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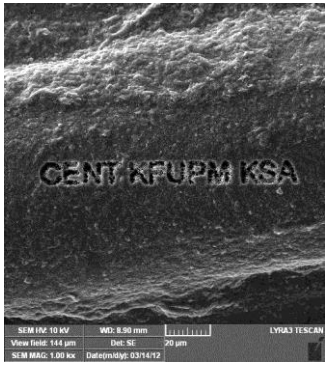
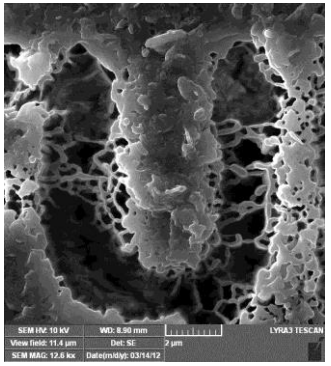
Short course:

Introduction to Nanotechnology





Zain Yamani
Center of Excellence in NanoTechnology, Director

19-22 Rabi-II, 1436

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Course Outcomes:

- Appreciate dimensions at the nano-scale.
- Understand how current technologies are improved through nanotechnology.
- Develop awareness about nanotechnology in the Kingdom of Saudi Arabia.
- Handle a scanning probe microscope.

Course Content:

Topic	# of hours
What is Nanotechnology: definition, fields of science, special characteristics, misconceptions, relevance to science and technology	4
Synthesis and Characterization of Nanomaterials	3
Nanotechnology at KFUPM and in the Kingdom	2
Hands on: atomic force microscopy	1

Some issues we will address

What is this course about, and the learning outcomes?

What is nanotechnology

Imagining the small size in some pictures

What is special about NT?

How NT is interdisciplinary

Has NT entered the market?

NT materials

Some questions we will address

NT devices

NT misconceptions

Physics at the nano-scale

Synthesizing nanomaterials

Characterizing nanomaterials

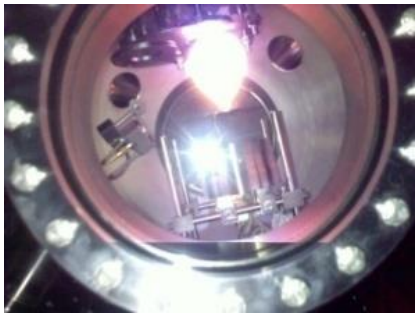
Nanotechnology and microscopy

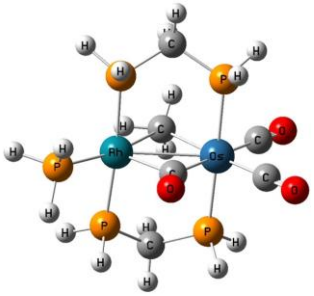
SPM in class

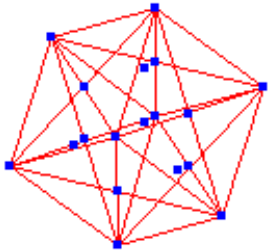
Some questions we will address

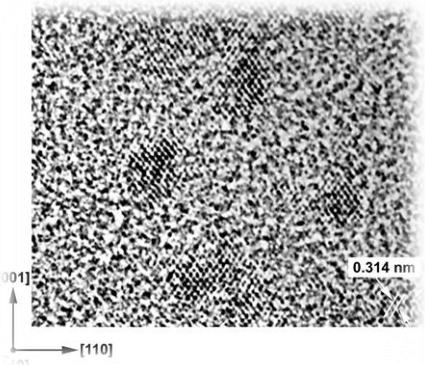
NT in NSTIP

NT at KFUPM [CENT and otherwise]









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What is Nanotechnology: **definition**, fields of science, special characteristics, misconceptions, relevance to science and technology

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Introduction to Nanotechnology:

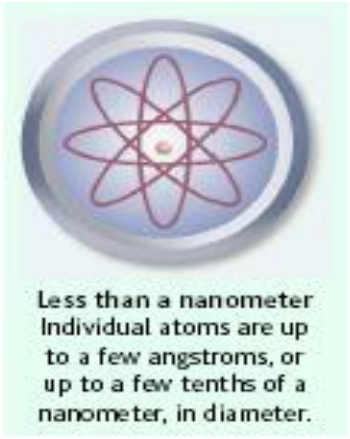
Nano: a prefix which means 1/1000,000,000

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

= 1/1000,000 of a millimeter

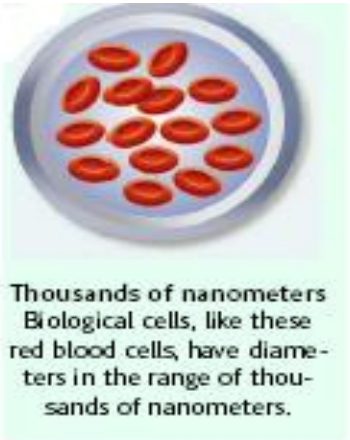
= 1/1000 of a micrometer

Nanometer, Nanogram, Nanonewton, Nanojoule, Nano..

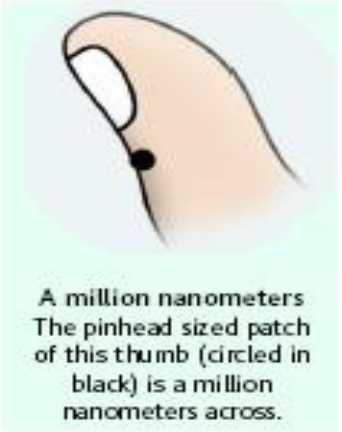


Less than a nanometer
Individual atoms are up to a few angstroms, or up to a few tenths of a nanometer, in diameter.

