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CURRENT TRENDS IN SCIENCE AND TECHNOLOGY

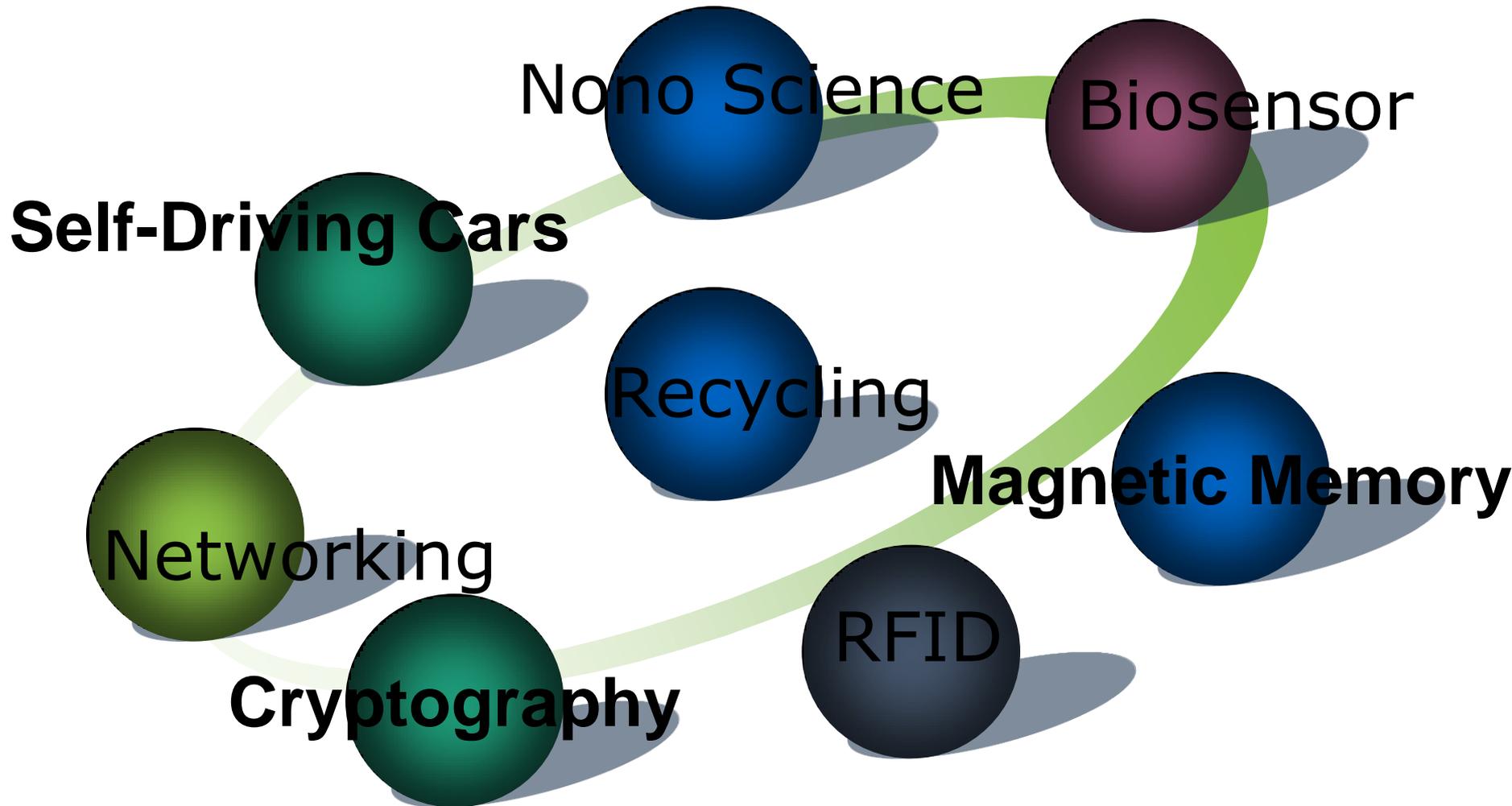
Agenda

Introduction

Hot technology

Conclusion

INTRODUCTION



Sensors

Definition:

- ❖ A device that measures or detects a real world condition, such as motion, heat or light and converts the condition into an analog or digital representation.
- ❖ A device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument.

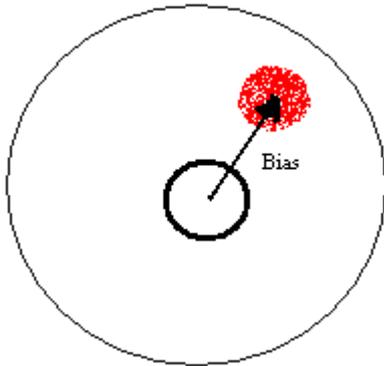
Classification of Sensors

- **Mechanical quantities:** displacement, Strain, rotation velocity, acceleration, pressure, force/torque, twisting, weight, flow
- **Thermal quantities:** temperature, heat.
- **Electromagnetic/optical quantities:** voltage, current, frequency phase; visual/images, light; magnetism.
- **Chemical quantities:** moisture, pH value

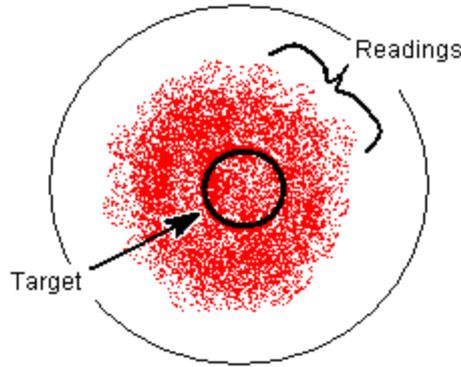
Specifications of Sensor

- **Accuracy**: error between the result of a measurement and the true value being measured.
- **Resolution**: the smallest increment of measure that a device can make.
- **Sensitivity**: the ratio between the change in the output signal to a small change in input physical signal. Slope of the input-output fit line.
- **Repeatability/Precision**: the ability of the sensor to output the same value for the same input over a number of trials

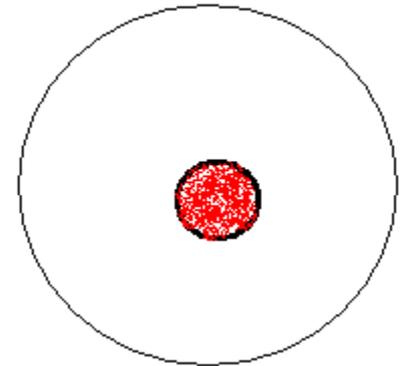
Accuracy vs. Precision



**Precision
without
accuracy**



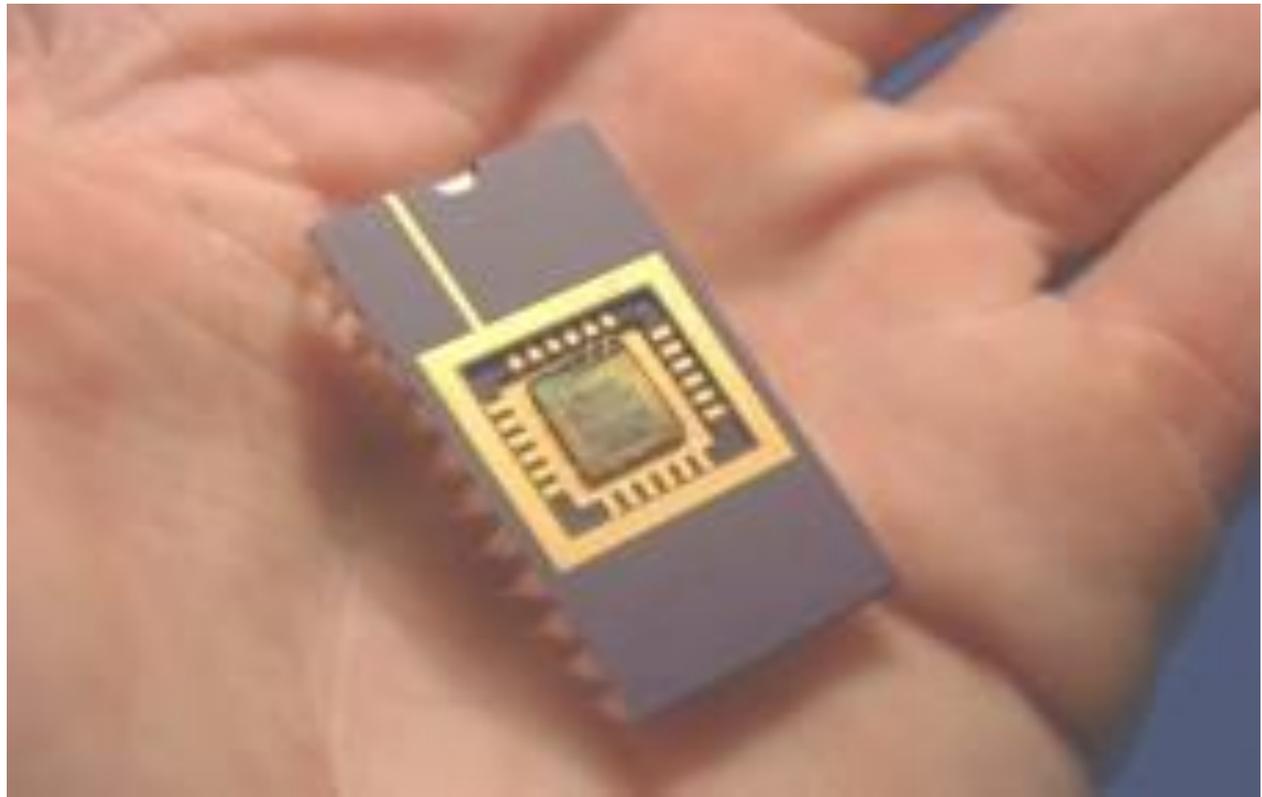
**Accuracy
without
precision**



**Precision
and
accuracy**

Health Care: Biosensors

A sensor that integrates a biological element with a physiochemical transducer to produce an electronic signal proportional to a single analytic which is then conveyed to a detector.



Example of biosensors



Infectious disease biosensor from RBS



Old time coal miners' biosensor

A Canadian lab has tested special fibers that can help make soft, flexible touch screens and batteries woven directly into the fabrics of modern life.

