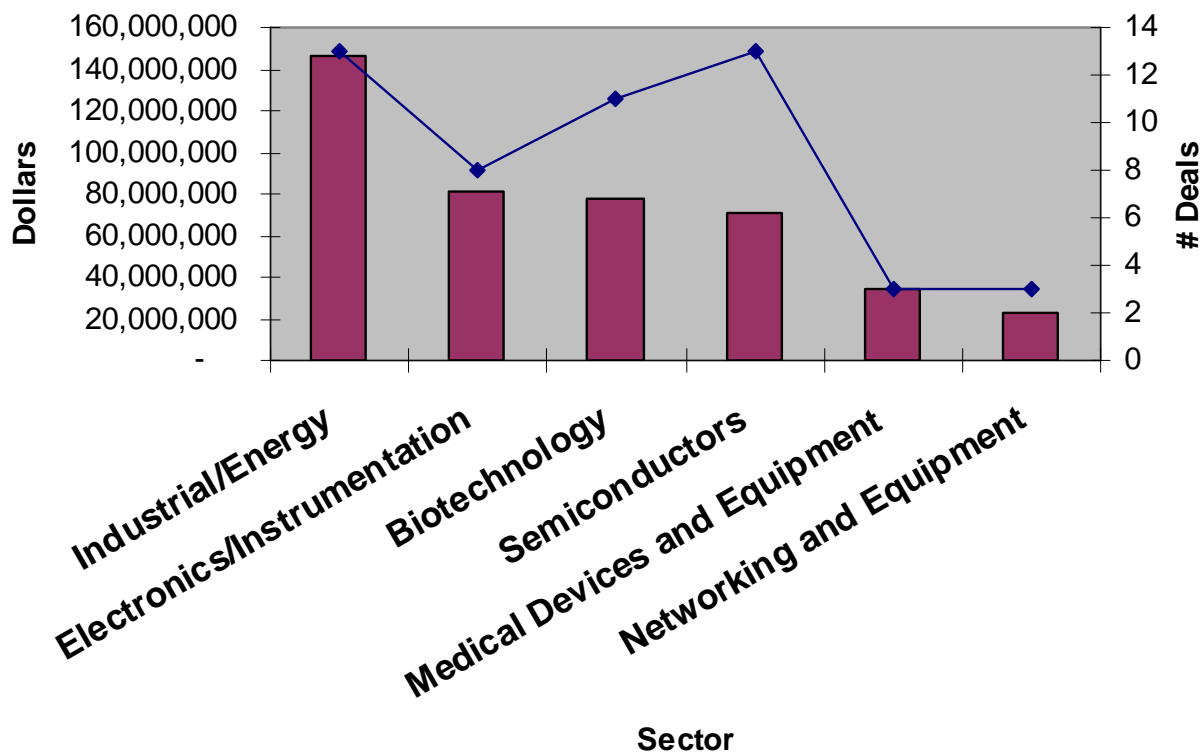
Investment

- VC investment increasing – 2% of total \$\$
- Avg. round \$8.4 million
- Later stage funding
- IPO market very flat in US



Investment

Nano VC Funding US 2005



Investment

Biggest Deals –US 2005

Year	Qtr	Company	Industry	Amount Invested
2005	4	Nanosys, Inc.	Electronics/Instrumentation	40,000,600
2005	1	Nano-Tex, Inc.	Industrial/Energy	35,000,000
2005	1	Aspen Aerogels, Inc.	Industrial/Energy	30,000,000
2005	3	Serenex, Inc.	Biotechnology	30,000,000
2005	2	Nanosolar, Inc.	Industrial/Energy	20,000,000
2005	2	NeoPhotonics Corporation	Electronics/Instrumentation	20,000,000
2005	2,3	Kereos, Inc.	Medical Devices and Equipment	21,000,000
2005	3	Molecular Imprints, Inc.	Semiconductors	17,000,000
2005	2	Miasole, Inc.	Industrial/Energy	16,000,000
2005	1	Nantero, Inc.	Semiconductors	15,000,000
2005	4	ImaRx Therapeutics, Inc.	Medical Devices and Equipment	15,000,000
2005	1,2	NanoOpto Corporation	Networking and Equipment	14,500,000
2005	3	Solicore, Inc.	Electronics/Instrumentation	12,700,000