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



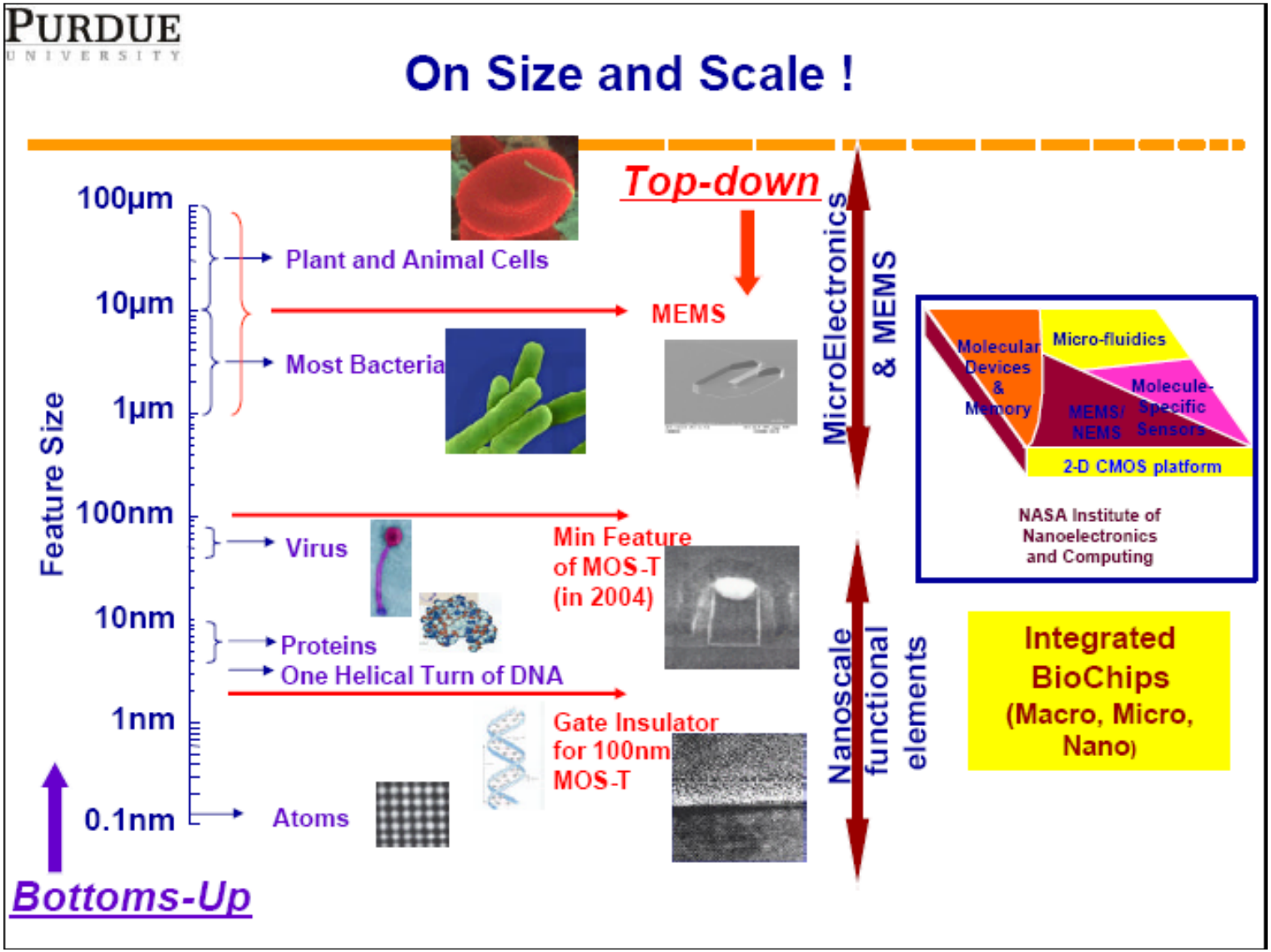
Thousands of nanometers
Biological cells, like these red blood cells, have diameters in the range of thousands of nanometers.

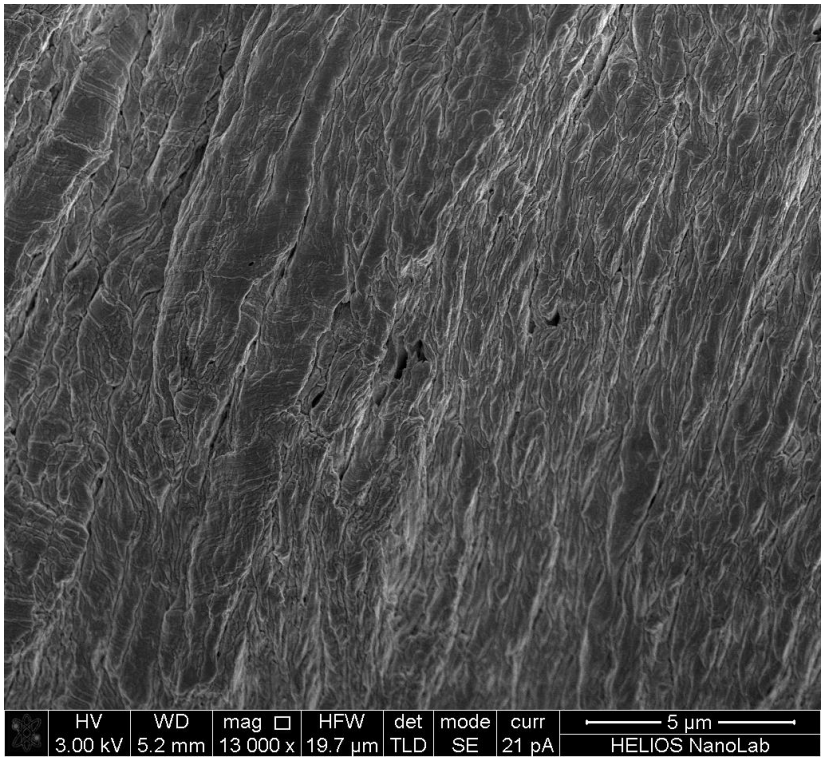


A million nanometers
The pinhead sized patch of this thumb (circled in black) is a million nanometers across.

