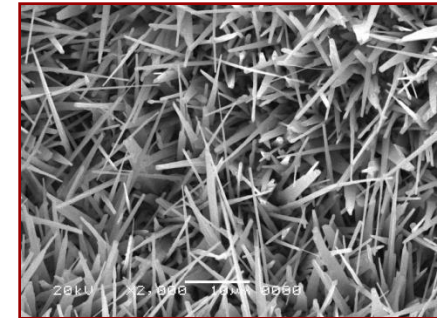
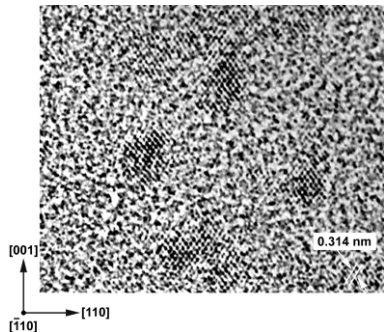


NANOTECHNOLOGY

it's impact on our present & future

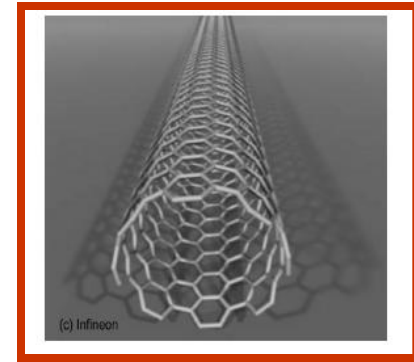
IEEE week (KFUPM)

11-6-1431 H



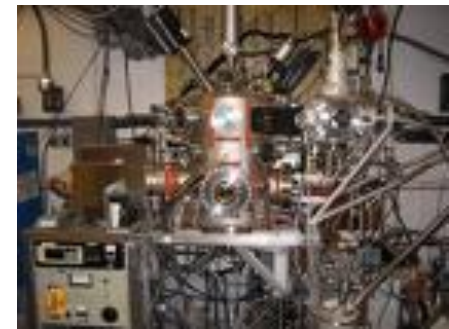
Zain H. Yamani
CENT Director
KFUPM



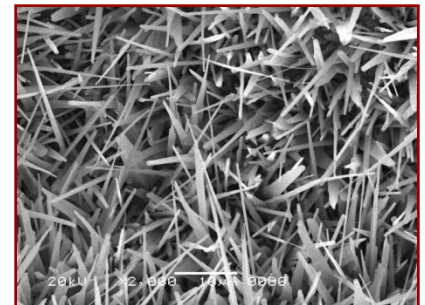


Outline

1. What do we mean by nanotechnology?
2. How is nanotechnology 'special'?
3. The impact of nanotechnology.
4. Nanotechnology R&D in the Kingdom.



What do we mean by nanotechnology?



What is “nano”

Nano: a prefix which means 1/1000,000,000

Nanometer = 1/1000,000,000 of a meter
= 1/1000,1000 of a millimeter
= 1/1000 of a micrometer



Less than a nanometer
Individual atoms are up to a few angstroms, or up to a few tenths of a nanometer, in diameter.



Nanometer
Ten shoulder-to-shoulder hydrogen atoms (blue balls) span 1 nanometer. DNA molecules are about 2.5 nanometers wide.



Thousands of nanometers
Biological cells, like these red blood cells, have diameters in the range of thousands of nanometers.



A million nanometers
The pinhead sized patch of this thumb (circled in black) is a million nanometers across.



Billions of nanometers
A two meter tall male is two billion nanometers tall.

Nanotechnology:

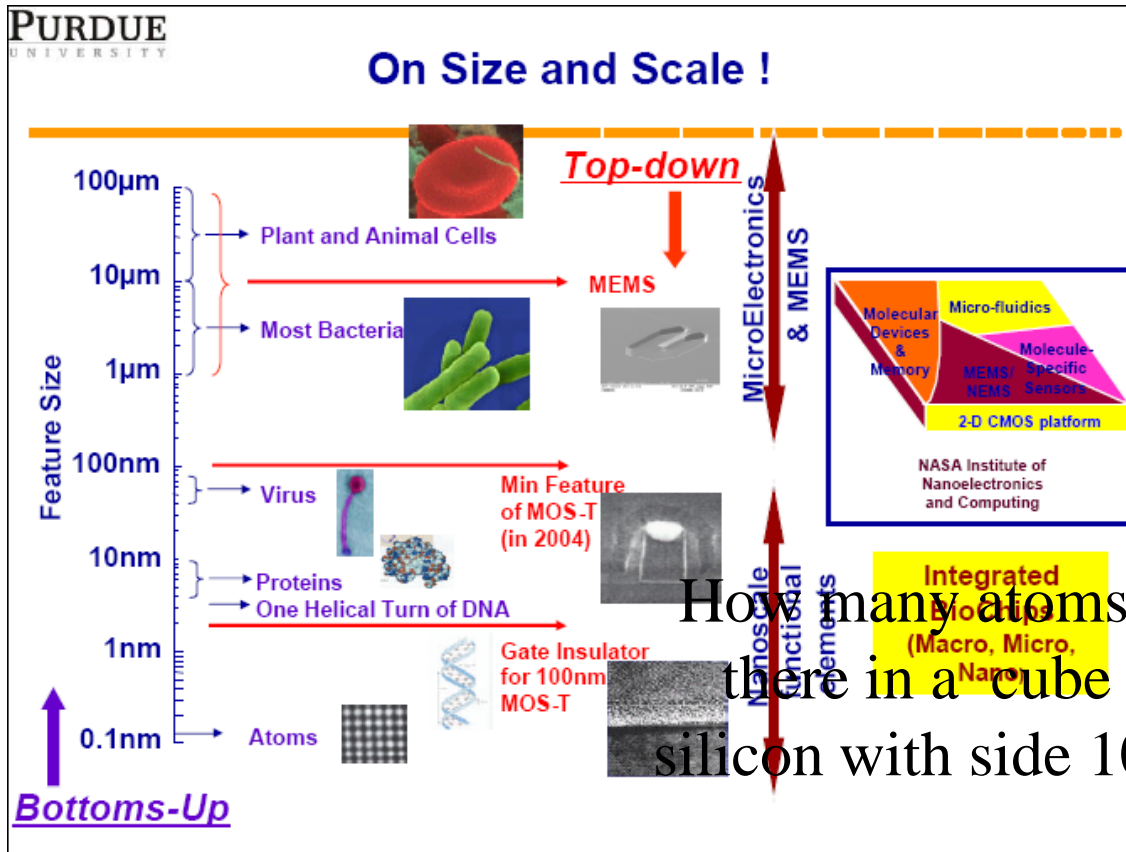
Nanotechnology is the understanding and control of matter at dimensions between approximately 1 and 100 nanometers, where unique phenomena enable novel applications.

Encompassing nanoscale science, engineering, and technology, nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale.

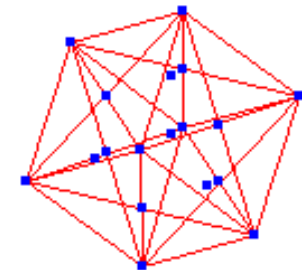
<http://www.nano.gov/html/facts/whatIsNano.html>

Nanometer, Nanogram, Nanonewton,
Nanojoule, Nano..

Imagine the nano-scale



How many atoms are there in a cube of silicon with side 10 nm



Not one atom, but many
(many) atoms

How is nanotechnology 'special'?