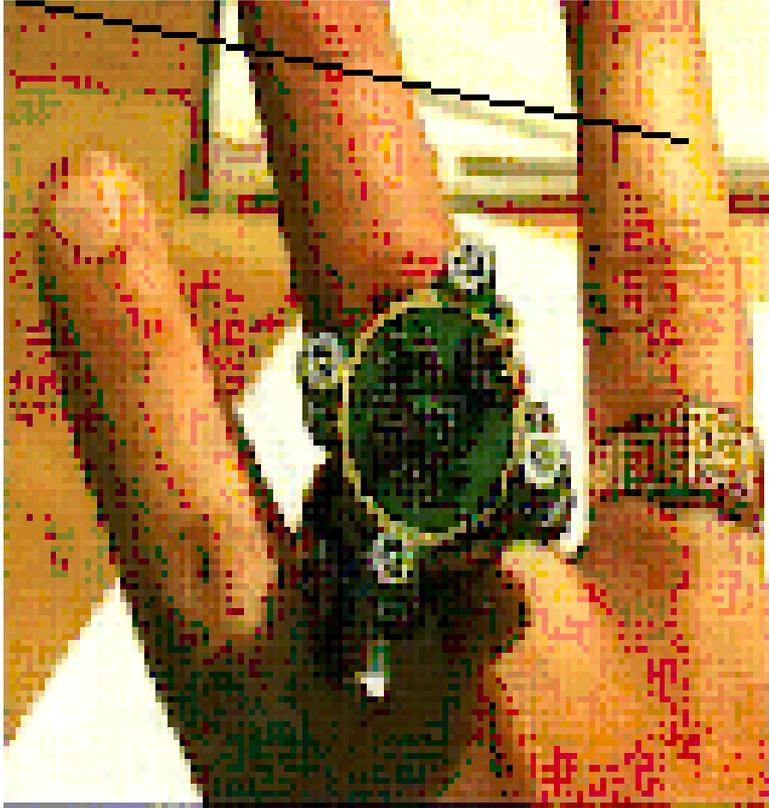


'Smart Clothing' Could Become New Wearable Gadgets



3/2/2015

Wearable Biosensors



Ring Sensor



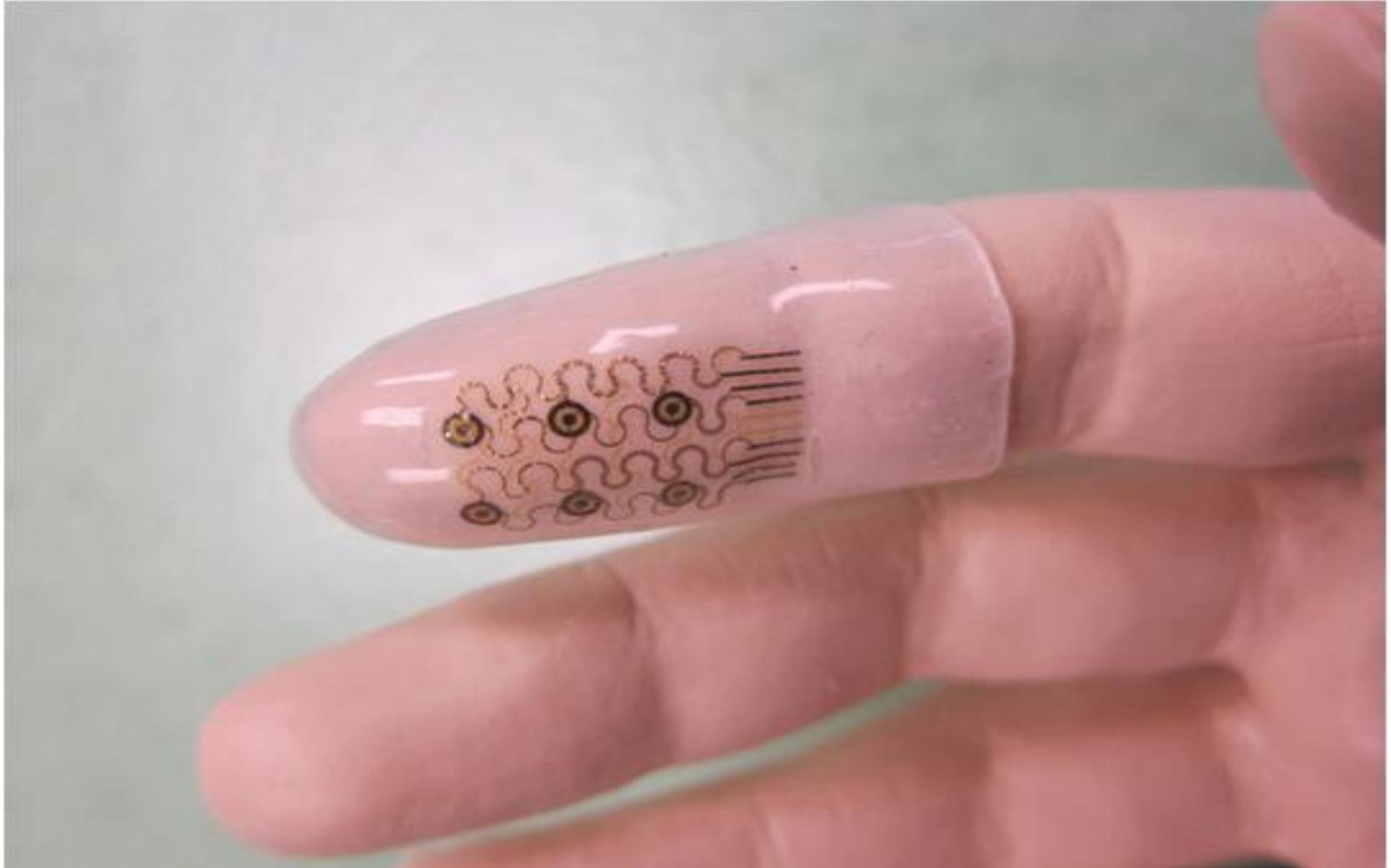
Smart Shirt

Smart' Helmet Wins Wearable Tech Award at SXSW 2014.

The helmet has a 180-degree rear-view camera that projects images to a transparent headset display, so the driver's eyes can see around them in every direction, while never having to leave the road ahead.



Wearable Electronics Pave Way for Smart Surgeon Gloves, Stretchy electronics can fit fingers or other parts of the human body for medical or athletic applications.



This month, Fit bit released 3 smart watches to read heart beat..



Three new activity trackers from Fitbit are being revealed today, including the company's first trackers with heart rate monitoring and smartwatch features.

Adidas Fit Smart: releases Fitness Tracker...



- ❖ Implantable biosensors that track blood glucose levels and deliver insulin.
- ❖ Microchips is testing a chip implant that offers long-term, time-controlled drug delivery.
- ❖ Technology expects usage of in-the-flesh physicians within ten years.
- ❖ Wirelessly controlled biosensor that detects and treats an acute condition, and then a biosensor that will approximate an artificial organ

- ❖ Presently, biosensors in **ENVIRONMENTAL MONITORING** stations nationwide can detect compounds like anthrax—but detection can take 12 to 24 hours. The best ones on the market take 20 minutes
- ❖ Sandia National Lab. developed a system that detects **BIO TOXINS** in 5 minutes.
- ❖ Integrate both gas and liquid-based into one handheld device could be incorporated into **MILITARY UNIFORMS** and eventually into houses as the **BIOWAR FARE** equivalent of a smoke detector.

- Biosensors monitor air quality and emissions at chemical refineries and quality control at food-processing plants.
- If funding isn't diverted to military applications, within five to ten years biosensors could be used in food lines to test every product.

- **MicroChips' Santini**, "I'm confident we'll have the biosensor artificial-organ system soon."
- **Applied Digital Solutions** - has even developed a tag called a **VeriChip** that can be implanted under the skin and contain information about allergies, immunizations, or pacemakers. It could also hold criminal records or security clearances.

Mobile: Self-Driving Cars

- ❖ Imagine a 180 KM trip from Almajmaah to Riyadh City, your car travels at 120 Km/hr, unassisted and in complete safety. You're in the driver's seat, but the car does the driving.
- ❖ **Dedicated Short Range Communications (DSRC) network for cars has allocated spectrum at 5.9 GHz.**
- ❖ Stop signs and traffic lights could also be fitted with DSRC transmitters.

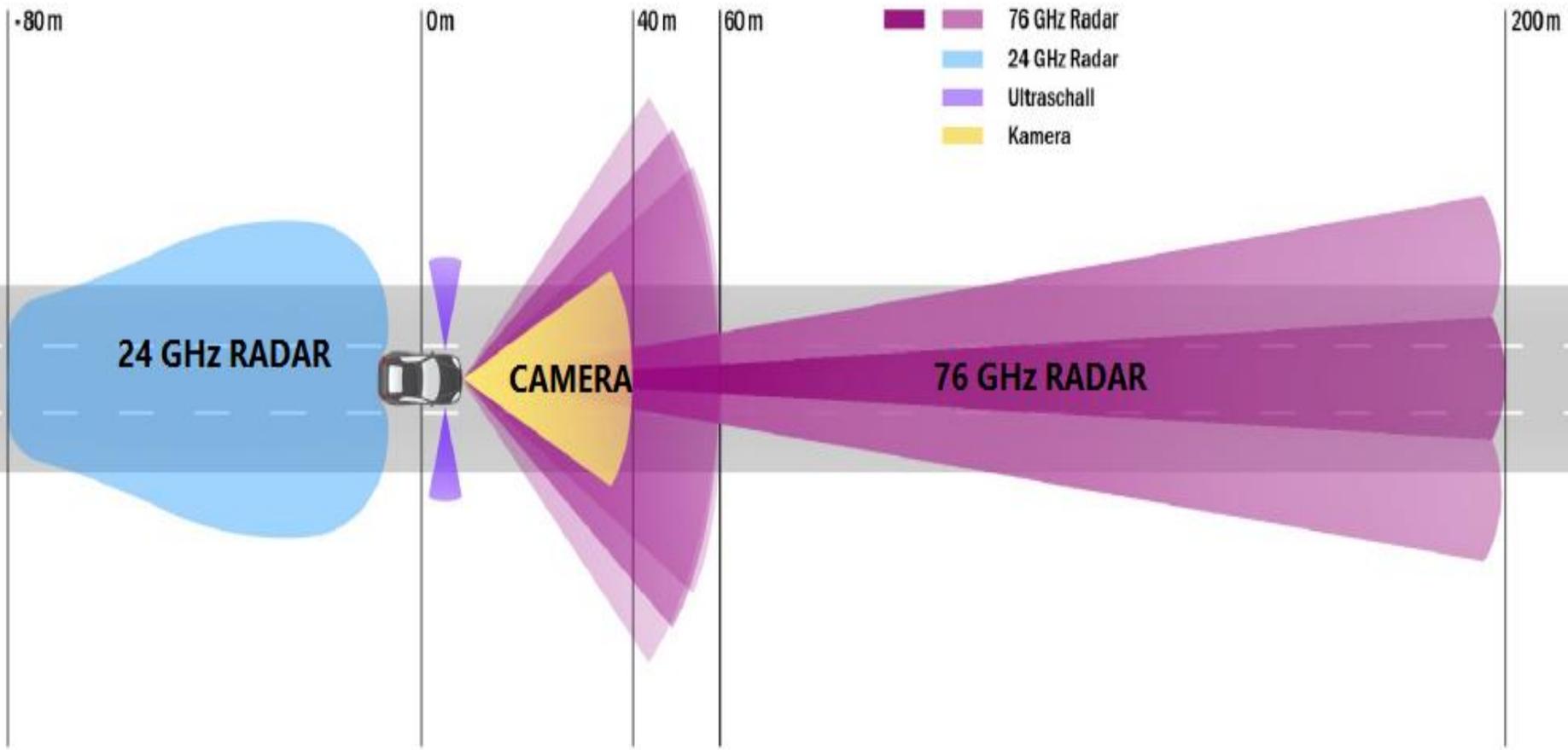
Ability of a car to get from point A to point B without human interaction





It consists of Ultra precise GPS fixes, Scanner, Google Translator, Lane assistance and Blind spot detection..