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

Introduction to Nanotechnology:

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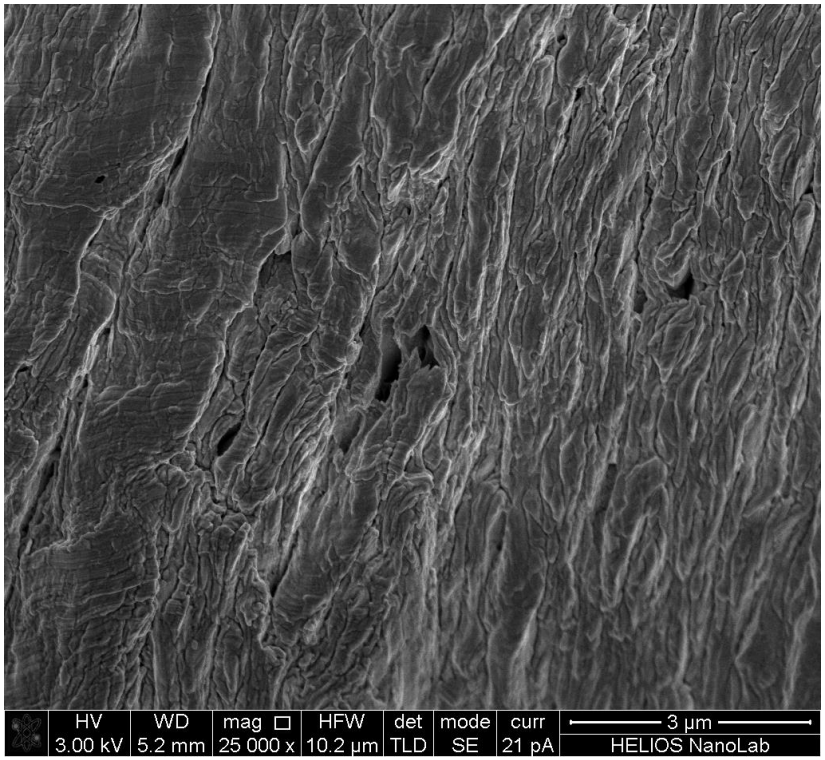
HELIOS NanoLab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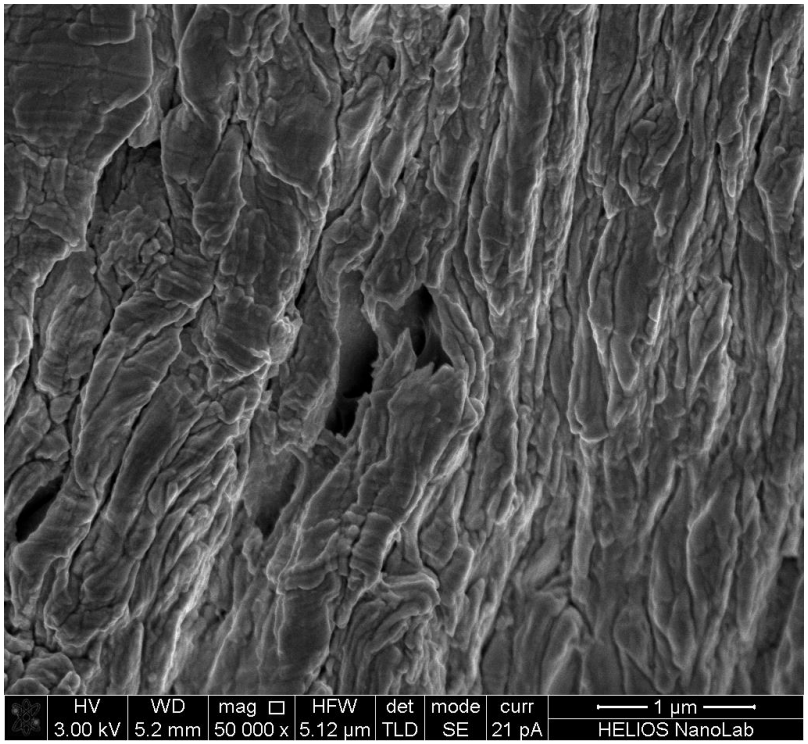

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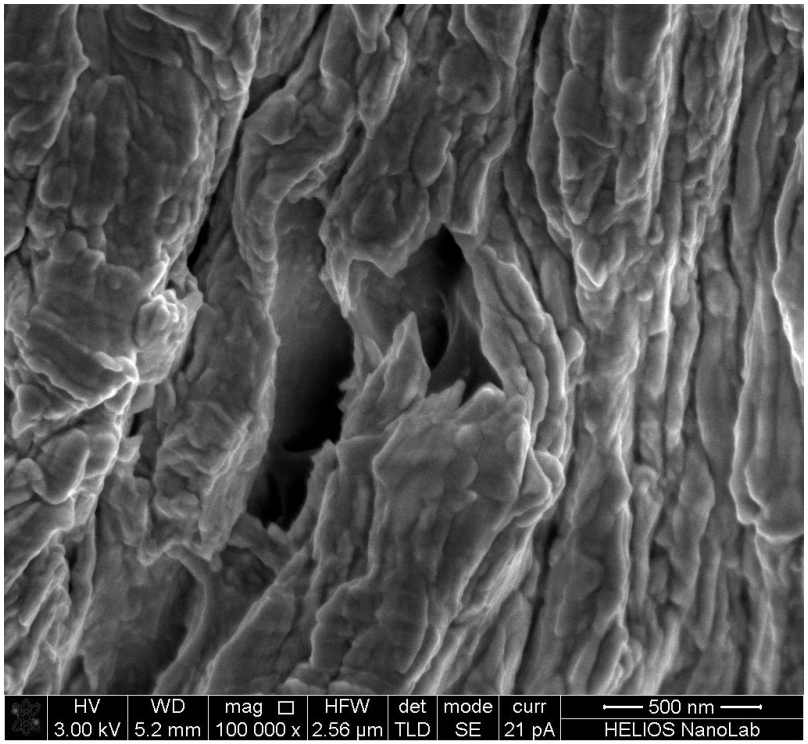