Optical qualities

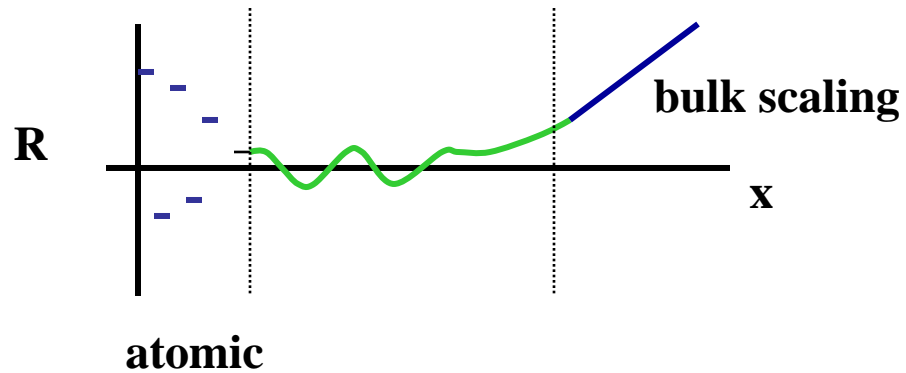


Bulk Gold = Yellow



Nanogold = Red

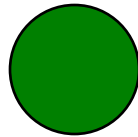
Quantum effects



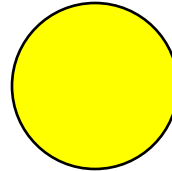
Small and Luminescent



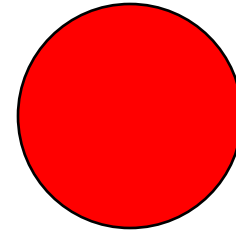
1 nm



1.67 nm

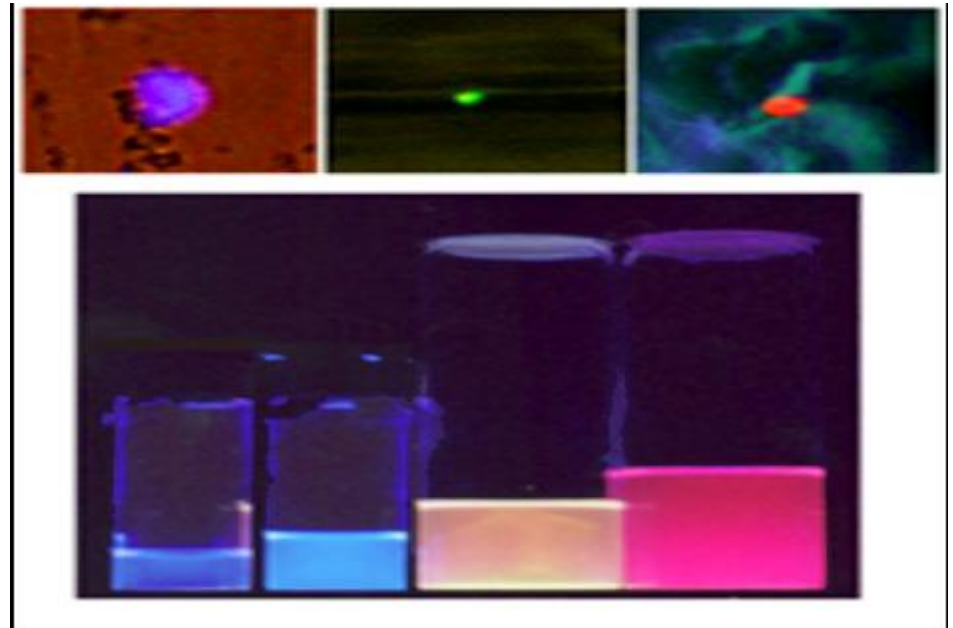
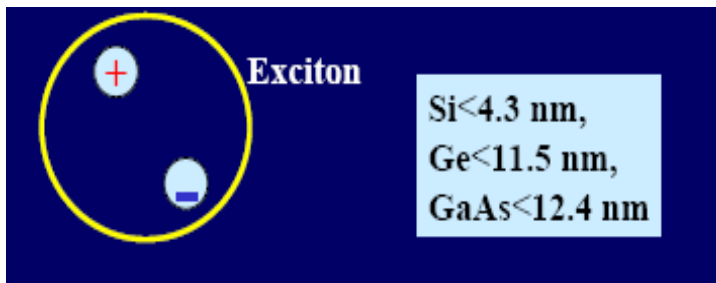
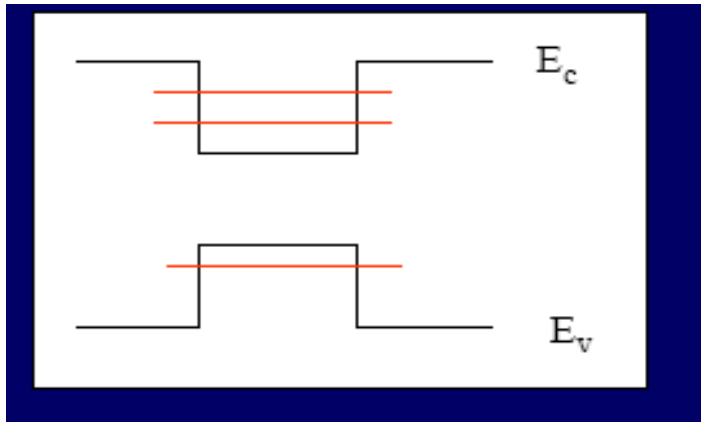


2.15 nm



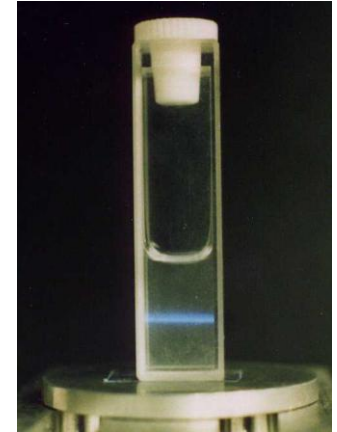
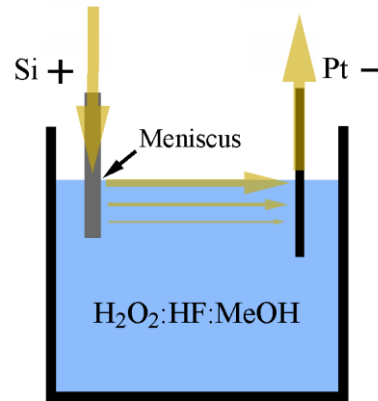
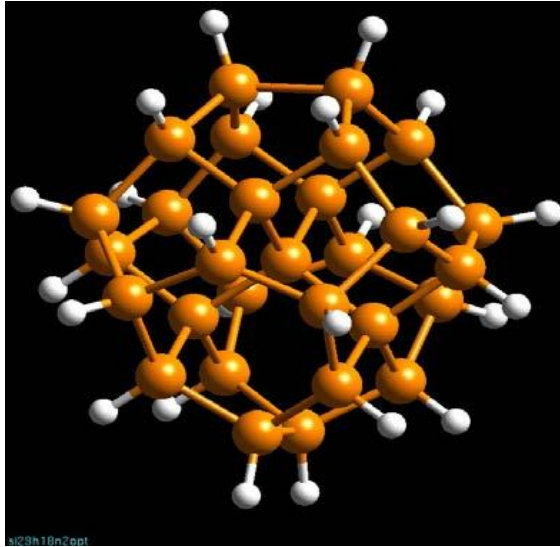
2.9 nm

Sizes



Silicon Nanoparticles

Nayfeh/ Yamani et. al (physics)



Z. Yamani, H. Thompson, L. AbuHassan, and M. H. Nayfeh , Appl. Phys. Lett. **70**, 3404-3406 (1997)

M. Nayfeh, J. Therrien, and **Z. Yamani: Method for producing silicon** nanoparticles, US 6,585,947 with a publication date of July 1, 2003.

M. Nayfeh, J. Therrien, and **Z. Yamani: "Silicon Nanoparticle and Method for Producing the Same"** 6,846,474; January 25, 2005.