Sensor concept







Google

self-driving car

Autonomous cars are already operating at **Heathrow airport.**
The computer-controlled, battery-powered cars automatically drive along a specially prepared road.





A team including **GM and Mellon** built the car and it won the **Darpa Urban Challenge**, a contest in which autonomous vehicles raced without drivers in a simulated urban environment.

Security: Quantum Cryptography

20 years of academic research, two companies have used the principles of quantum mechanics to create the most secure form of computer encryption the world has ever seen.

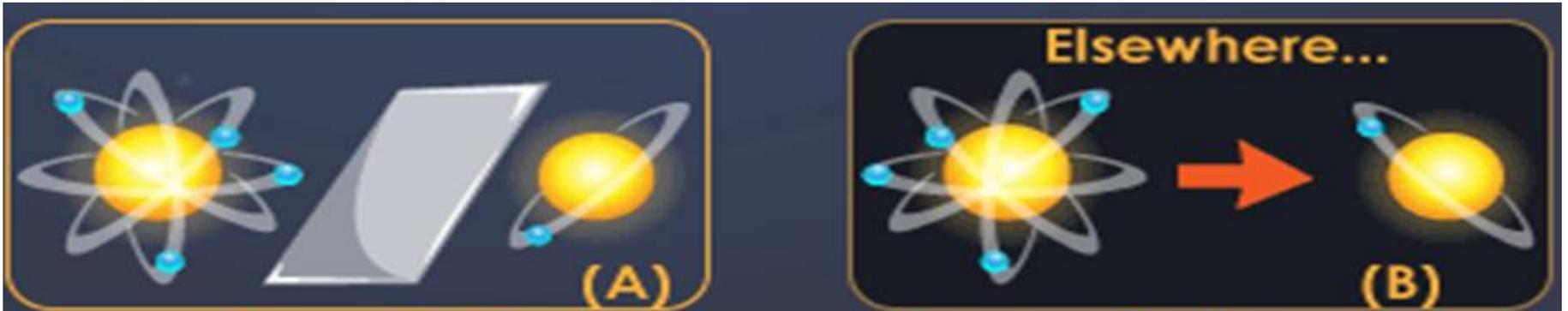
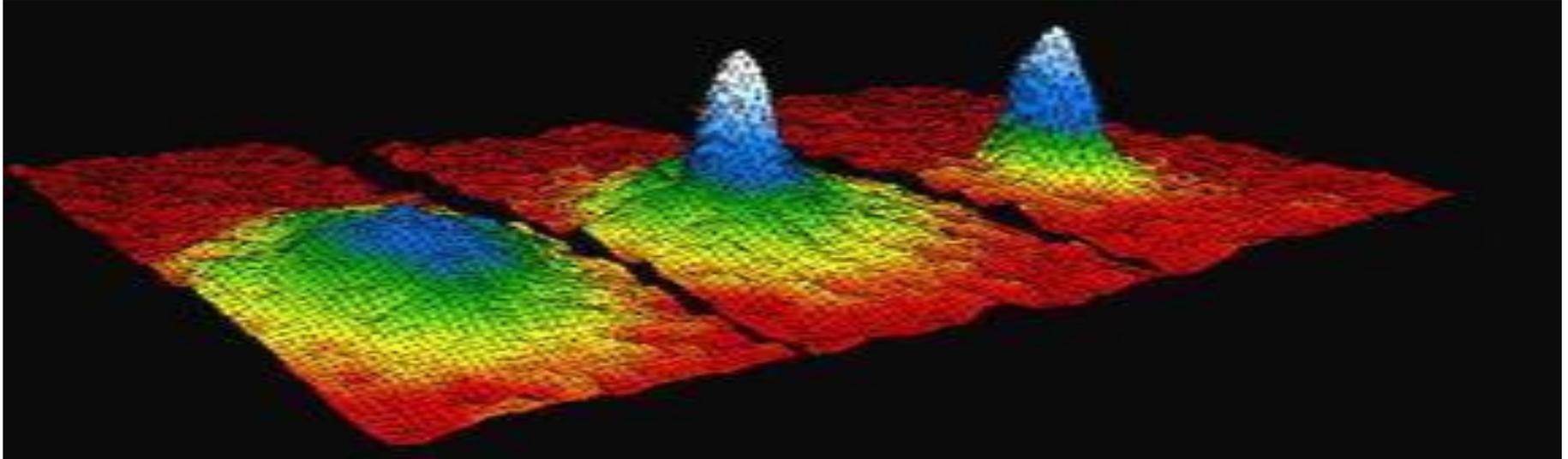
- **Telephone hacking**
 - Use telephone freely
 - It's called phreaking
- **Computer virus**
 - Destroy many computers
- **Network hacking**
 - Hack the important server remotely and destroy/modify/disclose the information



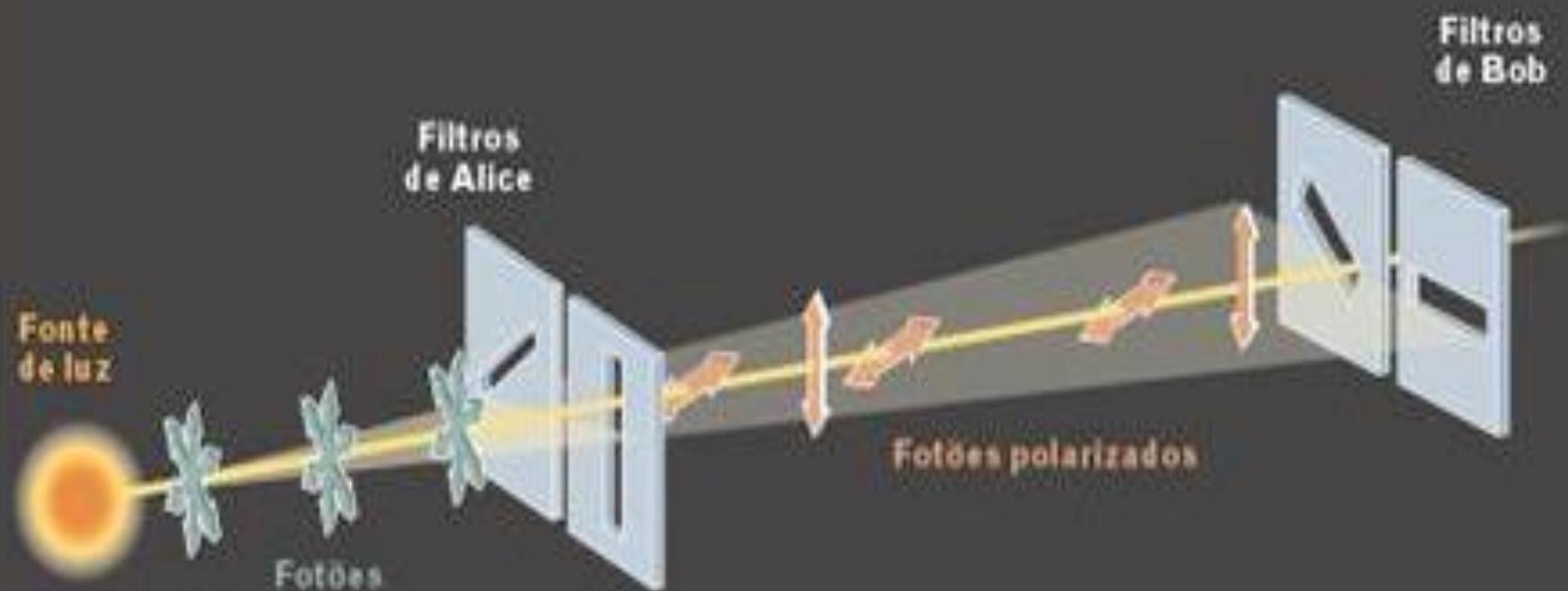
A new Firefox feature called “**Firesheep**” can be used to easily hack into a person’s computer over a public Wi-Fi network and gain access to several popular sites, including Facebook, Twitter, and Amazon.



Quantum Computer



Even after they move away from each other, measuring one entangled photon (A) will cause its partner to take the opposite state (B) without it being measured



Bits de Alice	1	0	1	0	1	0
Polarização de Alice	/		/		/	
Polarização de Bob	\	\	-	-	-	\
Resultado de Bob	N	N	S	N	N	S
Chave aceita	-	-	1	-	-	0

- When you exchange quantum keys with someone, you can be sure that no one could ever hope to figure them out. Any e-mail message, telephone call, or financial transaction encrypted with these keys will be safe.
- "If there are things that you want to keep protected for another 10 to 30 years, you need quantum cryptography,"

Components: Magnetic Memory

- MRAM – **Magneto Resistive Random Access Memory**
- Today's PCs use **SRAM** (static RAM) and **DRAM** (dynamic RAM), both known as volatile memory. They can store information only if they have power
- If an **MRAM** computer loses power, you can restart it in an instant, and when you do, that four-page e-mail will be right where you left it.