Source: PWC, Thompson Economics, NVCA, Small Times

Key Industry Segments

- Consumer products
- Energy
- Bio/life sciences
- Computers/electronics
- Military & defense
- Aerospace & automotive
- Environment/remediation

Consumer Products - external

- Sporting goods
- Paints/coatings
- Clothing
- Appliances



Consumer Products - internal

- Cosmetics
- Supplements
- Food

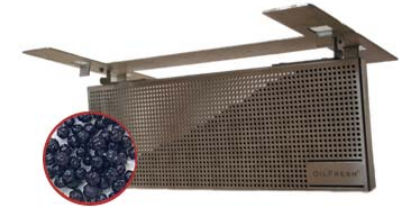


Photo Courtesy: Chanel



Photo Courtesy:
GM Collin Homme



Photo Courtesy: Lancome



Photo Courtesy: la prairie

Energy

➤ Light, Power, & Efficiency

- Batteries – size, performance
- Catalytic converters (improved performance & emission levels)
- Fuel enhancers
- Lighting



➤ Killer apps –

- Solar
- Hydrogen economy
- Energy transmission



Photo Courtesy: LEDtronics

Medical – Today's applications

➤ Wound Care

- Silver-based nanocoating for an antimicrobial effect
- Bone restoration

➤ Surgical tool coatings

➤ Drug discovery

➤ Lotion-based drug delivery

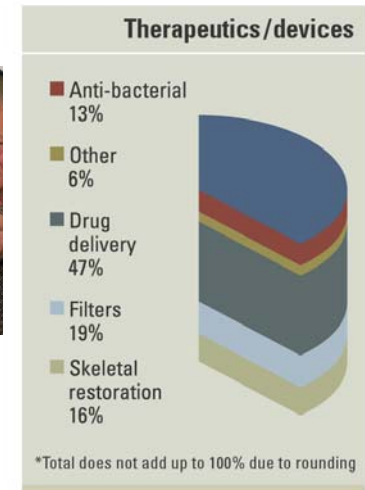
➤ Catheters / stents

➤ Filtration

- Virus sortation
- Masks & breathing equipment
- Air filters

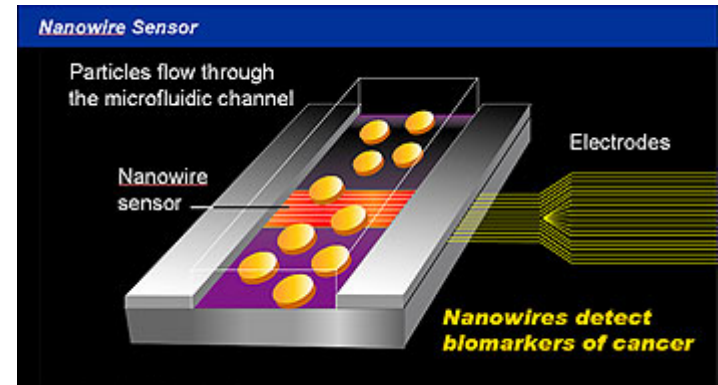


Photo Courtesy: smith&nephew/Nucryst



Medicine & Health - tomorrow

- Advanced diagnostics
- Targeted drug delivery
- Implants



Reference: Jim Heath, California Institute of Technology

Cancer Treatments
Diabetes Management
Genetic screening
Tailored drugs

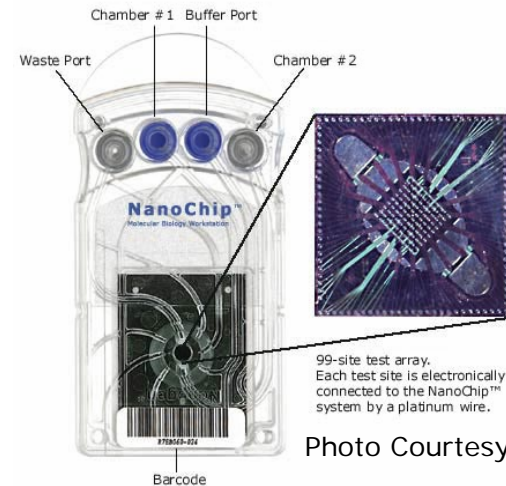
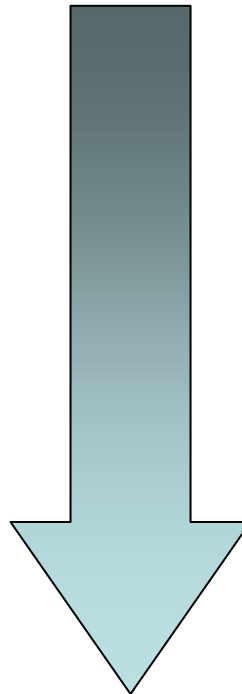