Silicon nano-crystallite synthesis, characterization,
 functionalization, applications, computation

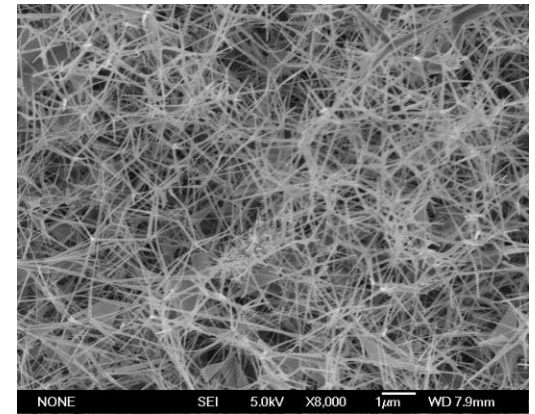
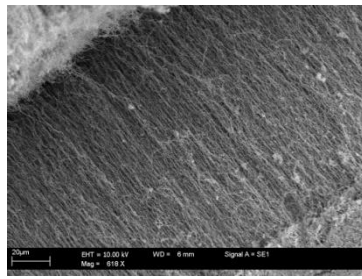
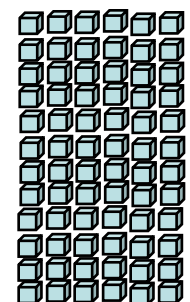
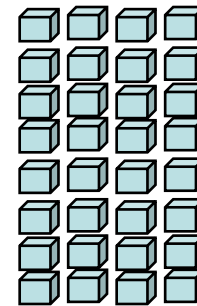
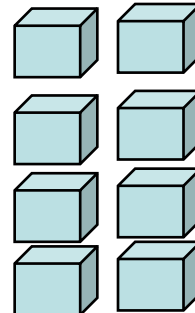
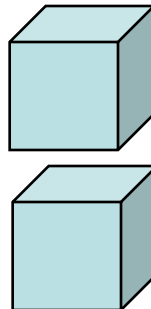
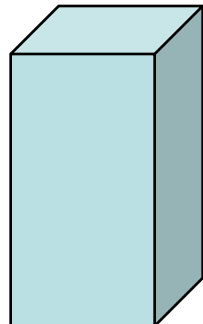


Table 1
The relation between the total number of atoms in full shell clusters and the percentage of surface atoms (reprinted from [5] with permission from John Wiley & Sons)

Full shell clusters	Total number of atoms	Surface atoms (%)
One shell	13	92
Two shells	55	76
Three shells	147	63
Four shells	309	52
Five shells	561	45
Seven shells	1415	35

Extremely important for catalysis, sensors, purification and the like.

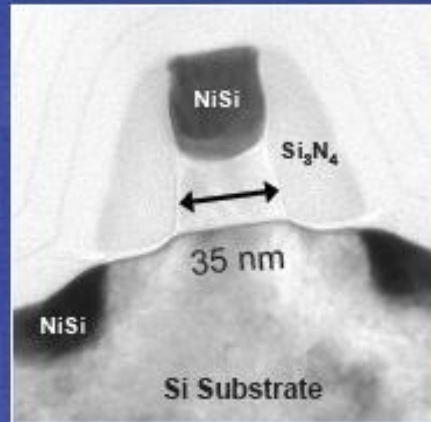
Specific surface



Larger number of smaller devices that consume less energy

2005

- 35 nm gate length
- 1.2 nm gate oxide
- NiSi for low resistance
- 2ND generation strained silicon for enhanced performance



~ 350 Million Transistor Chip

ENIAC, 1945

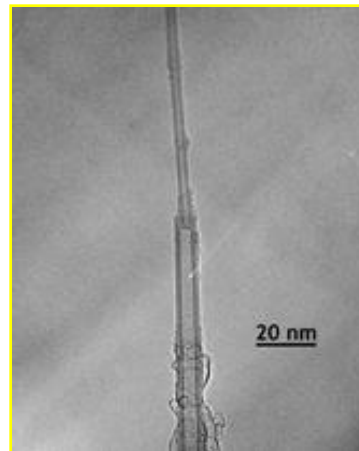
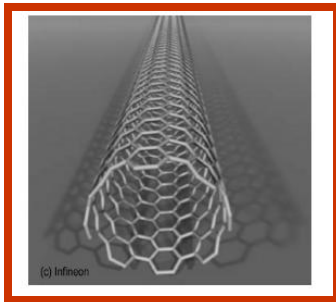


DNA delivery

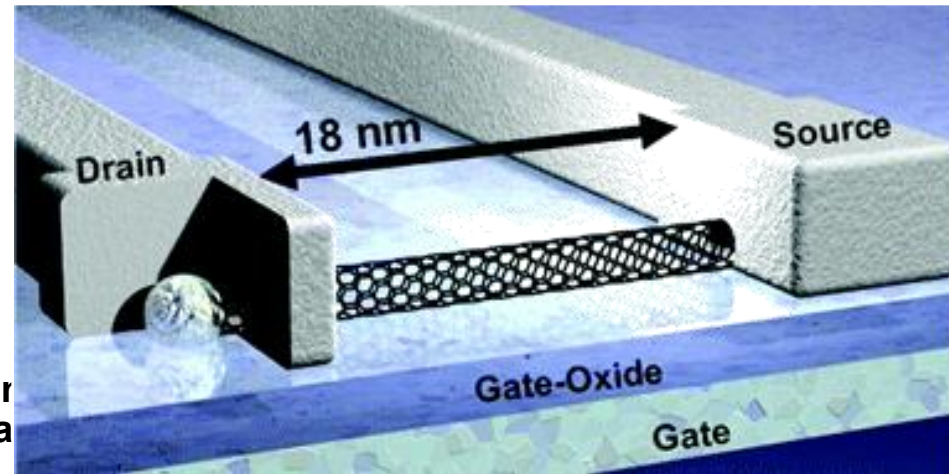
27,000 kg
1800 vacuum tubes
140kW

CNT: Very light/ very strong

Ijima, 1991



Nar
 “va



Seidel et al Nano-letters- Vol. 5, 1, (2005) 147

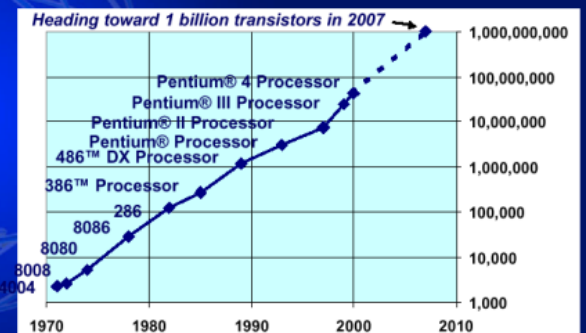
video

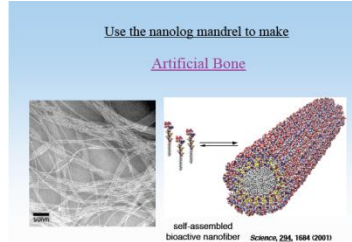
The impact of nanotechnology



Moore's Law Continues

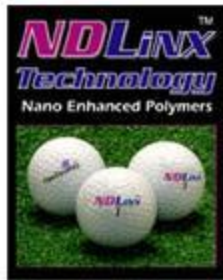
Transistors doubling every 2 years toward the billion-transistor microprocessor





Energy/ photovoltaics

**Membranes/ water
purification**



Add to Cart



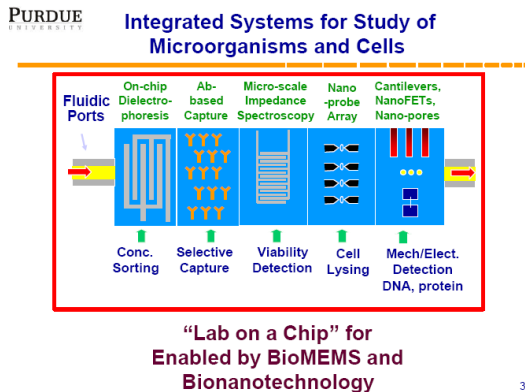
**Porous material/
hydrogen storage**



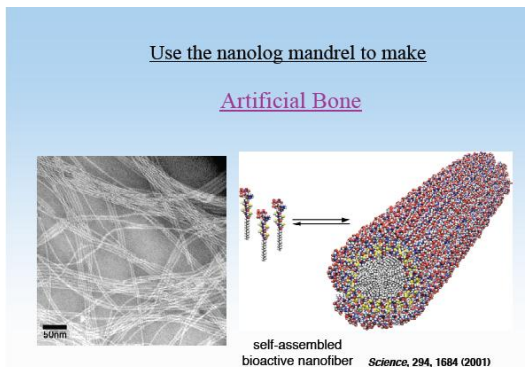
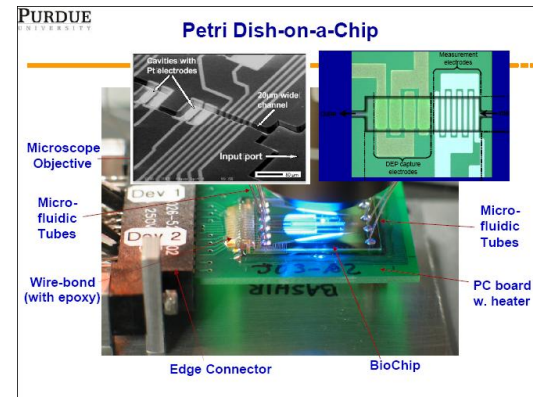
Nano-engineered catalysis