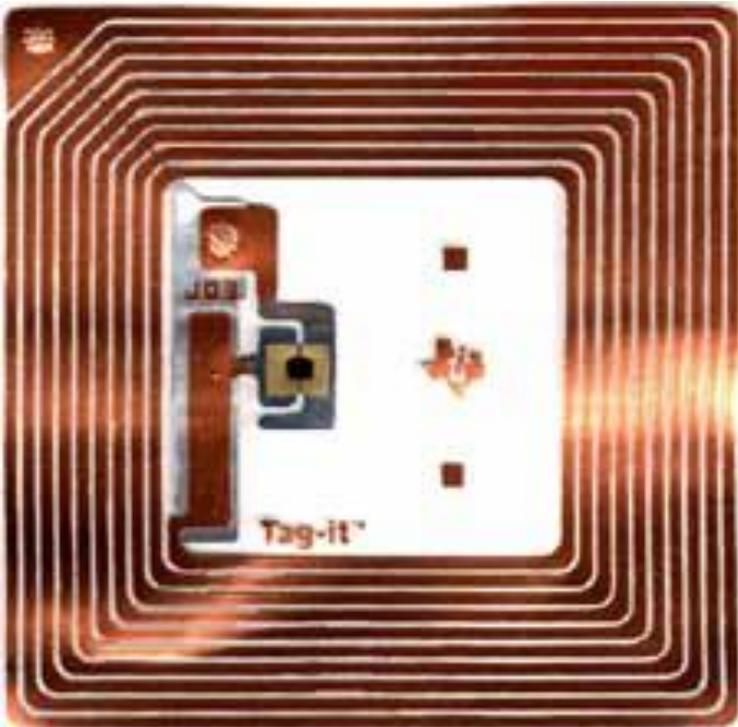
- ❑ MRAM stores bits as magnetic polarities rather than electrical charges.
- ❑ MRAM bits are made from magnetized metal material.
- ❑ When a bit's polarity points in one direction, it holds as 1, when its polarity points in another direction, it holds as 0. The bits need electricity to change polarities but not to maintain them.
- ❑ MRAM is nonvolatile, so when you turn off the power, all the bits retain their 1's and 0's.

- MRAM could let developers reinvent other parts of a PC as well. Potentially much faster than the continuous magnetic media inside today's hard drives, it may lead to better mass storage devices.

Wireless: Radio-Frequency ID Tags

- Radio-frequency Identification (RFID) are tiny tags containing a microprocessor, an antenna, and an identification code are embedded in items.
- RFID goes back to World War II, when researchers created a system to reduce "friendly fire" incidents by beaming radio signals to an aircraft's transponder. Over time, the transponders, or tags, got smaller, cheaper, and more sophisticated, and RFID's.

What is RFID? How RFID works?



Activation Signal



Data



Data



New Tracking Chip Size of a Dust Grain: 0.05 x 0.05 millimeters. "RFID" chip (The world's smallest and thinnest tags by **Hitachi**). It is use a tiny antenna to transfer small amounts of data for identification purposes. It can call as TATO tag



RFID

The new RFID chips have a 128-bit ROM for storing a unique 38 digit number. Hitachi used semiconductor miniaturization technology and electron beams to write data on the chip.

Hitachi's mu-chips are already in production; they were used to prevent ticket forgery at last year's Aichi international technology exposition. RFID 'powder,' on the other hand, is so much smaller that it can easily be incorporated into thin paper, like that used in paper currency and gift certificates.

RFID-Booming markets

- **Analysts:** tremendous market-growth
- **Problem:** estimates vs. guesstimates
(remarkable differences in market volume,
growth rates)
- **Frost & Sullivan:** 11.7 billion USD (2010)
Research and Markets: 3.8 billion USD
(2011)
IDTechEx: 26.90 billion USD (2015)

- **Security and privacy issues:** consumers, policy makers, researchers
- **Pricing:** very low
- **Standards landscape**



- **Transport and logistics:** toll management, tracking of goods **Security and access control** tracking people (students etc.), control access to restricted areas
- **Supply chain management:** item tagging, theft-prevention
- **Medical and pharmaceutical applications:** identification and location of staff , students and patients, asset tracking, forging protection for drugs
- Marathon runners wear tags on their shoes to record their race times; drivers use tags in their cars to pay tolls automatically.

Proposal to Implant Tracking Chips in Immigrants

Scott Silverman, Chairman of the Board of **VeriChip** Corporation, has proposed implanting the company's [RFID tracking tags](#) in immigrant and guest workers. He made the statement on national television on May 16



V Software: Text Mining

- Text-mining software is one of the front-line tools that the government is now using to ease out valuable connections.
- These specialized search engines can quickly shift through mountains of unstructured text—anything that's not carefully arranged in a database or spreadsheet—and pull out the meaningful stuff.

- It is something we do all the time automatically but is enormously complicated for computers. **“It bridge the gap between information and action.”**
- More government agencies, including the Defense Intelligence Agency, the Department of Homeland Security, and the FBI, are using them to evaluate the multitude of e-mail messages, phone call transcripts, memos, foreign news stories, and other pieces of intelligence data these agencies collect each day.

It is necessary to automatically analyze, organize, summarize... Informa: "



Recycling: Reverse Engineering

- Over the next three years, 250 million computers are expected to become obsolete, according to the Environmental Protection Agency
- Old PCs can quickly become harmful PCs. A typical computer monitor, for example, contains between 2 and 4 pounds of lead, which can leach into the groundwater in a landfill.

The problem is severe : Do you know that in USA alone?

- **Between 1997 and 2007, nearly 500 million personal computers will become obsolete- almost two computers for each person.**
- **15,000,000 PCs become obsolete every year.**
- **7,000,000 computers will end up stored for at least 3 years.**
- **750,000 computers will end up in landfills this year alone.**
- **85% of the 63 million computers taken out of service in the U.S. end with landfills, according to the National Safety Council.**

Robotics: Cognitive Machines

- Today's robots are a like sweeper.
- They can perform programmed tasks but can't think for themselves.
- These control everything from Cog's arm, neck, and head movement to its voice and its eyes, which capture and interpret action at 30 frames per second.
- Under the guidance of lab director **Rodney Brooks**, a project's is proposed develop Cog with the thinking abilities of a 3-year-old.



Leonardo

The ultimate goal is to have **Leonardo** (or another robot like it) pick up on cues, respond to ever-changing situations, and interact with people naturally.

Entertainment: Social Gaming

- Gaming is a bigger industry than movies.
- Gaming is becoming an increasingly social activity.
- IDSA finding shows that nearly 60% of gamers playing with friends, 33% with siblings, and about 25 % with spouses or parents.

Energy: Fuel Cells

- The long-lasting, environment friendly fuel cell is one of the most hotly pursued technologies of the decade.
- "There is an energy revolution happening that is similar to what we saw with the PC revolution,"
- "Moore's Law has set in with fuel cells," referring to the falling cost and increased efficiency of fuel cell technology.

- Toshiba recently demonstrated a prototype of a **direct methanol fuel cell** that can power a notebook, PC for 5 hours works by **converting chemical energy directly into electricity**.
- NEC is a front runner - building a fuel cell based on **carbon nano-tubes** that is small enough to power handhelds and cell phones.
- **Ford Motor Company** is investing \$420 million to produce a commercial hydrogen-powered car by next year.
- USA earmarked \$1.2 billion for a hydrogen fuel cell initiative.

More than 100 **Chevrolet Equinox Fuel Cell electric vehicles** will be deployed by General Motors in the streets of AMERICA to market test of fuel cell vehicles of its kind (2007)



The U.S. Navy has developed a hydrogen-powered aircraft that can fly for nearly an entire day without refueling.



Cockroach get their own power source.
The secret is an implantable biofuel cell
powered by a sugar make from their food.



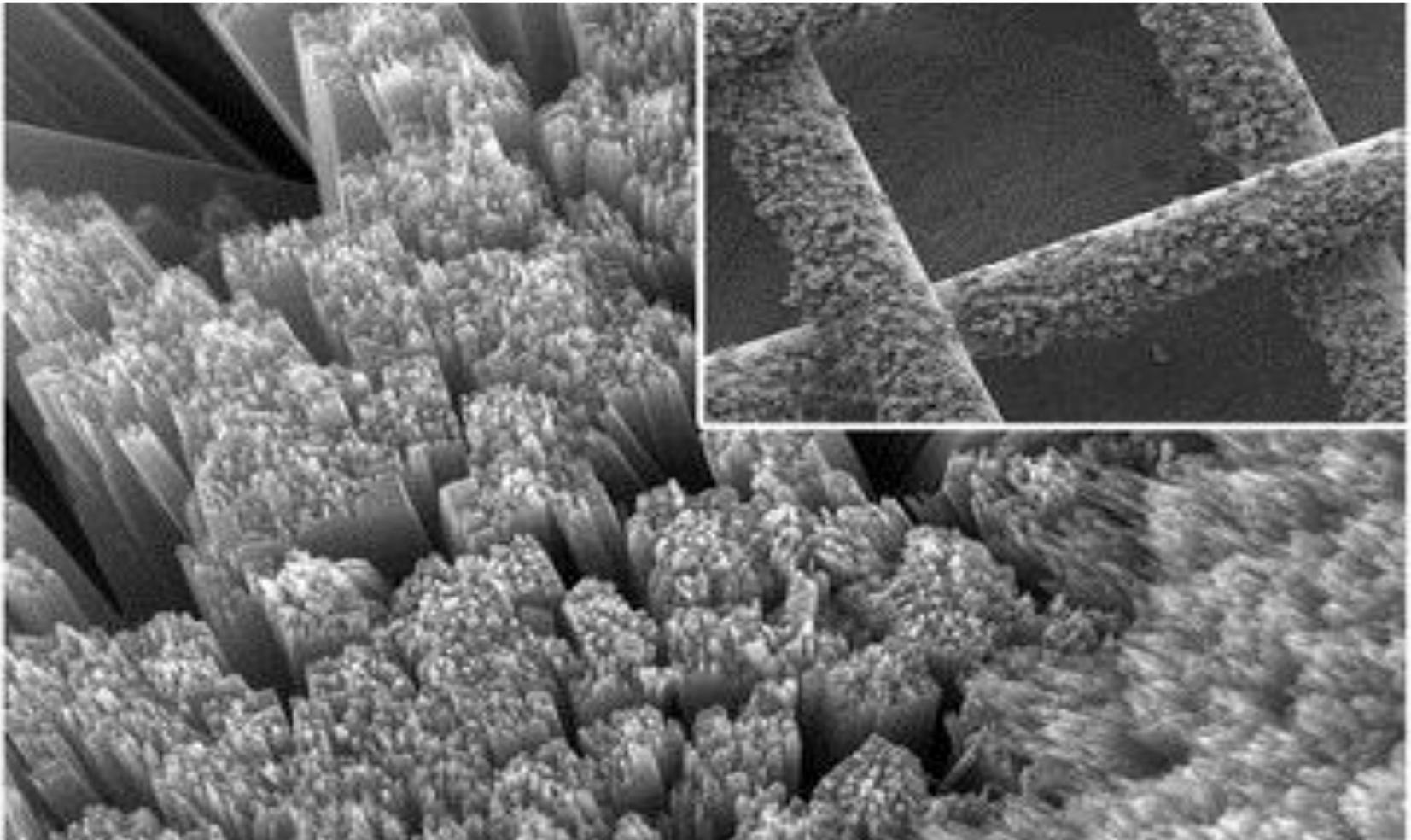
Futurist and inventor **Ray Kurzweil** is part of distinguished panel of engineers.