Photo Courtesy: Nanochip

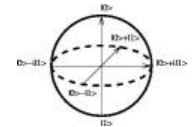
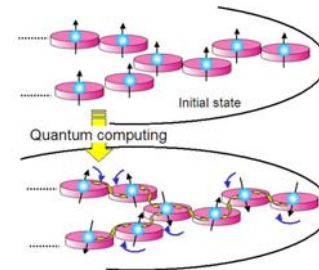
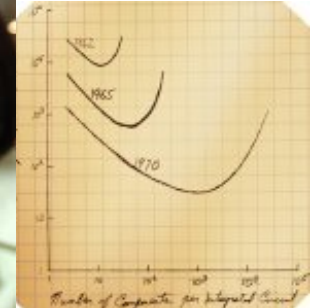
Computing/Electronics

- Memory – MRAM, nanocrystals
- Displays – OLEDs, CNT, (bioLEDs)
- Storage
- Molecular circuitry
- Quantum computing

Near-term



Long-term



Military/Defense

- Coatings (air valves \$20 mil over 10 years)
- Portable power
- Protective gear
- Weapons
- Communications
- Sensors/detection
 - Explosives
 - Biological agents



Automotive/Aerospace

- Paint colors
- Protective Coatings
- Trims, mirror casings, fenders
- Sensors
- Composites

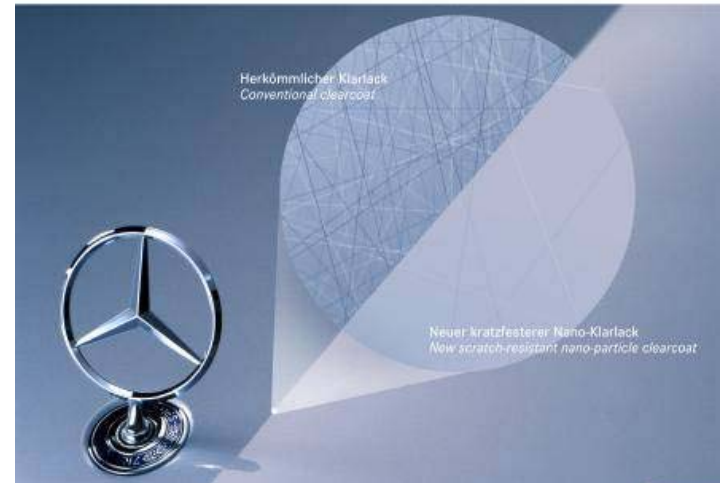


Photo Courtesy: DaimlerChrysler



Photo Courtesy:
NanoFilm

Environment/Safety

- Waste containment
- Detection
- Water filtration
- Remediation
 - Hurricane Katrina

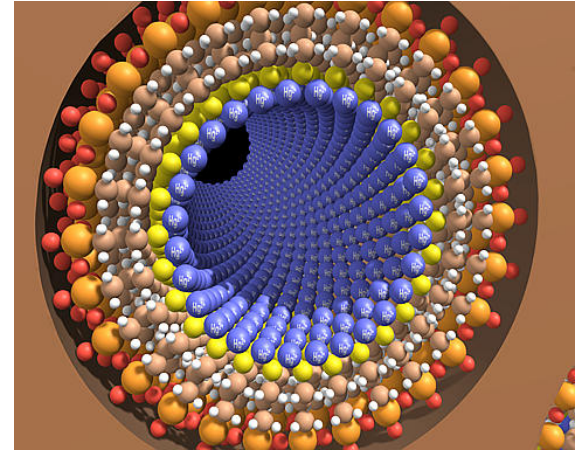


Image courtesy of Pacific Northwest National Lab



Construction zone – next 10-20 years

- Sustained funding
- Public acceptance & education
- Workplace, environmental, human safety standards
- Ethical guidelines
- Skilled workforce

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