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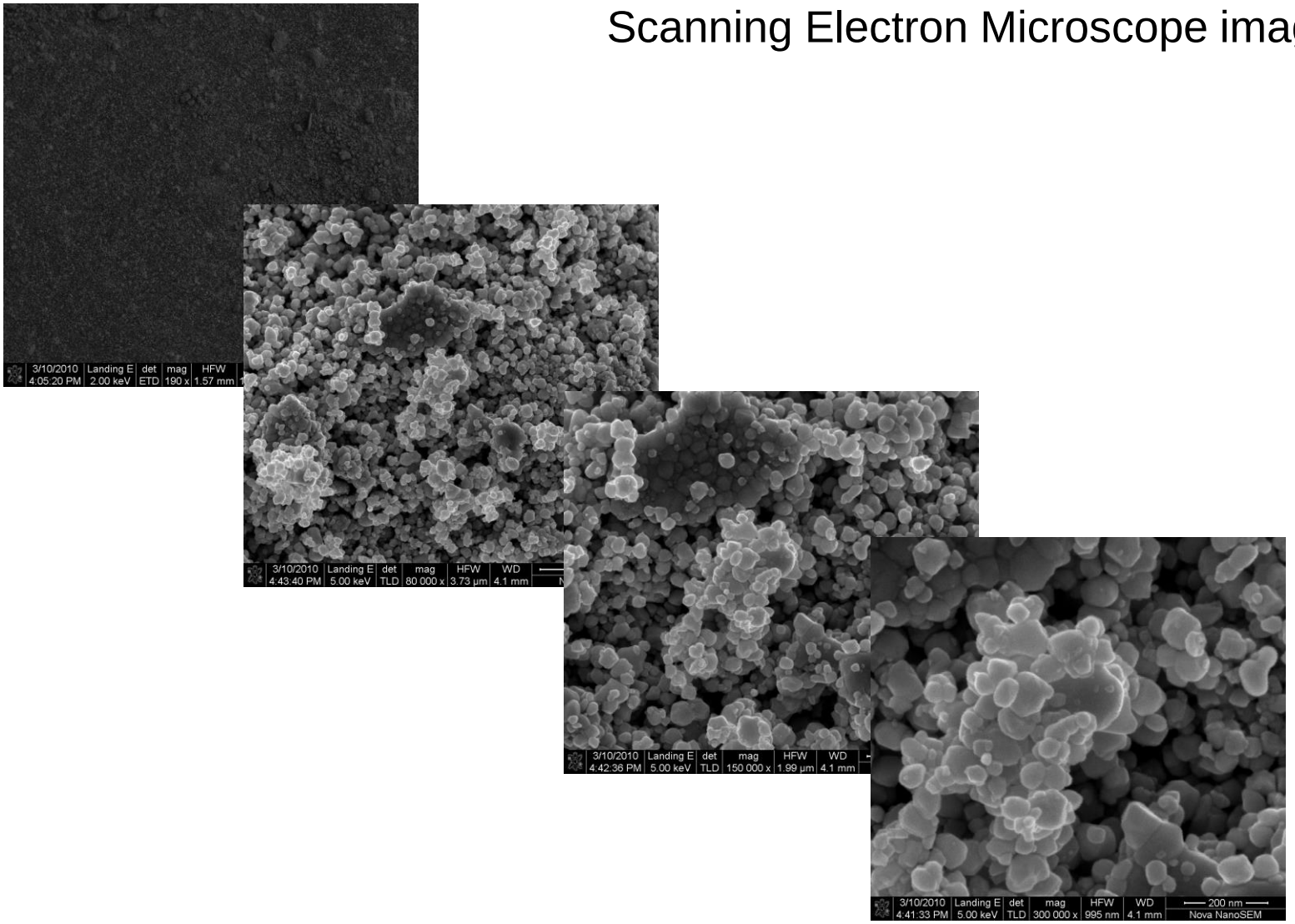
Scanning Electron Microscope images



Introduction to Nanotechnology:

Nanotechnology definition:

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

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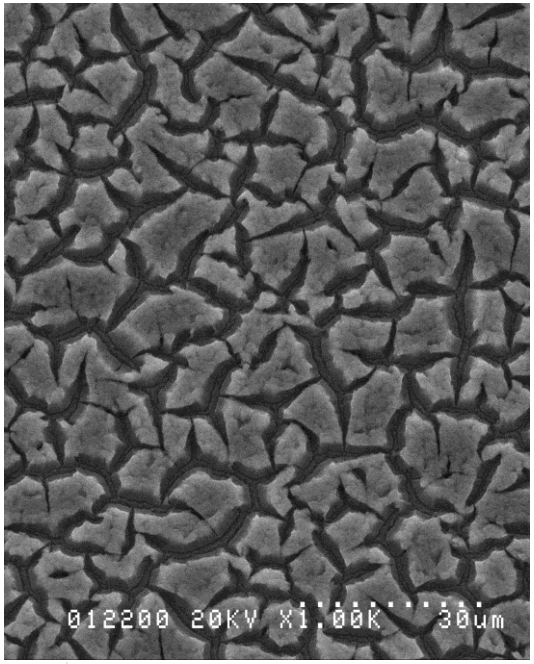
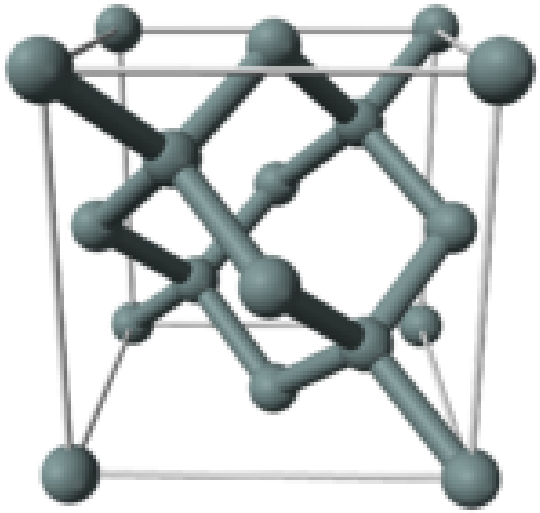


What is the photo on the left about?