He predicts that the [solar power](#) will scale up to produce all the energy needs of Earth's people in 20 years.



New solar nano carbon tube battery could generate cheaper clean energy

October 17th, 2014



Materials: Plastic Transistors

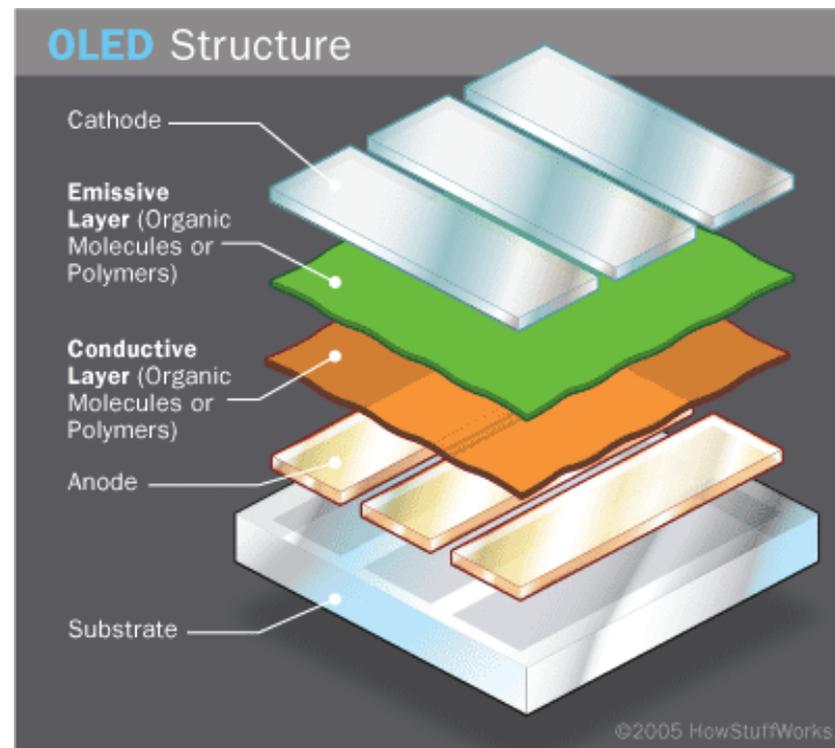
- Today, plastics are the future of the \$30 billion computer display market, and they may even lead to new breeds of computer memory and microprocessors.
- Within five years, using plastics with **organic light-emitting diode technology ("OLED)** and **organic transistors**, to build flexible displays.
- Eventually, plastics could be used to build entire machines that you can bend and drop without breaking.

- "These devices will be so flexible and light can integrate them directly onto almost any type of matter we want, including a piece of clothing".
- **Scientists at Bell Labs and Xerox have found ways of using organic materials rather than silicon to build electronics.**
- IBM researcher who's worked on plastic electronics for the past five years. And they may be even cheaper than silicon-based devices.

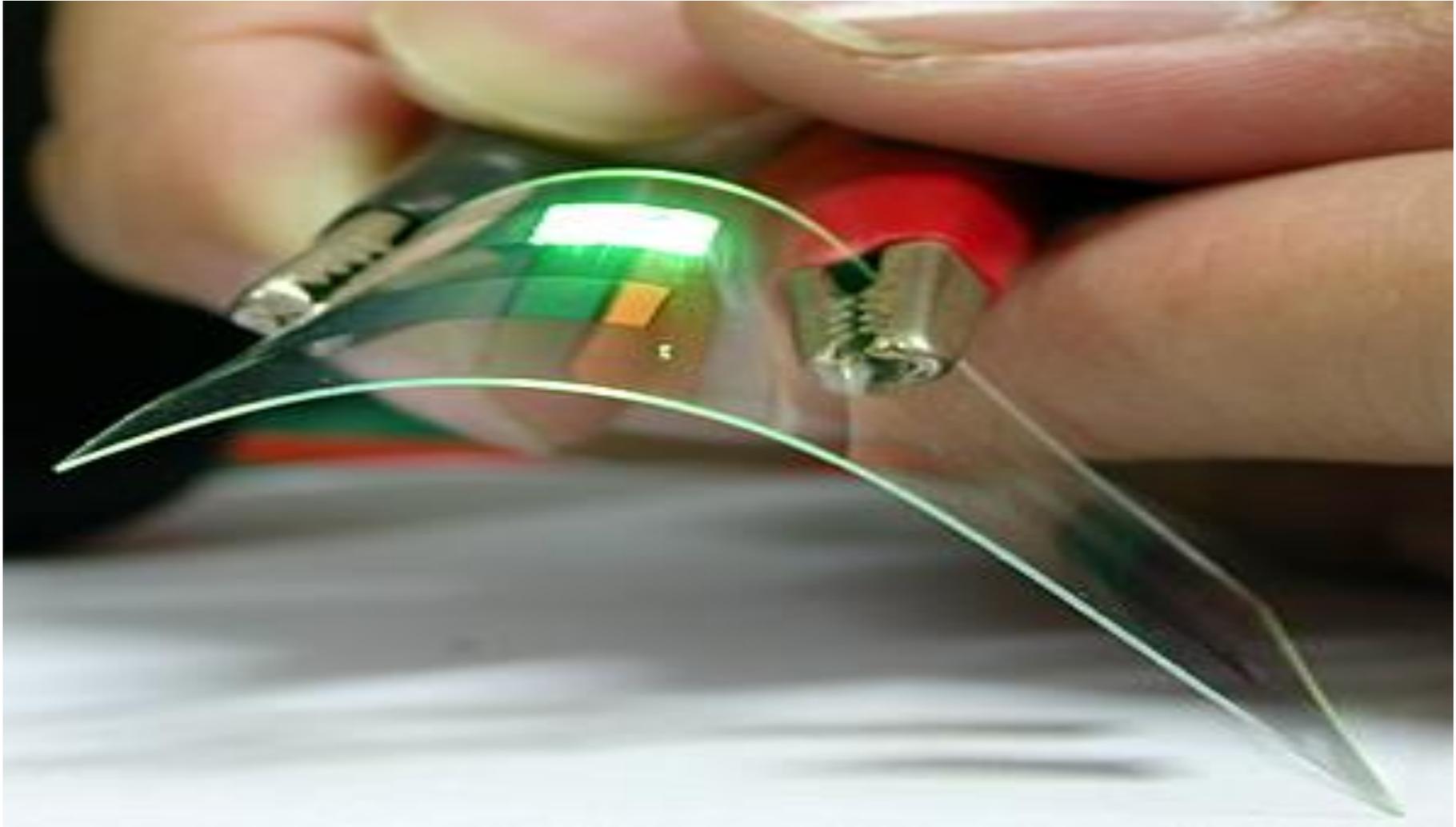
Materials: OLED Displays

- **OLED (Organic Light Emitting Diode)**
- An OLED uses a carbon-based molecule that emits light when an electric current passes through it.
- Piece consists of lot of molecules together and get a super thin display of stunning quality—no power-draining backlight required.
- **OLED displays can be produced in the same way an ink jet printer sprays ink onto a sheet of paper, making manufacturing cheap and simple.**

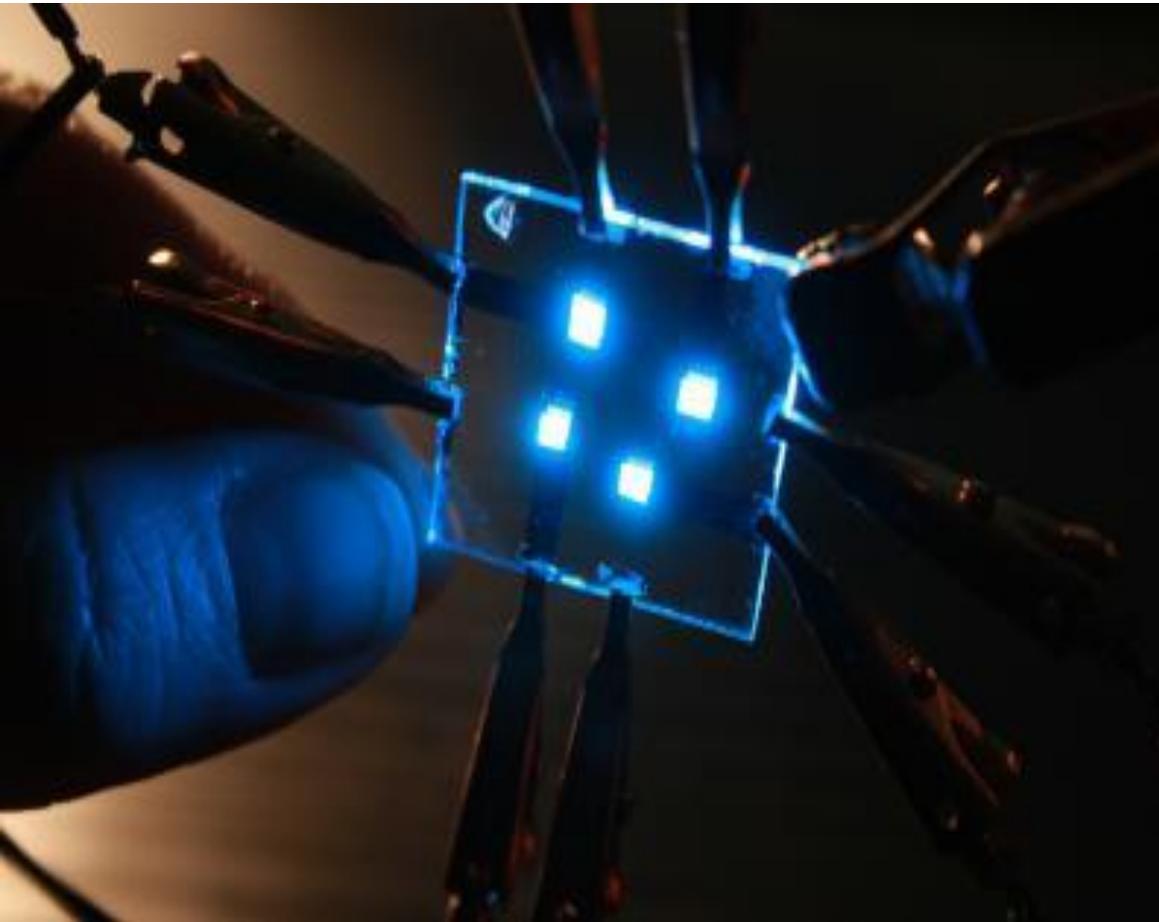
- **Organic layer:**
 - **Conducting layer** - This layer is made of organic plastic molecules that transport "holes" from the anode. One conducting polymer used in OLEDs is polyaniline.
 - **Emissive layer** - This layer is made of organic plastic molecules that transport electrons from the cathode; this is where light is made.