Petrochemicals/ fuel cells

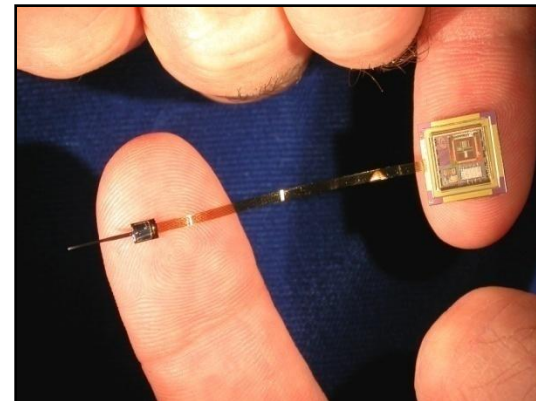
in medicine.. diagnostic and therapeutic



38



Nanoscale “vacuum tube”



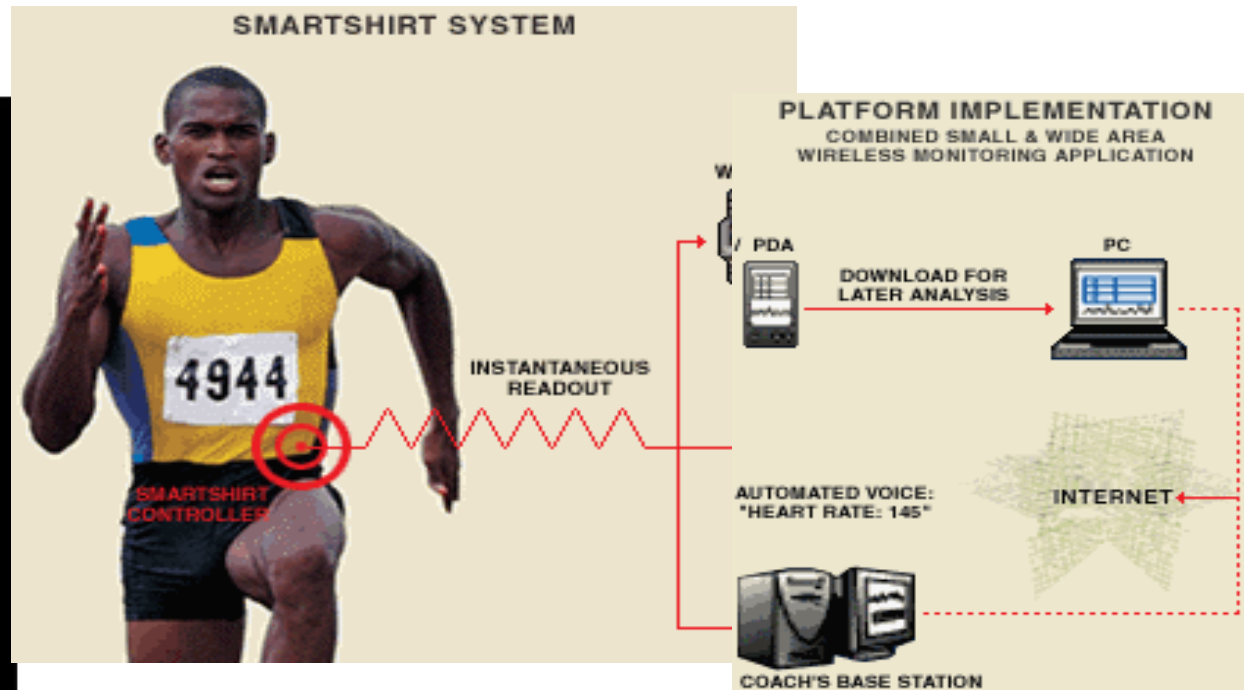
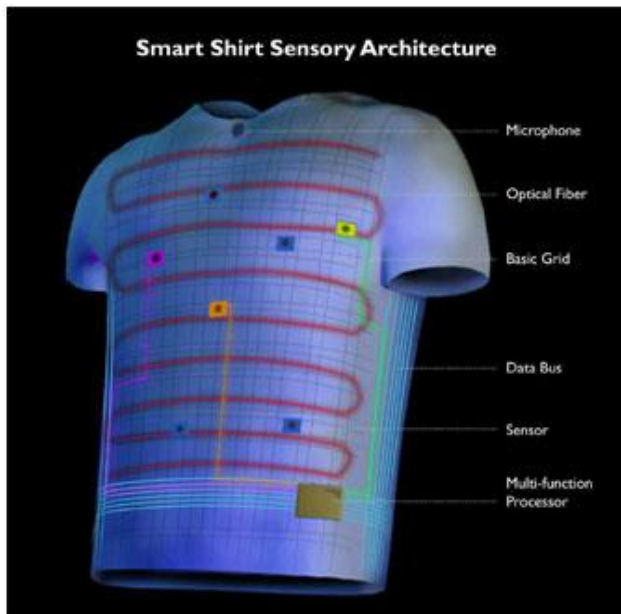
DNA delivery

Developing a nanotechnology anti-militant "bionic hornet"

Israel is using nano technology to try to create a robot no bigger than a hornet that would be able to chase, photograph and kill its targets, an Israeli newspaper reported on Friday.

The flying robot, nicknamed the 'bionic hornet', would be able to navigate its way down narrow alleyways to target otherwise unreachable enemies such as rocket launchers, the daily Yedioth Ahronoth said.

Sports clothes: mandatory safety!



Nano-bots

How Nanorobots Will Work

by Jonathan Strickland

Print Cite Feedback Share Recommend

Inside this Article

1. Introduction to How Nanorobots Will Work
2. Take Two Bots and Call Me in the Morning
3. Nanorobot Navigation
4. Powering the Nanorobot
5. Nanorobot Locomotion
6. Teeny, Tiny Tools
7. See more »

How Its Made Videos

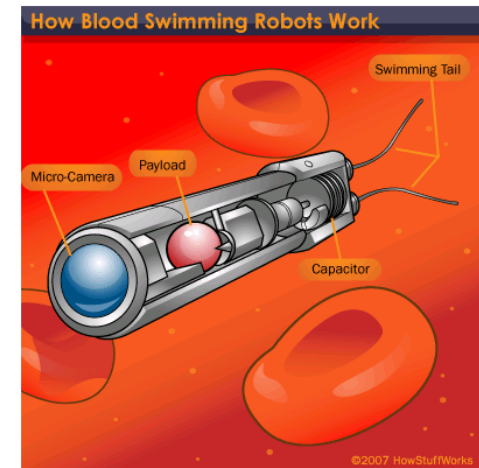


Play Video

More Science Videos »

Imagine going to the [doctor](#) to get treatment for a persistent fever. Instead of giving you a pill or a shot, the doctor refers you to a special medical team which implants a tiny [robot](#) into your [bloodstream](#). The robot detects the cause of your fever, travels to the appropriate system and provides a dose of medication directly to the infected area.

Robot Image Gallery



The robot in this illustration swims through the arteries and veins using a pair of tail appendages.

<http://electronics.howstuffworks.com/nanorobot.htm>

Biomimetics

http://www.spacemart.com/reports/Nano_World_Water_Harvesting_Surfaces.html

The Future of Nanotechnology

The future of nanotechnology is completely uncharted territory. It is almost impossible to predict everything that nanoscience will bring to the world considering that this is such a young science.

There is the possibility that the future of nanotechnology is very bright, that this will be the one science of the future that no other science can live without. There is also a chance that this is the science that will make the world highly uncomfortable with the potential power to transform the world.