Exercise



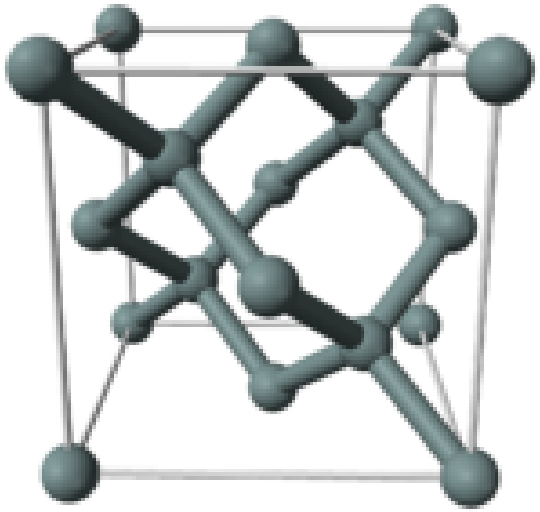
How many atoms are there in a cube that is 10 nm x 10 nm x 10 nm large? [or should I say "small" ☺☺]

Exercise

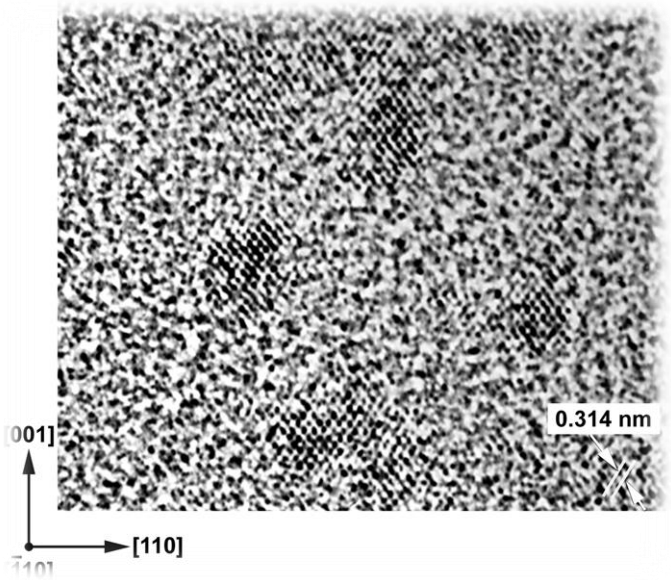
What is the distance between atoms?

Density of silicon ~ 2.33 gm/cm^3
Atomic number: 14
Atomic mass: 28.1 a.m.u.

http://www.chemicalelements.com/elements/si.html



cubic lattice 5.43 angstrom
FCC structure with a two-atom basis (8 atoms per cube)



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What is Nanotechnology: definition, **fields of science**, special characteristics, misconceptions, relevance to science and technology

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What should you specialize in
if you like to be a
nanotechnologist??

Is it a good thing to be a
“nanotechnologist”??

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What is Nanotechnology:
definition, fields of science,
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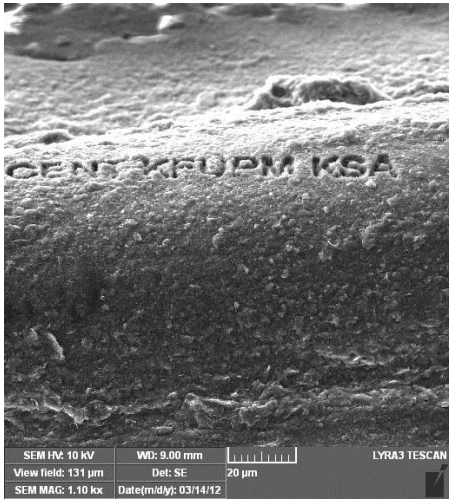

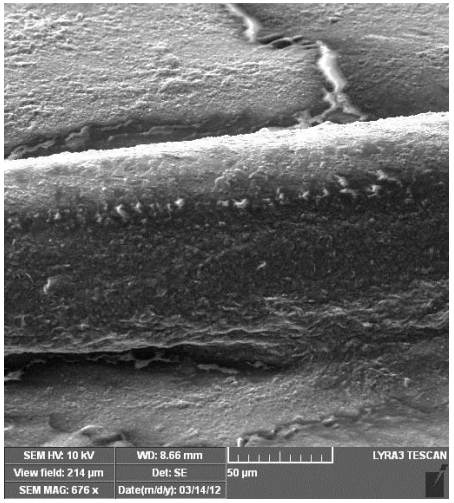

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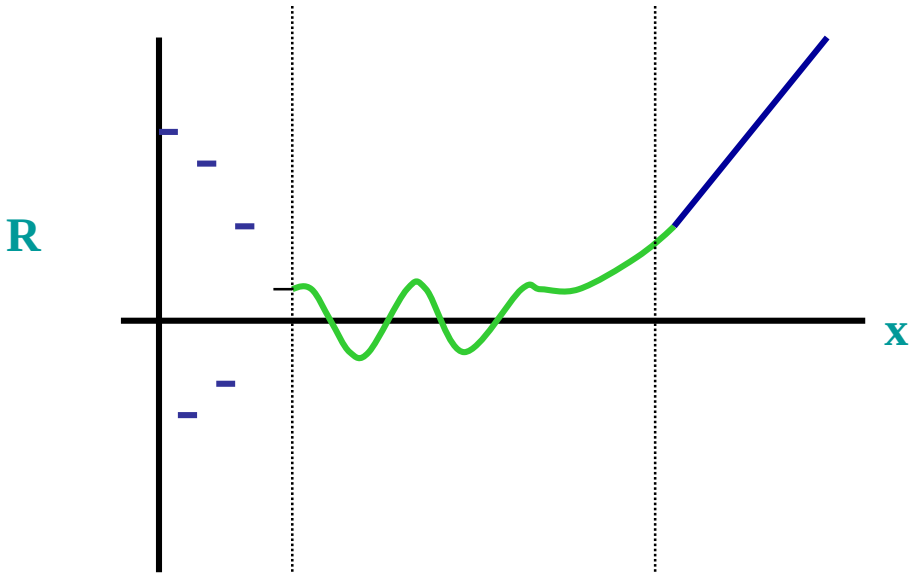
Discussion

How is nanotechnology 'special'?