OLED is an light emitting diode (LED) which emissive electroluminescent layer is composed of a film of organic compounds.



- Manufacturers focusing on finding a cheap way to produce "Roll-to-Roll" OLED.



- Cell Phone screens
 - Computer Screens
 - Keyboards
- (Optimus Maximus)
- Portable Device displays





- First OLED TV (SONY) sold in stores.
- 11" screen, 3mm thin
- \$2,500 MSRP
- Weighs approximately 1.9 kg
- Wide 178 degree viewing angle
- 1,000,000:1 Contrast ratio.



Maximus Keyboard

- Small OLED screen on every key total 113 OLED screens.
- Each key can be programmed to perform a series of functions
- Keys can be linked to applications
- Display notes, numerals, special symbols, HTML codes, etc...SD card slot for storing settings



OLED Displays Vs. LCD and Plasma

- Able to display "True Black" picture
- Wider viewing angles
- Thinner display
- Better contrast ratio
- Safer for the environment
- Has potential to be mass produced inexpensively



OLED Lighting Vs. Incandescent and Fluorescent

- Cheaper way to create flexible lighting
- Requires less power
- Better quality of light (ie. no "Cold Light")
- New design concepts for interior lighting

Lighting

- Flexible / bendable lighting
- **Wallpaper lighting defining new ways to light a space**
- Transparent lighting doubles as a window



Future Uses for OLED

- Using Samsungs' transparent OLED technology
- Heads up display
- GPS system
- Scroll Laptop



Wireless: Mesh Networks

- The term 'wireless mesh networks' describes wireless networks in which each node can communicate directly with one or more peer nodes.
- Still, this is quite different than traditional wireless networks, which require centralized access points to mediate the wireless connection.

Wireless: Mesh Networks

- Nodes are comprised of mesh routers and mesh clients.
- Each node operates not only as a host but also as a router, forwarding packets on behalf of other nodes that may not be within direct wireless transmission range of their destinations.
- A WMN is dynamically self-organized and self-configured, with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves

- WMNs consist of two types of nodes:
Mesh Routers and Mesh Clients.

A wireless mesh router contains additional routing functions to support mesh networking.

- **It is equipped with multiple wireless interfaces built on either the same or different wireless access technologies.**
- A wireless mesh router can achieve the same coverage as a conventional router but with much lower transmission power through multi-hop communications.

WMN COMPONENTS



(a)



(b)

Examples of mesh routers based on different embedded systems:

(a) PowerPC and

(b) Advanced Risc Machines (ARM)

WMN COMPONENTS



(a)



(b)



(c)



(d)

Examples of mesh clients: (a) Laptop, (b) PDA, (c) Wi-Fi IP Phone and (d) Wi-Fi RFID Reader.

WMN COMPONENTS



WMN COMPONENTS



What is Nanotechnology?

- Nanotechnology is the creation and use of materials or devices at extremely small scales.

$$1 \text{ nm} = 0.000000001 \text{ m}$$

What is Nanoscale?



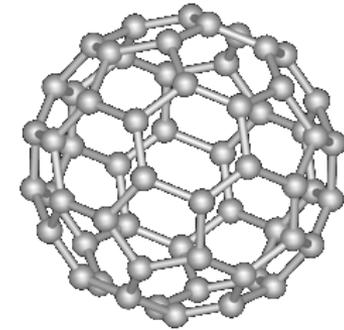
12,756 Km

$1.27 \times 10^7 \text{ m}$



22 cm

0.22 m



0.7 nm

$0.7 \times 10^{-9} \text{ m}$

www.physics.ucf.edu

10 millions times smaller

1 billion times smaller

Materials behave differently at this size scale.

It's not just about miniaturization.
At this scale---it's all about INTERFACES



Size Matters!

Color depends on particle size

Quantum dots 3.2 nm in diameter have blue emission

Quantum dots 5 nm in diameter have red emission

Size dependent properties of cadmium selenide:

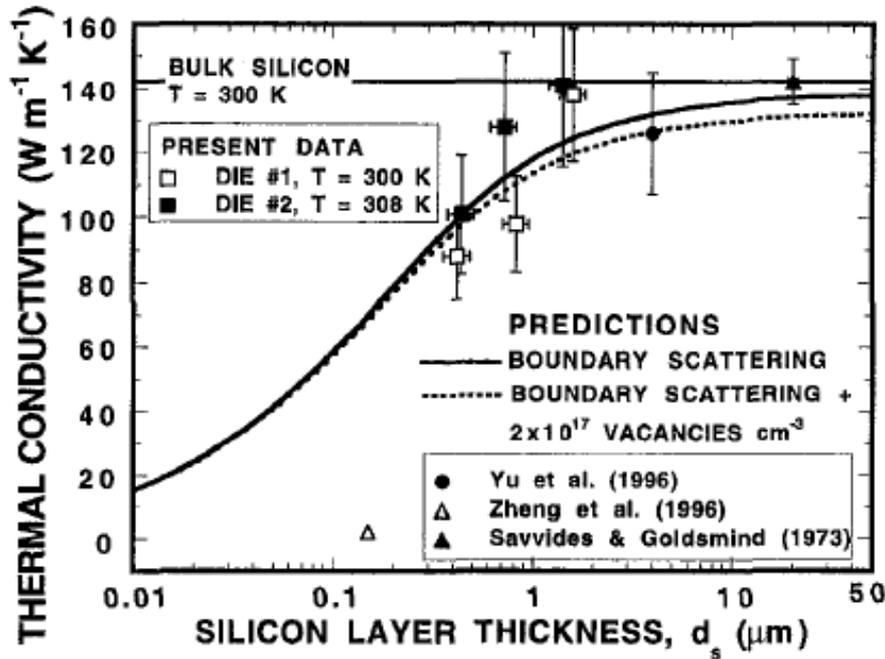
Colour of nanophase materials vary according to the size of their constituent grains, or clusters.



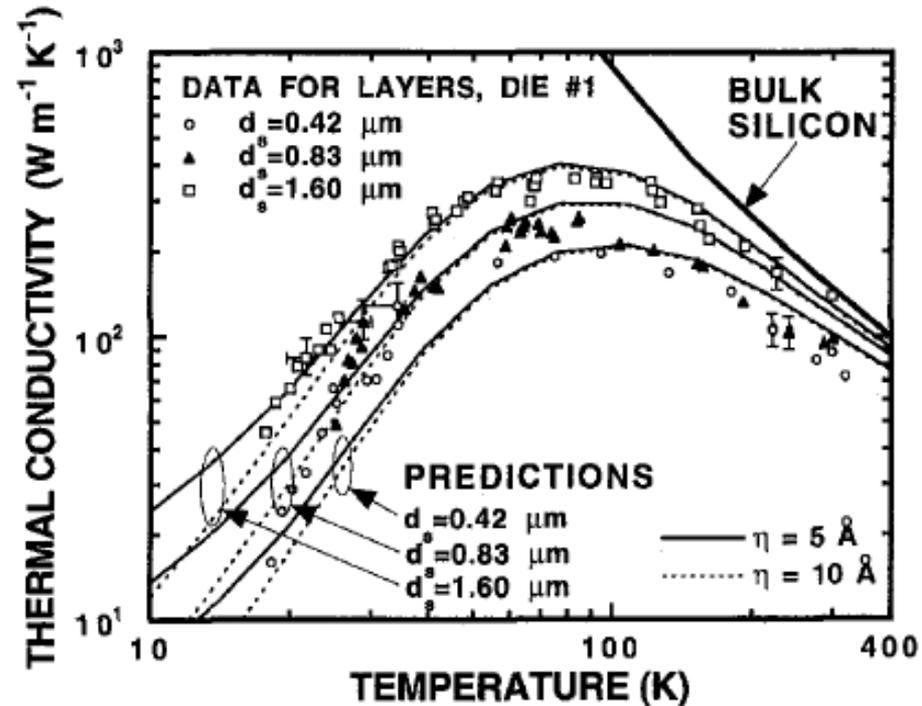
white light (*left*) and ultraviolet light (*right*).

Thermal Conductivity

Si phonon thermal conductivity: **Bulk vs. Micro scale**



Room-temperature thermal conductivity data for silicon layers as a function of their thickness.



Thermal conductivities of the silicon device layers with thicknesses 0.42, 0.83, and 1.6 μm .

Asheghi, A., Touzelbaev, M.N., Goodson, K.E., Leung, Y.K., and Wong, S.S., 1998, "Temperature-Dependent Thermal Conductivity of Single-Crystal Silicon Layers in SOI Substrates," *ASME Journal of Heat Transfer*, **120**, 30-36.