The Future of Nanotechnology

DDT cured malaria



Toxic to animals

Pesticides improved crop yields



Human carcinogens

Refrigerants made houses cool



Lead to ozone hole

Nanotechnology



????

Nanotechnology R&D in the Kingdom

KAU

KAIN

KAUST

KACST/ CENA

universities

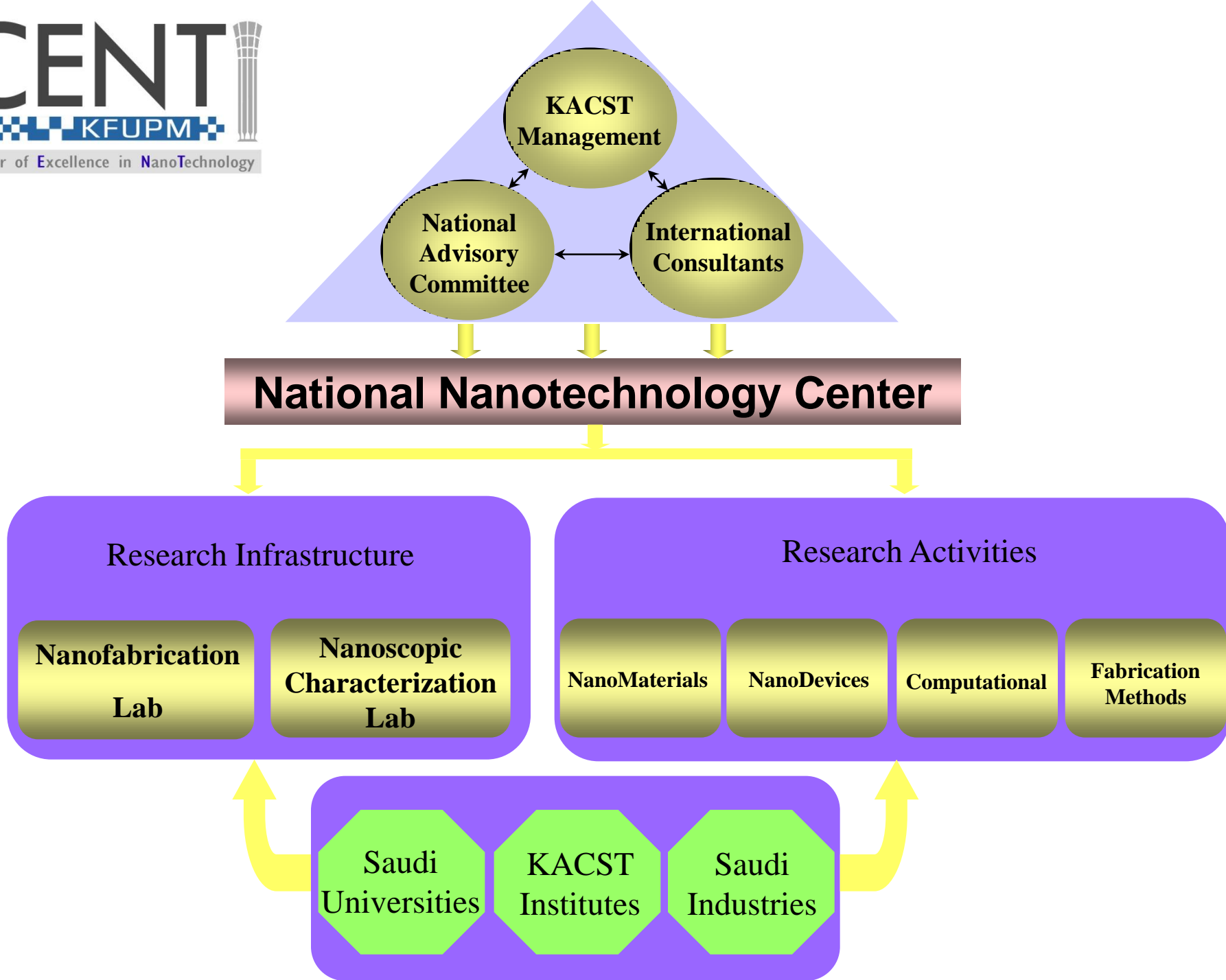
CENT

NSTP

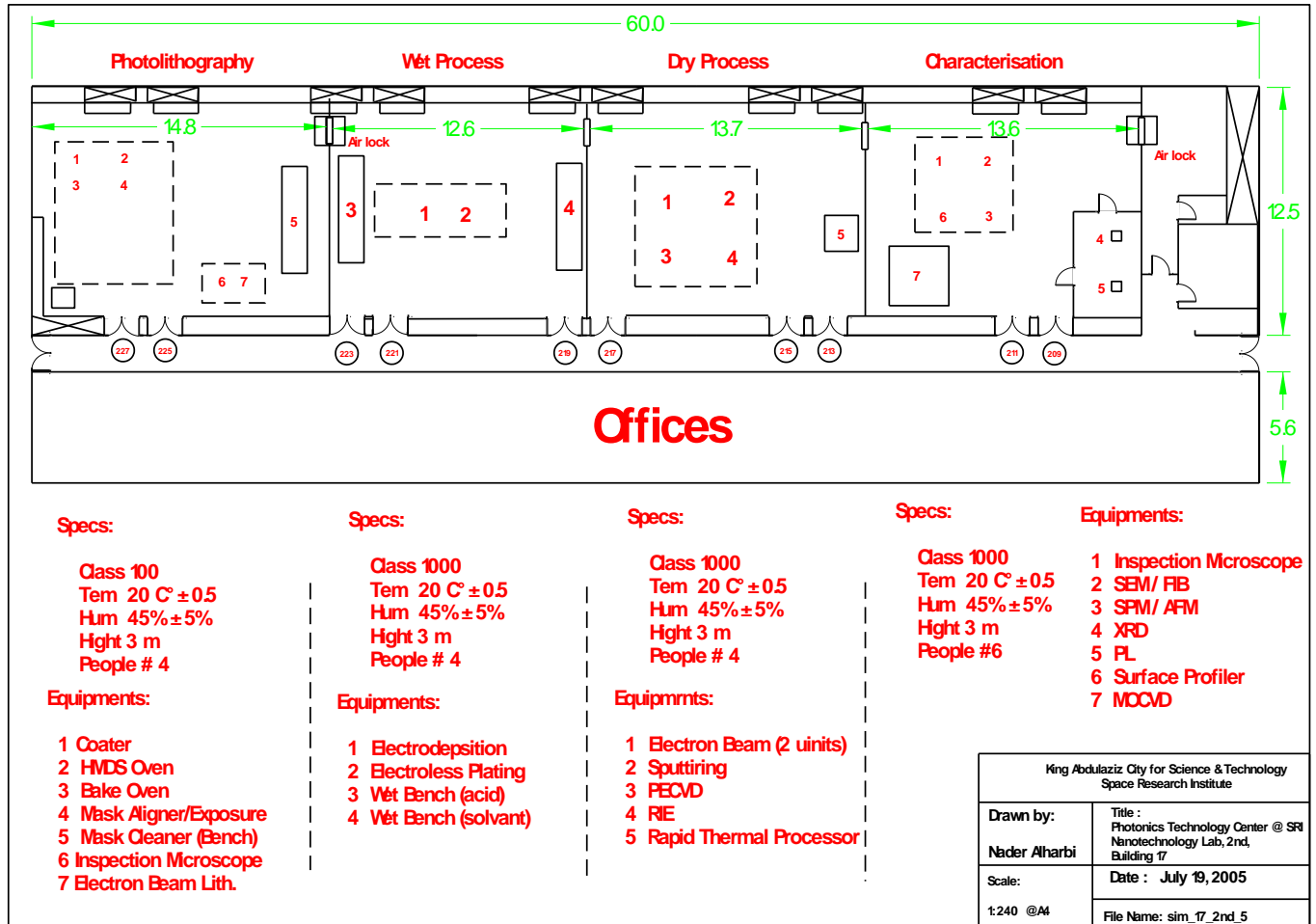


- تشكيل صناعة المستقبل وتعزيز عناصر استمرار التنمية بأبعادها الحقيقية
- طريقا إلى تبوأ المملكة مكانة مرموقة على المستويين العلمي والتعليمي
- تفعيل كافة الجوانب البحثية للتطبيق العلمي في مشروعات المملكة التنموية
- أن تصبح التقنية الحديثة إحدى الركائز الصناعية

[illegible]



NNC Laboratory Layout



NNC Laboratory Layout



AFM/SPM



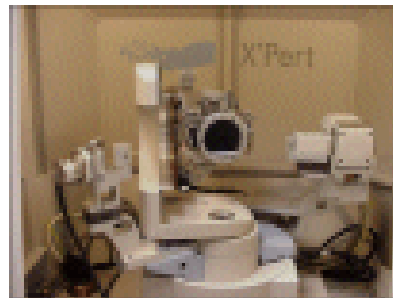
Photo resist coater/developer bench



E-beam evaporator



ECV Doping profiling



X-Ray



RTP

Where are we?