Classical Physics or Quantum Physics



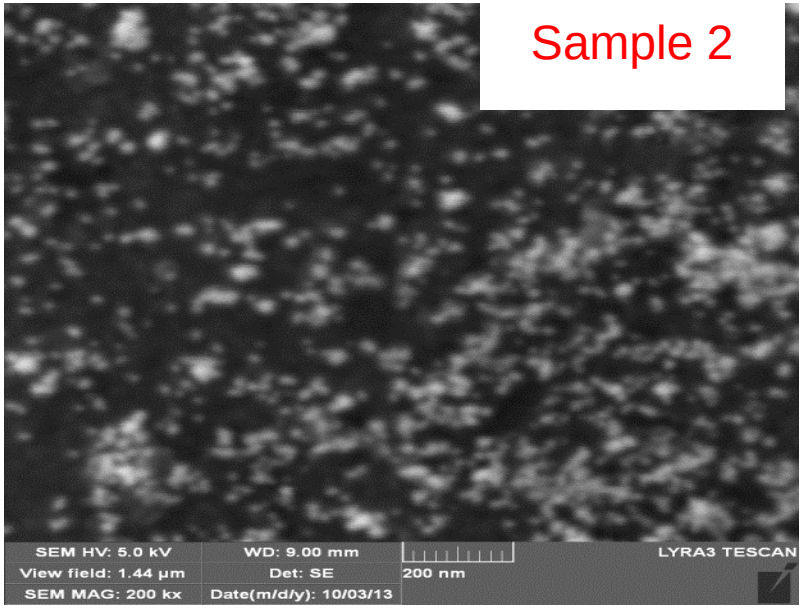
“weird” things happen in the quantum world.. like??!

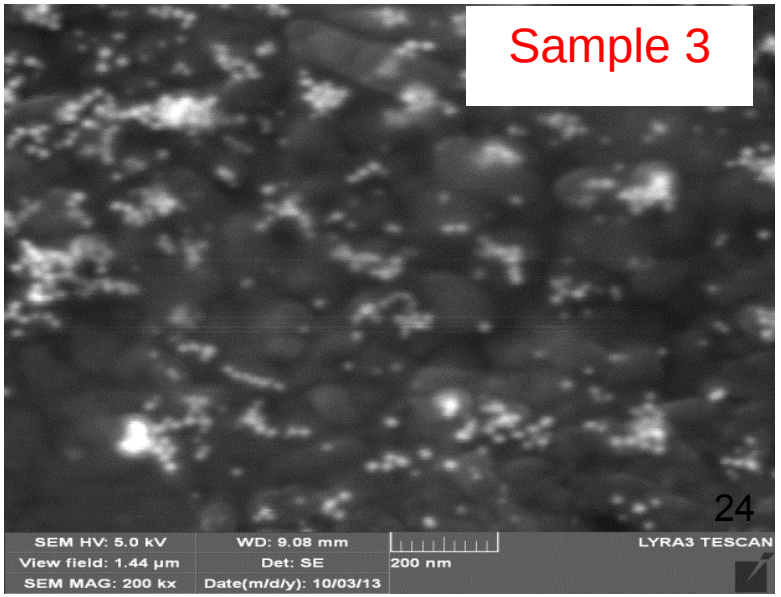
E&M interaction might get modified

How do we fabricate nanogold?
How can we control its size and properties??

Bulk Gold = Yellow

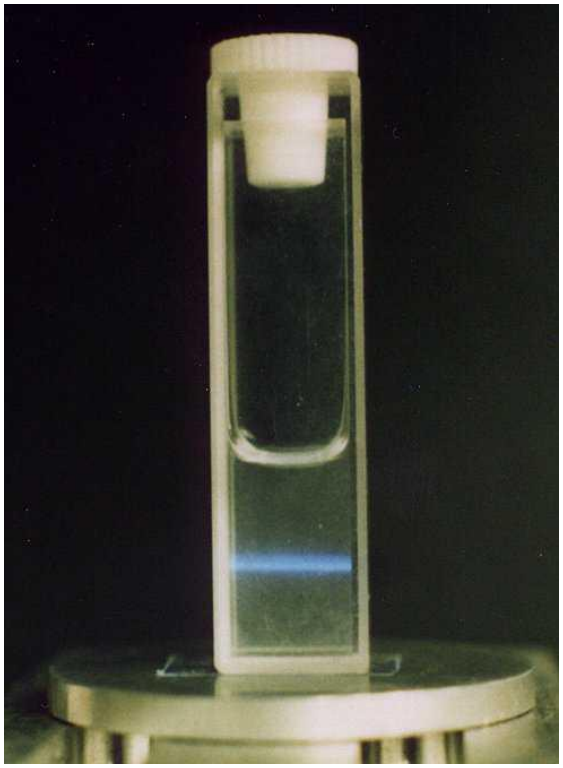
Nanogold = Red





E&M interaction might get modified

Silicon vs. n-Si (or porous silicon)