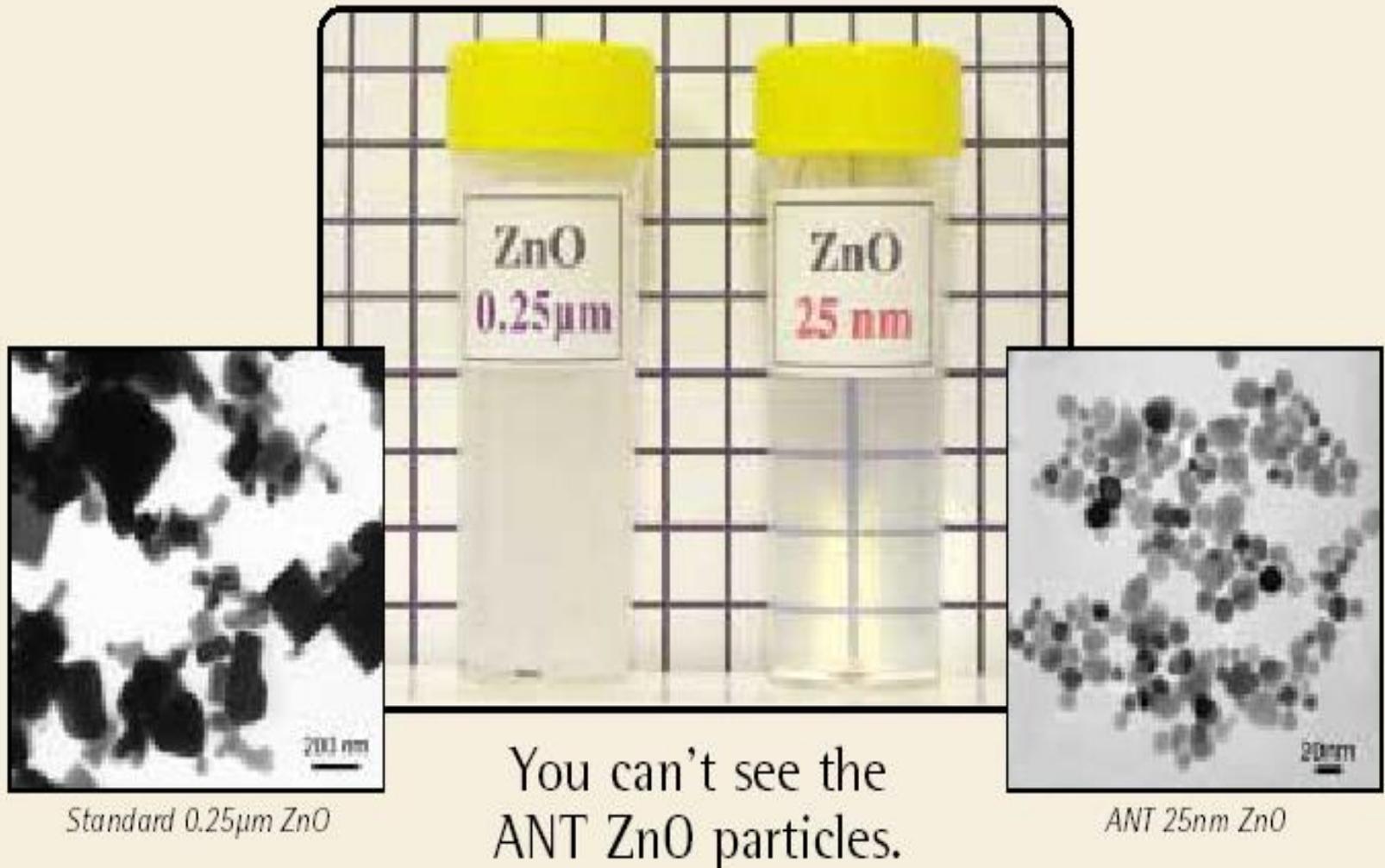
Nanoscale Size Effect

- Attainment of high surface area to volume ratio
- Change in properties, including changes in:
 - **Physical Properties** (e.g. melting point)
 - Chemical Properties (e.g. reactivity)
 - **Electrical Properties** (e.g. conductivity)
 - Mechanical Properties (e.g. strength)
 - **Optical Properties** (e.g. light emission)

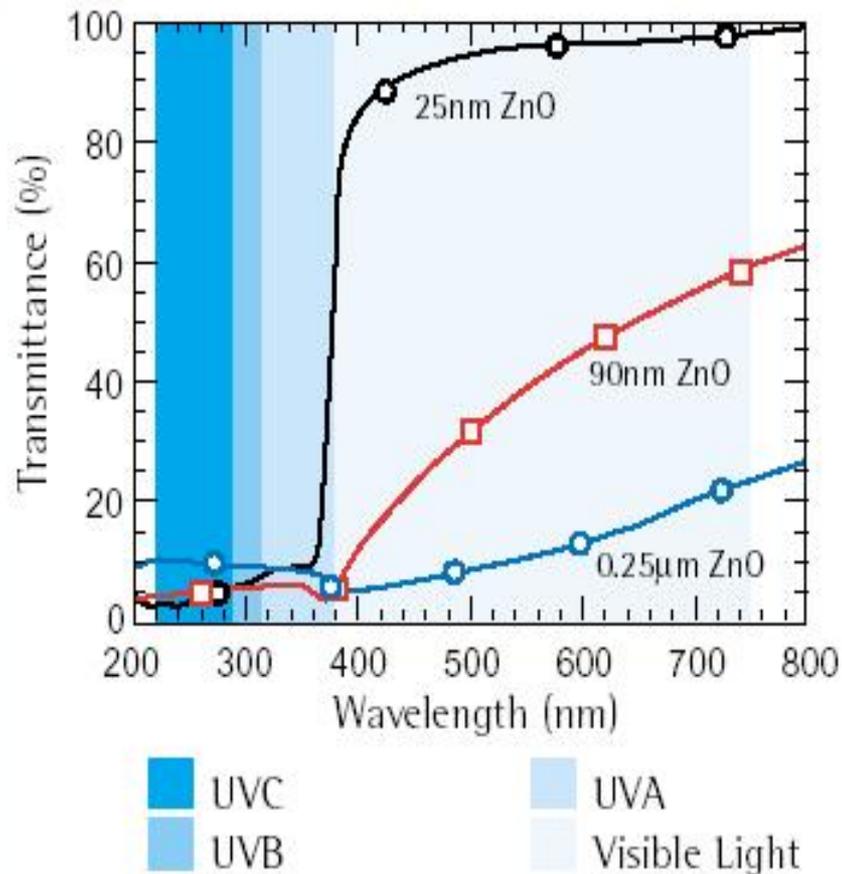
...Nanoscale Size Effect

- Magnetic materials like iron loses its magnetism at nano-size.
- Gold shines as a metal and non-reactive. At nano, chemically reactive.
- Melting point of solid changes with size of particle.

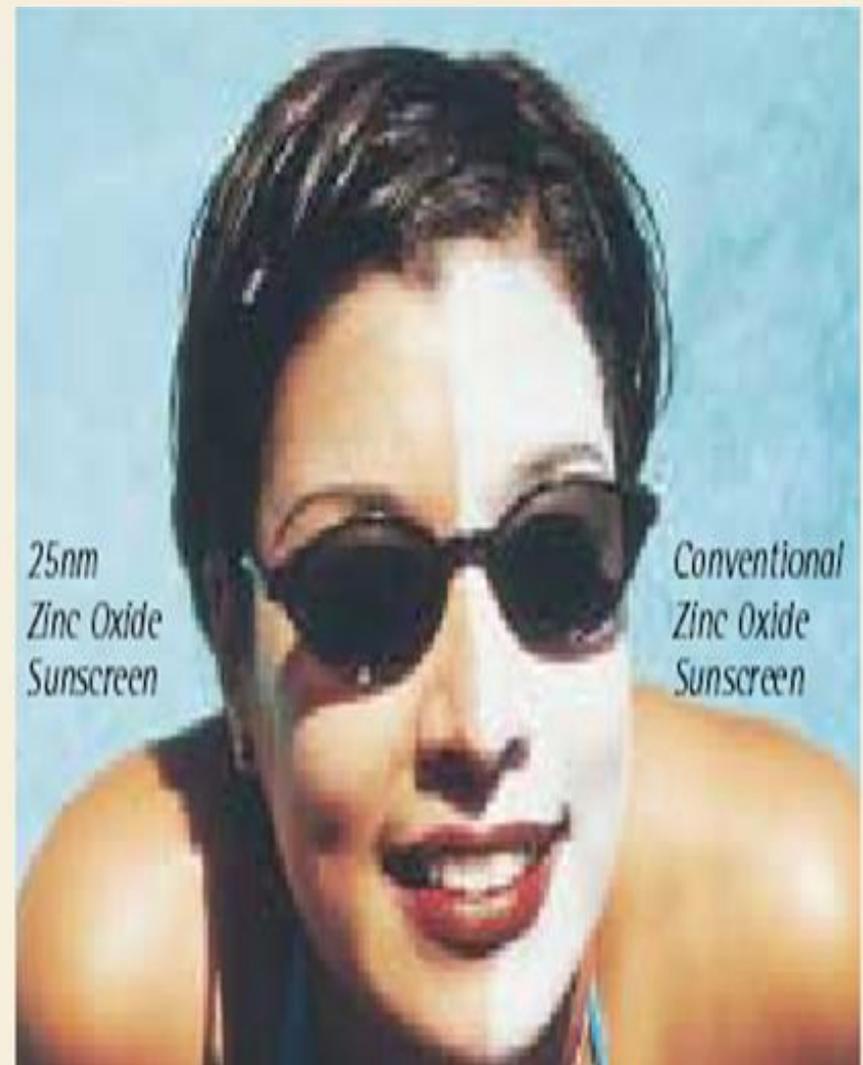
Nanopowder are transparent to visible light.



UV/Visible Light Absorption



As ZnO absorbs UV radiation¹, ZnO nanopowders will function as a transparent UV absorber.

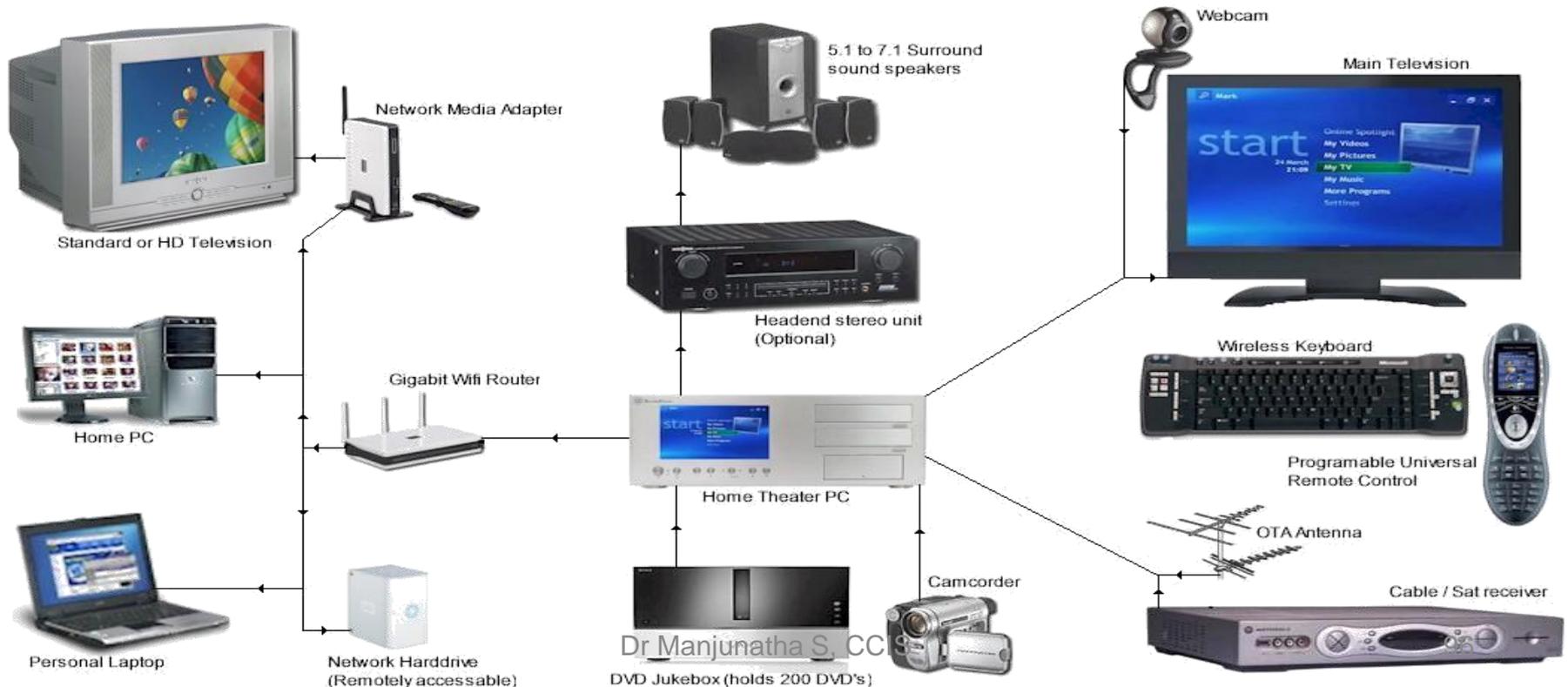


As opposed to conventional inorganic based sunscreens, you can't see the ANT NanoPowder based sunscreen.