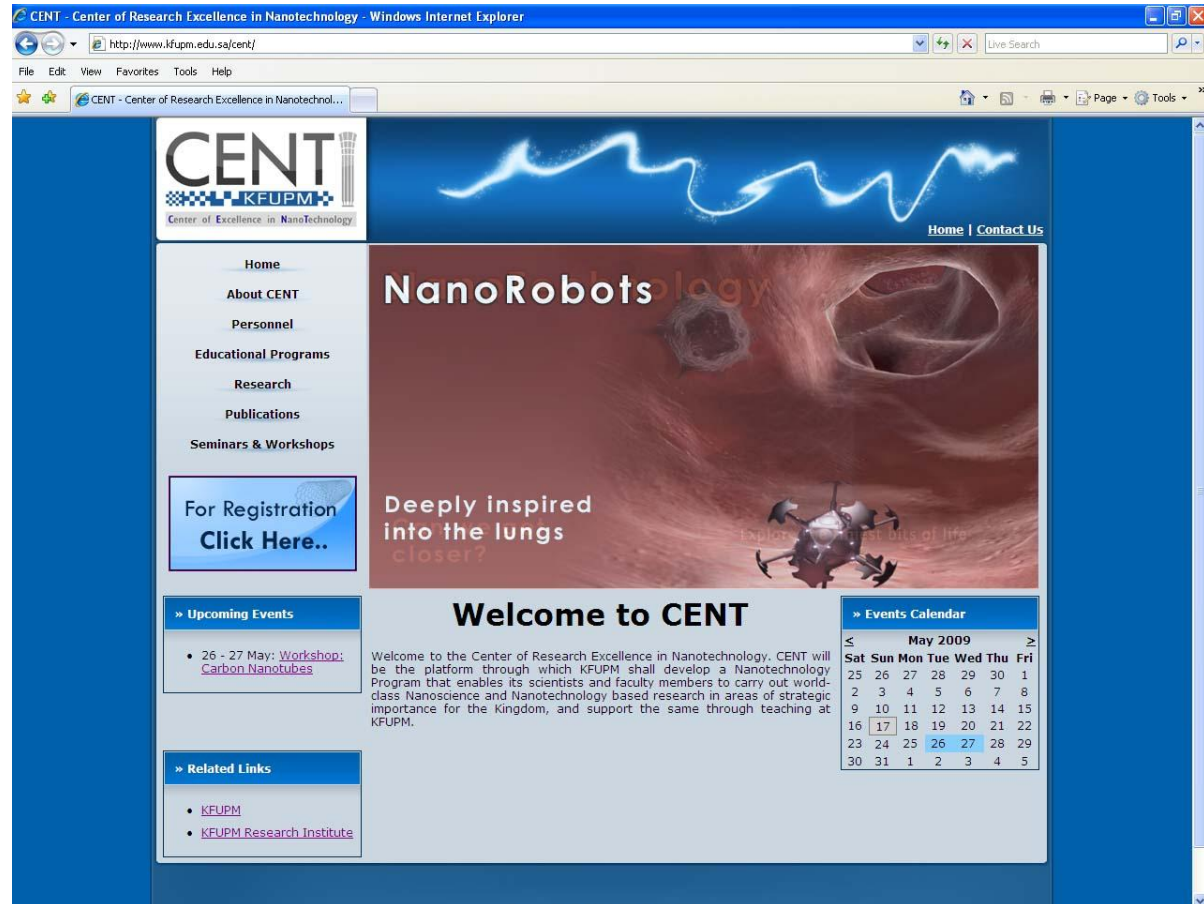
CENT is here!!!!



What is CENT?

Center of Excellence in NanoTechnology

Check our website



www.kfupm.edu.sa/cent

CENT: Vision and Mission

Vision:

CENT shall be an internationally recognized leading research center that develops innovative research and cutting edge knowledge in the field of Nanoscience and Nanotechnology

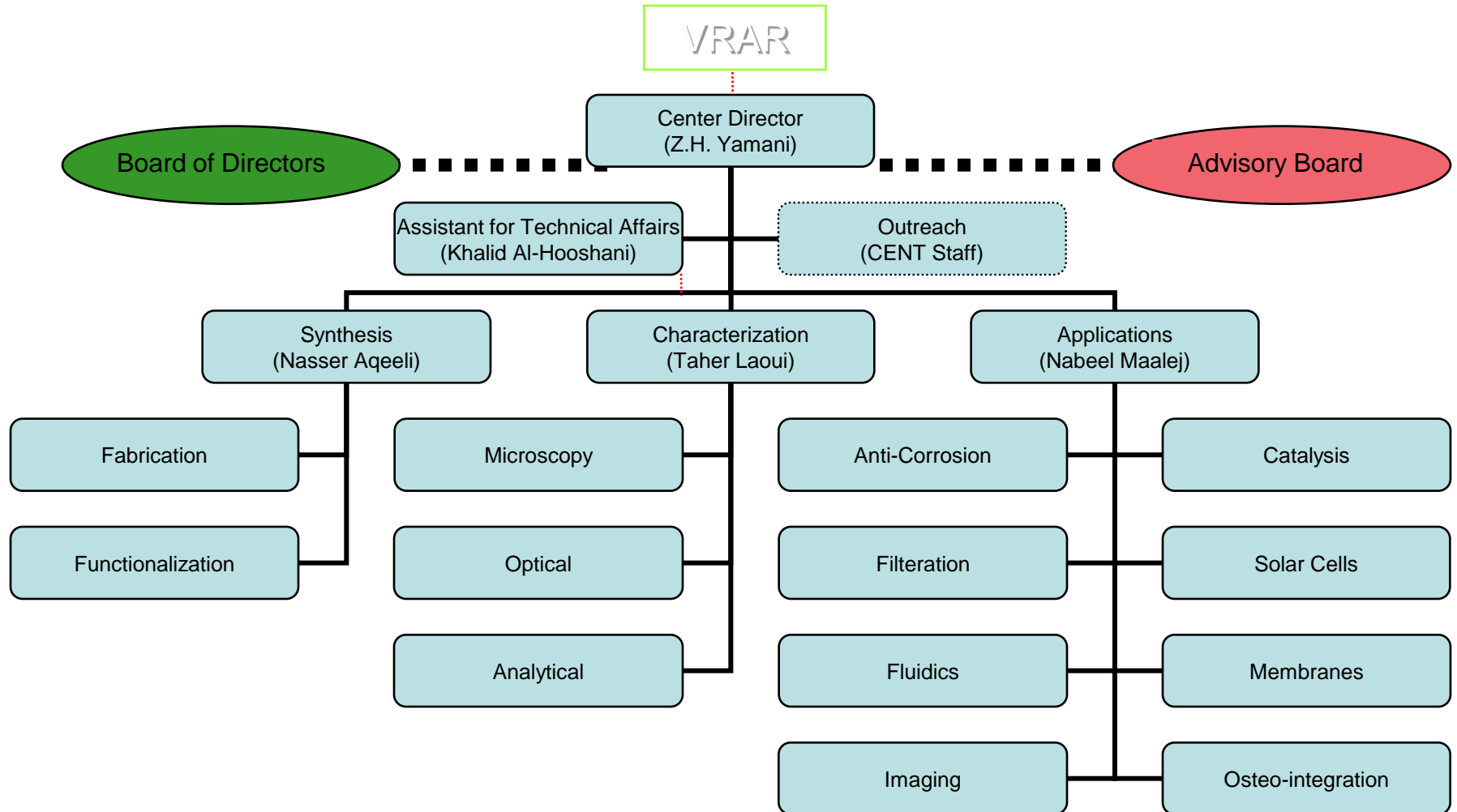
Mission:

CENT will be the platform through which KFUPM shall develop a Nanotechnology Program that enables its scientists and faculty members to carry out world-class Nanoscience and Nanotechnology based research in areas of strategic importance for the Kingdom, and support the same through teaching at KFUPM.