http://www.chemicool.com/elements/silicon.html

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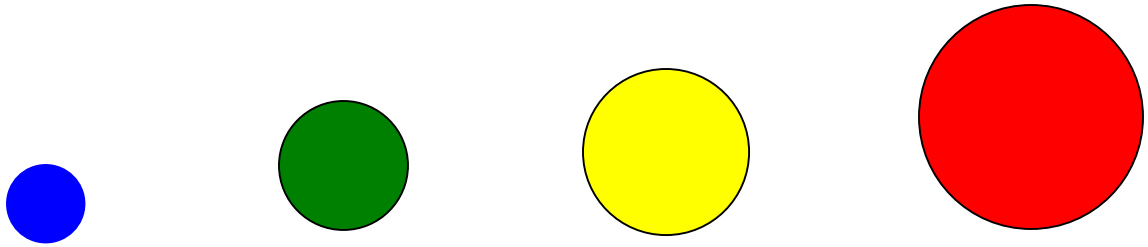
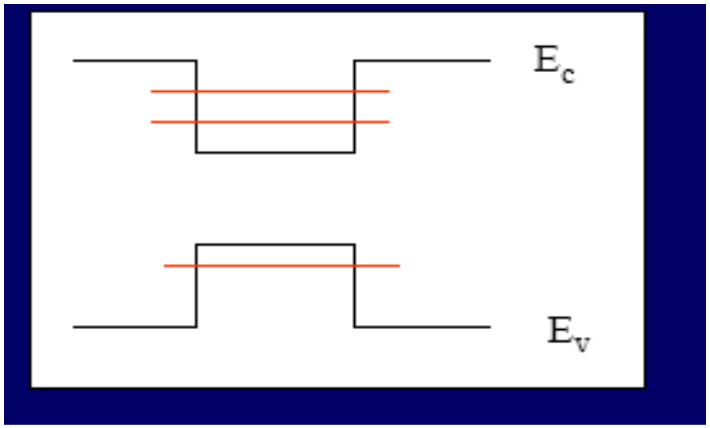
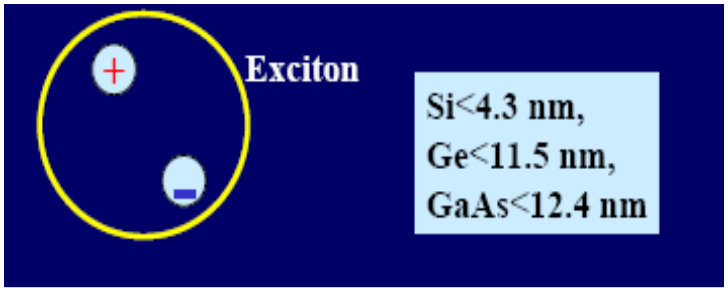
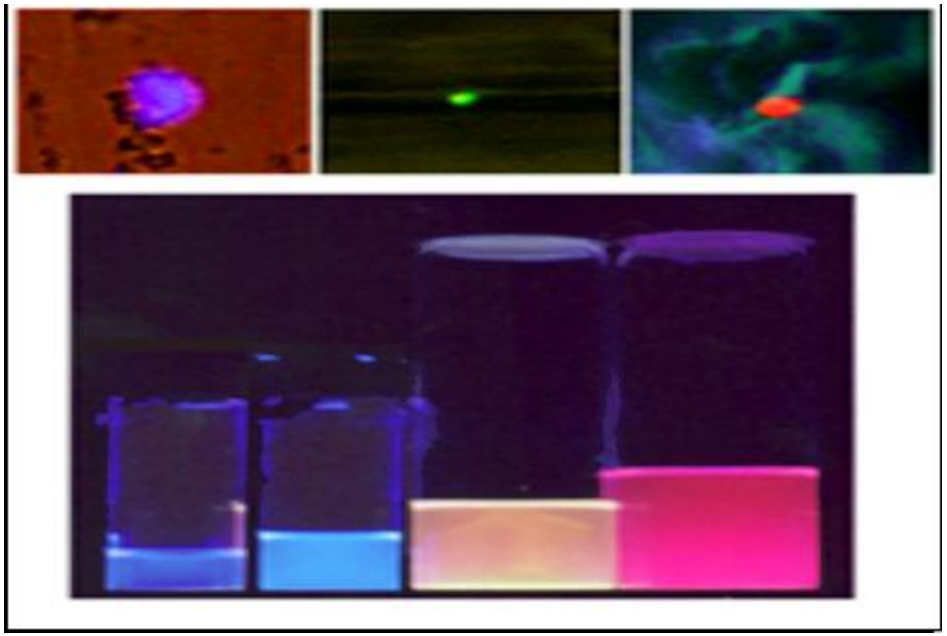
Small and Luminescent



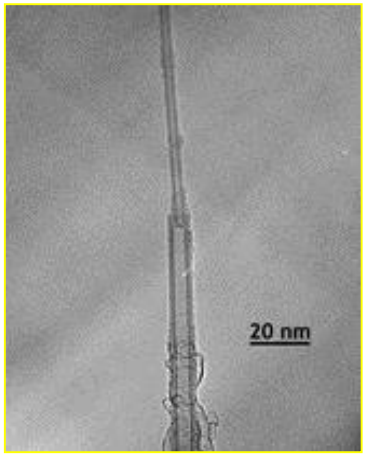




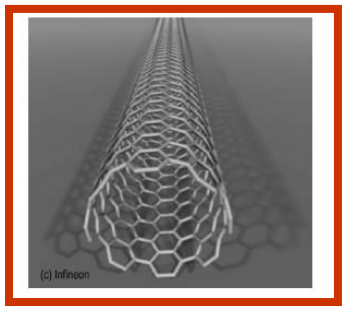


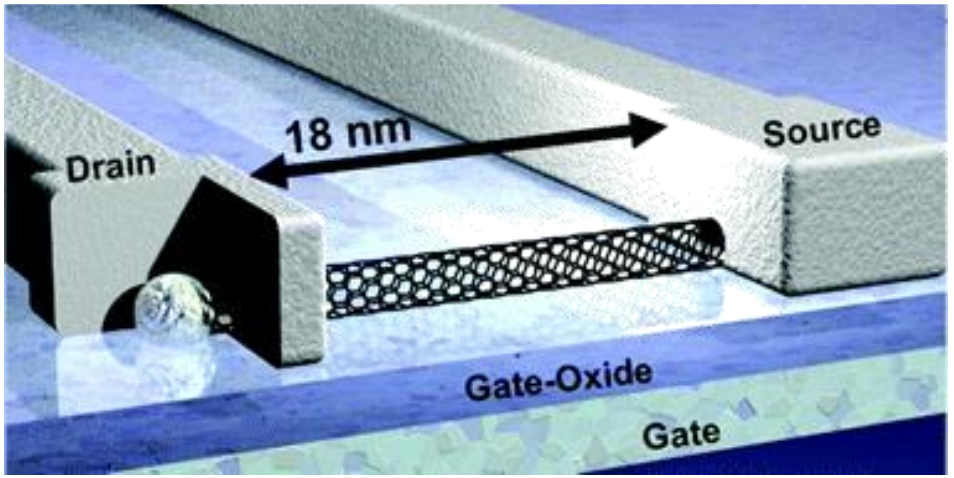
Z. Yamani and M. Nayfeh

Mechanical properties of CNT



Ijima (1991)