How can Nanotechnology help us?

Nanotechnology will help us :

1. Develop new manufacturing technology
2. Help us build computer systems inexpensively with mole quantities

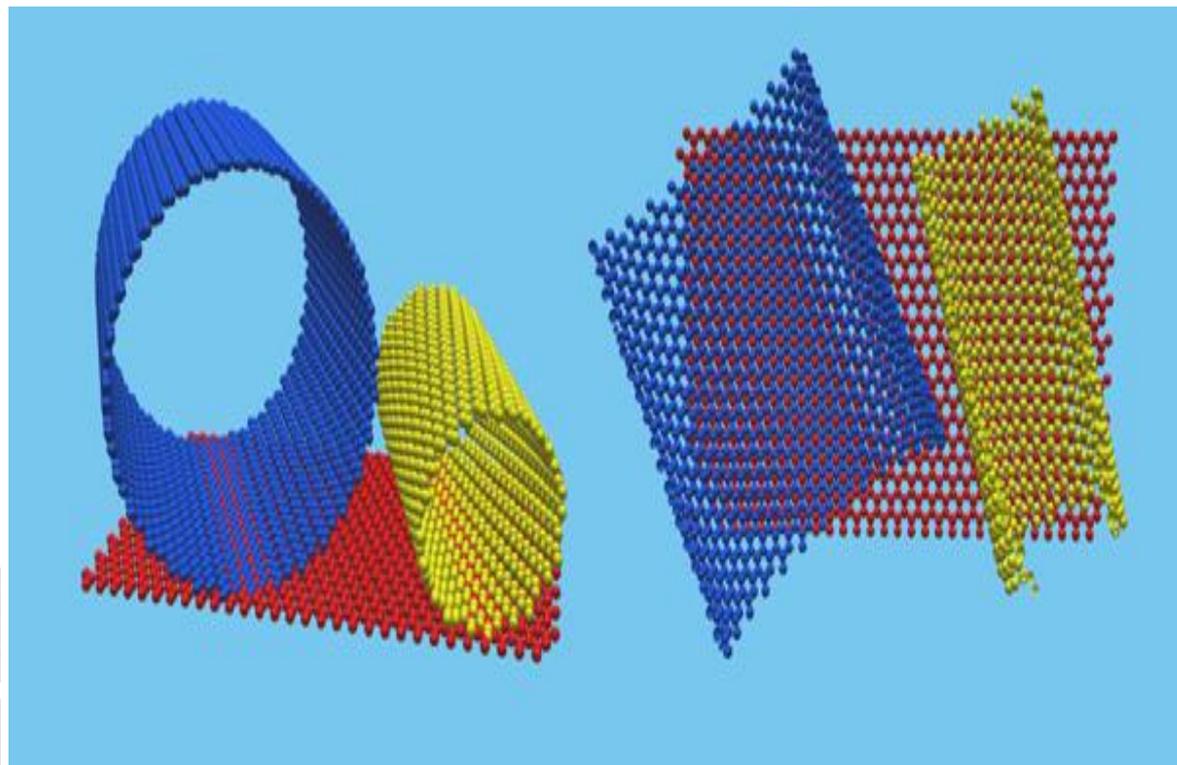
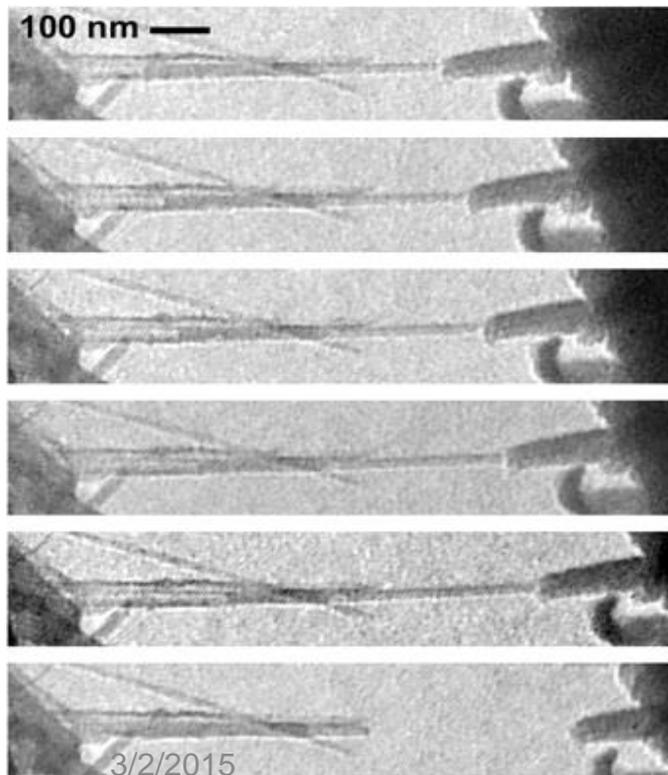
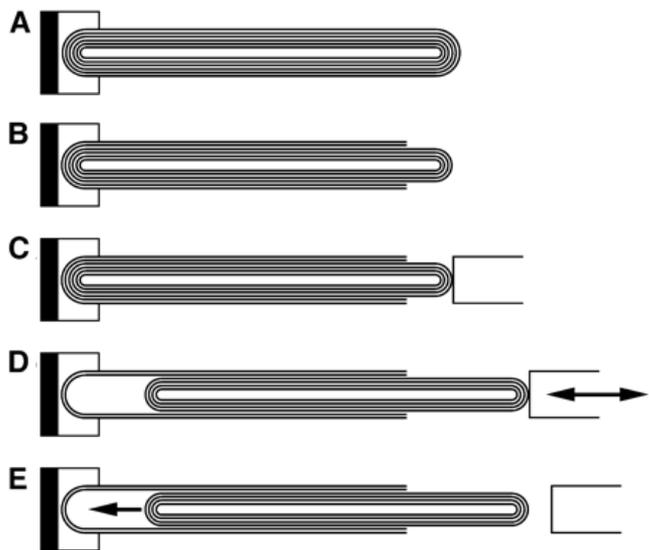


Recycling: Reverse Engineering

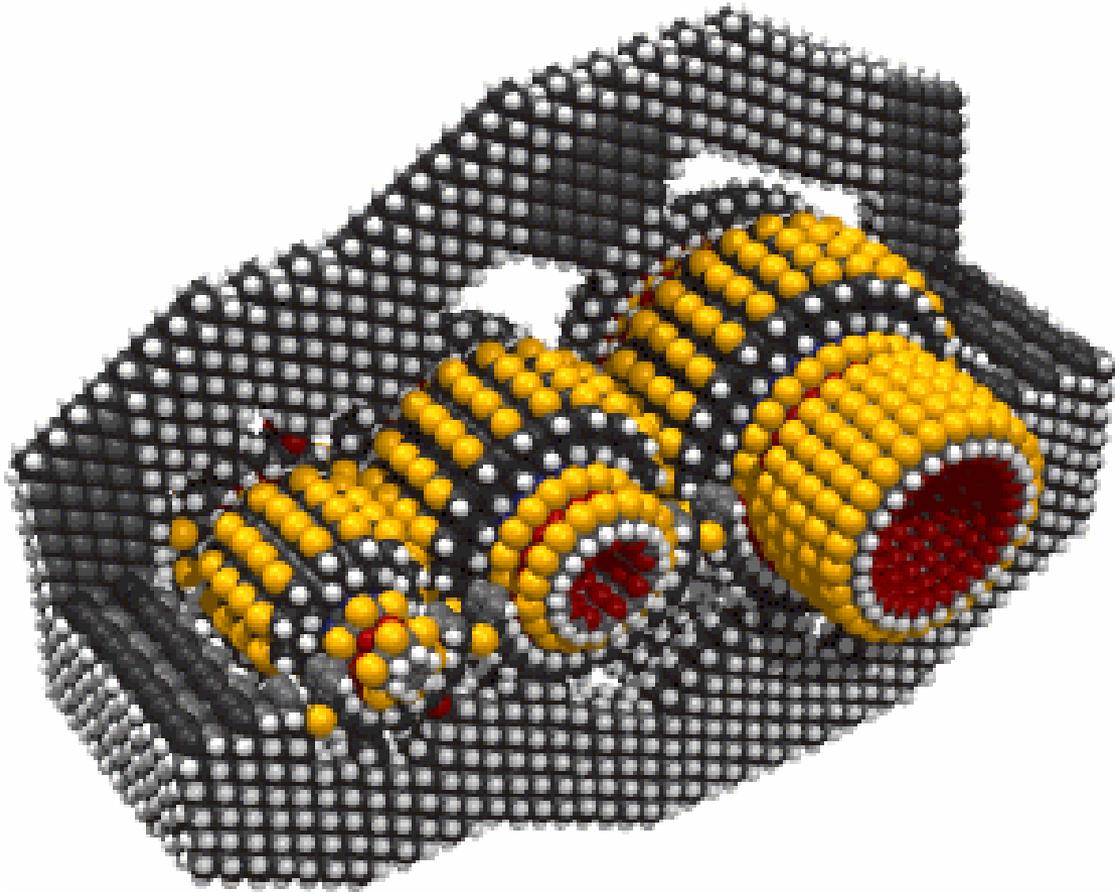
Over the next three years, 250 million •
computers are expected to become
obsolete.

[According to the Environmental Protection Agency]

Old PCs can quickly become quickly •
obsolete. A typical computer monitor, for
example, contains between 2 and 4 pounds
of lead, which can leach into the
groundwater in a landfill.



With 15,342 atoms, this parallel-shaft speed reducer gear is one of the largest nano-mechanical devices ever modeled in atomic detail.



**Thank you for
your attention!**