CENT: Objectives

1. To build up a world class human resources research capacity including highly qualified scientists and staff and trained graduate students in the field of nanomaterials synthesis and their characterization & applications.
2. To develop a research infrastructure including state of the art facilities that enables the Center to achieve its goals.
3. To develop innovative nanotechnology-based solutions in strategic areas for the Kingdom related mainly to petroleum and petrochemical industries.
4. To establish Industrial Partnerships with relevant companies and entrepreneurships as a step toward commercialization, in coordination with DTV.
5. To contribute to the development of teaching graduate programs and training students in the field of nanotechnology.
6. To promote public awareness regarding the benefits and the risks of nanotechnology.

CENT Structure



CENT Areas of Focus

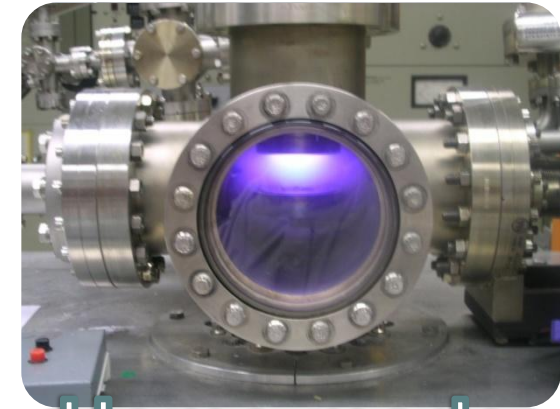
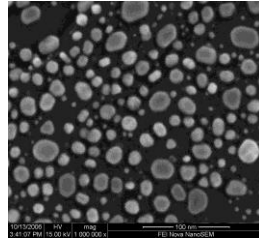
focusing on the petroleum and petrochemical industries.

- 1. Nano-engineered Catalytic Materials**
- 2. Nano-structured Materials for Sensing Applications**
- 3. CNT Applications**

Equipment

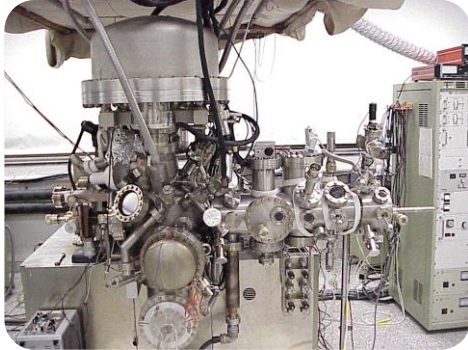
XPS

XRD



Home-made
DC-Magnetron

TEM



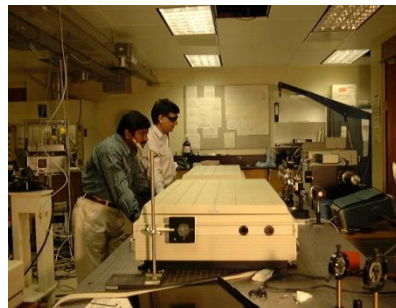
SEM

AFM/ STM

Lasers



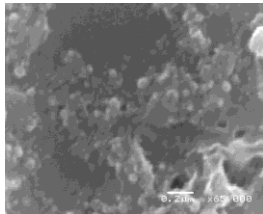
PVD/ CVD



AFM/STM

Synthesis, characterization and applications of nanostructured materials

We use different synthesis methods: CVD, laser ablation, sputtering, flame pyrolysis, [laser pyrolysis], microwave combustion, sol-gel, chemical dispersion and functionalization

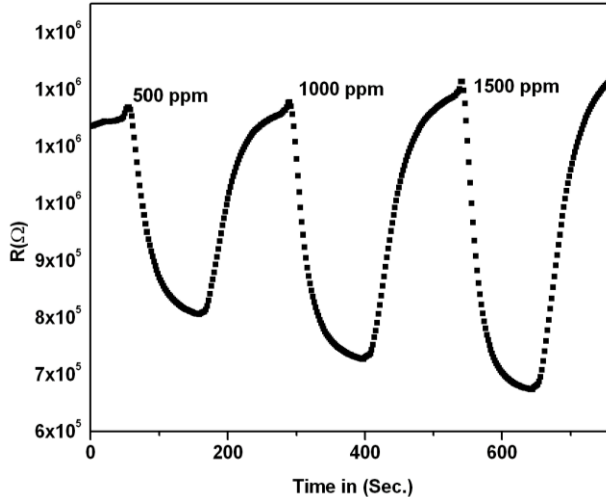


Laser and Nanotechnology

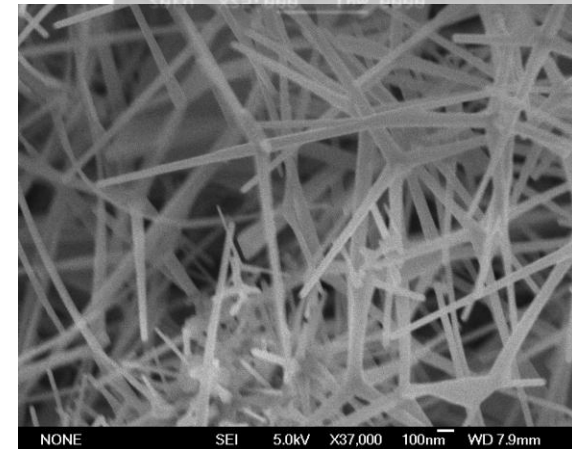
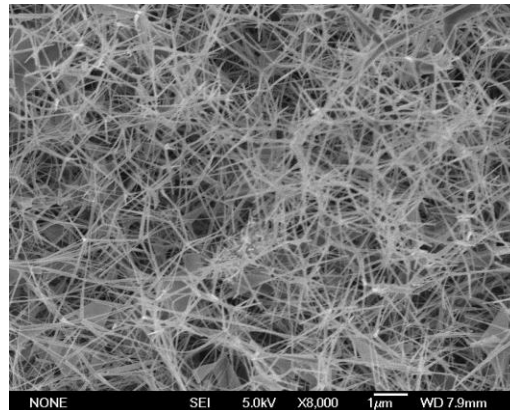
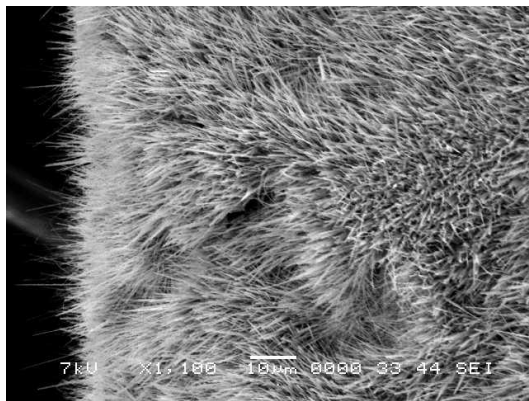
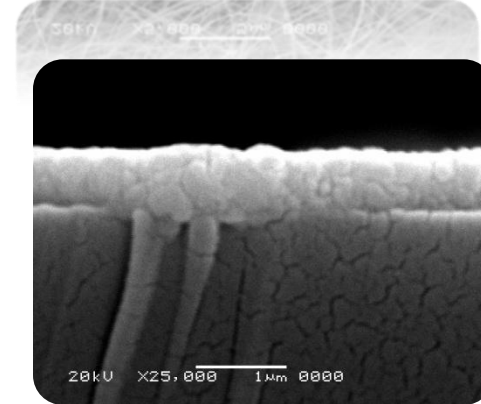
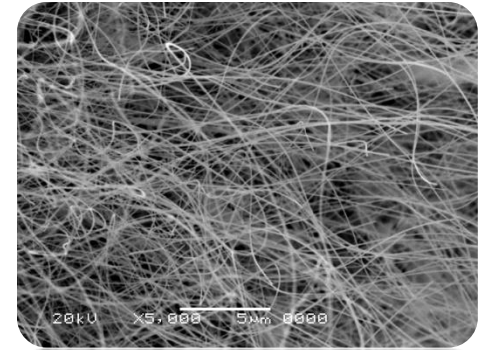
Zinc Oxide Nanowires/ Nanodots

N. Tabet et. al (Physics & CENT)

Dynamic and fast
response of MW ZnO
nanowires to H_2 gas at
different temperatures

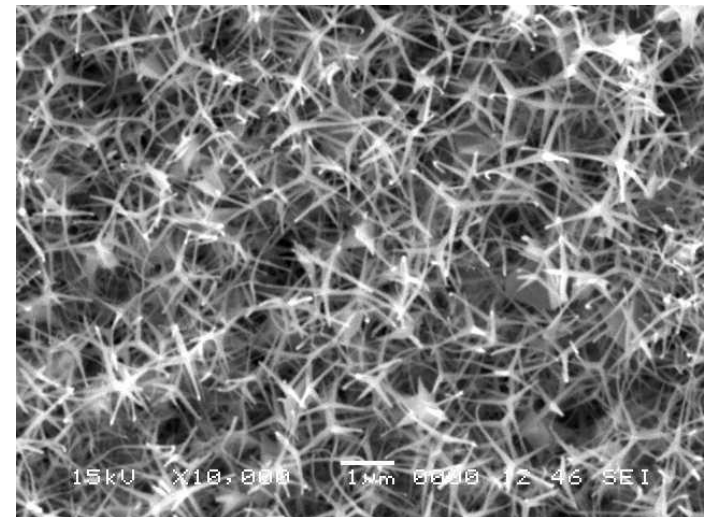
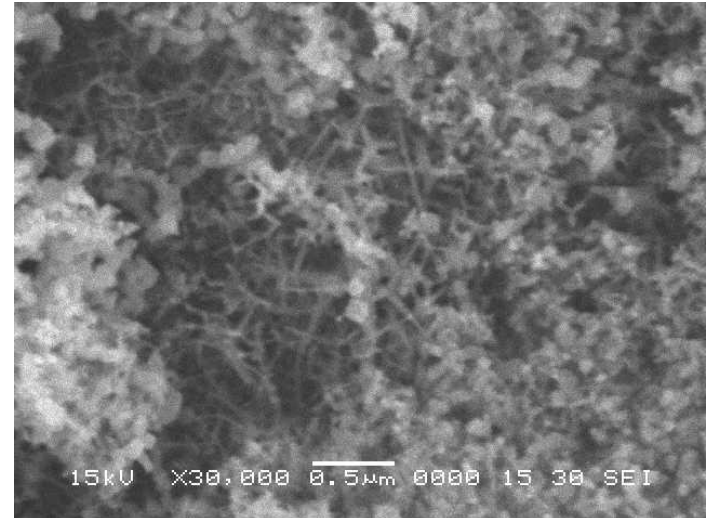
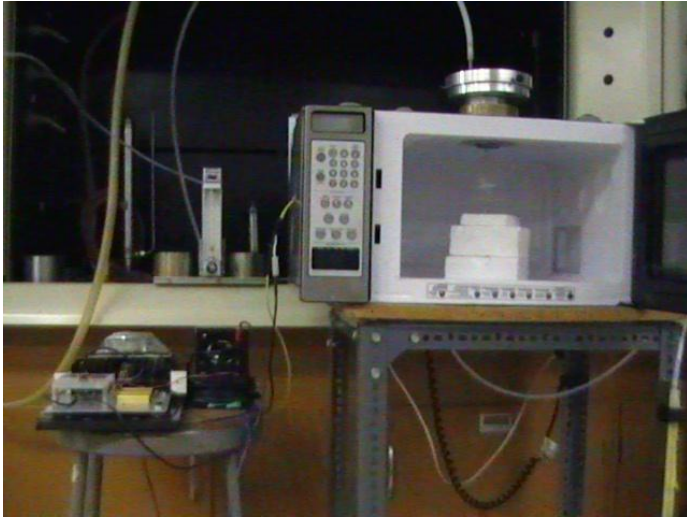


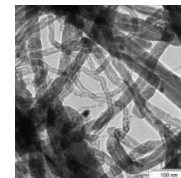
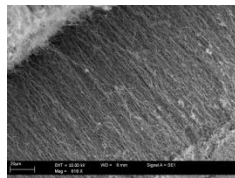
Operating temp. 200°C temp.
Measured by Dr Ahsan,
Tokayama, Japan, Oct. 2008.
Unpublished



VIDEO

*Flame Pyrolysis and
Microwave Combustion*
Saleh Al-Quraishi/ N. Tabet





Carbon Nanotube Research Unit (CNRU)

PhD and MSc Students working under CNRU

Issam Amr (PhD. Student)

Zahid Koker (PhD. Student)

Omar Bakather (MSc. Student)

Osama Bin Dahman (MSc. Student)

Mahmoud Ghassan Halim (MSc. Student)

Salaman Al-Khaldi (MSc. Student)



On-going CENT projects (2008-2010)

#	Title	Focus Area	PI	e-address
1	<u>Biocide properties of novel polyelectrolytes nanofilms</u>	Nano-Bio	Mazen Khaled	mkhaled@kfupm.edu.sa
2	<u>Production of Carbon Nanotubes (CNTs) by using Gas/Solid Atomizer Chemical Vapor Deposition (GSA-CVD) for Nanocomposite Application</u>	CNT	Mo'taz Ali	motazali@kfupm.edu.sa
3	<u>Study of the Structural Properties and Hydrodesulfurization Activity of MoS₂ and Co/MoS₂ Catalysts Prepared by Laser Pyrolysis</u>	Catalysis	Zain Yamani	zhyamani@kfupm.edu.sa
4	<u>Development of High Performance CNTs and SiC Reinforced Metal Matrix Nanocomposites for Pistons Applications</u>	CNT/ Corrosion	Saheb Nouari	nouari@kfupm.edu.sa

Other Activities/Programs Maintained by CENT

- Strengthening Collaborations
- Hosting seminars and organizing workshops.
- Visiting professors (B. Ahsan, Zerkov)
- Participation in scientific events

- Kick-Off
- DLS
- Veeco

- Computational G

- Professor Ian Bruce (Kent University)
- Dr. Paulo Morais is the head of the Brazilian Nanobiomagnetism Network (BNN) through S. Aramco/ Naizak
- Dr. Mark Geoghegan (Sheffield University)
- Professor Edward Cupoli (CNSE NanoEconomics Constellation Head) through Arba7 Capital
- Gregory Lance (Hystiron) through Naizak
- Jim Tour (Rice University)
- Stephan Podzimek (Wyatt Technology, USA)
- Mohammad Rab'ah (KFUPM)
- Ahsanul-Haqq (Material Engineering Toyama University Japan)
- Zain Yamani (CENT)
- Many more.. [check web-site]

Other Activities/Programs Maintained by CENT

Bi-weekly seminars:

-Al-Somali, Bani-Yaseen,
Ahmad Omar, ...etc.

Publishing papers

Patent Applications:

MK, SQ, NT, MA, ...

Visiting professors:

- Syed Qadri (NRL,USA)
- Collaborators/ Consultants

CENT Affiliates Meetings

Developing CENT labs on campus

Increasing Capacity

Workshops under preparation:

- CNT Applications
- X-ray Characterization Techniques

Graduate Program

More inter-Centers collaborations

Collaborations potentially with:

DuPont, Dow Chemicals, S. Aramco, SABIC

KAUST, KACST, KSU, Taibah, KFU,...etc

We'd be happy to add you to Friend's of
CENT (e-)mailing list.

Just sent us a note: cent@kfupm.edu.sa

Thank you for your attention