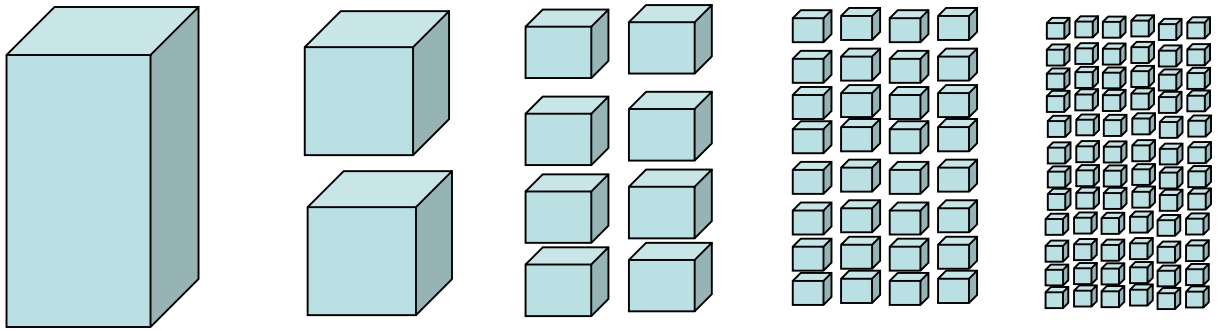


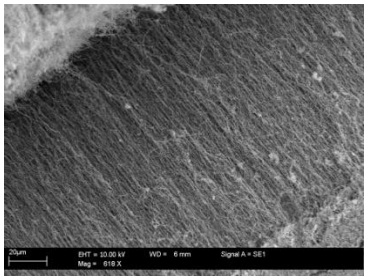
Seidel et al Nano-letters- Vol. 5, 1, (2005) 147

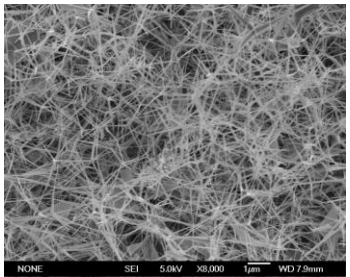
http://www.lbl.gov/Science-Articles/Research-Review/Magazine/2001/Fall/features/02Nanotubes.html

Huge specific area

For what applications is this important??







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Exercise

Compare the specific area of 'normal' material and nanomaterials.

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

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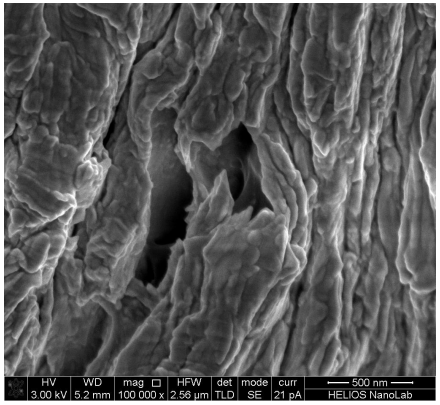
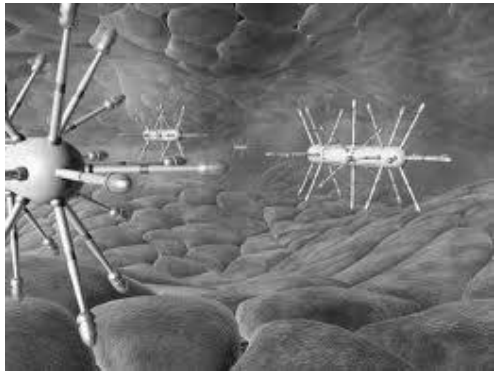
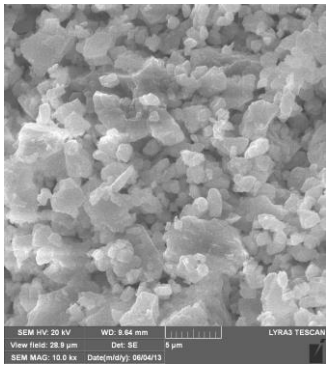
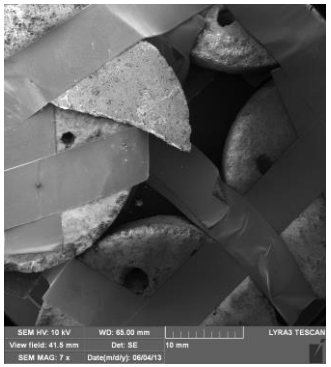
Nanomaterials can reach where no one has ever reached before ☺







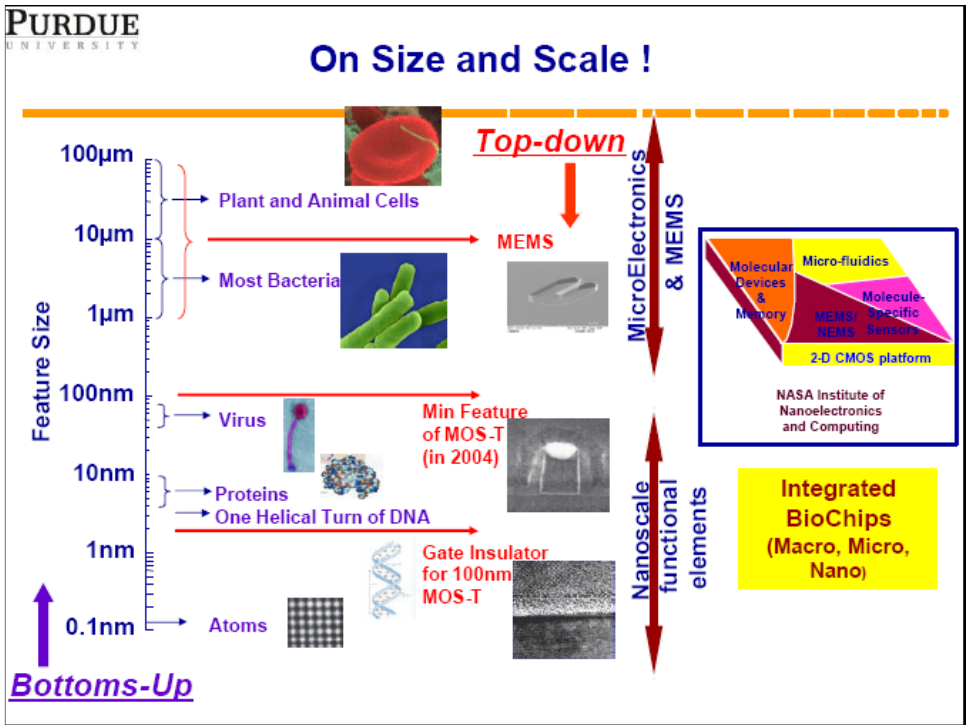


No pass required: good or bad??

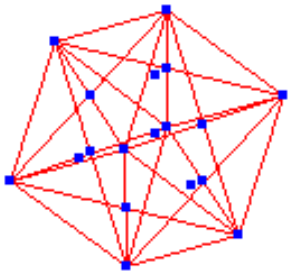
Can we step back.. and *contemplate*??

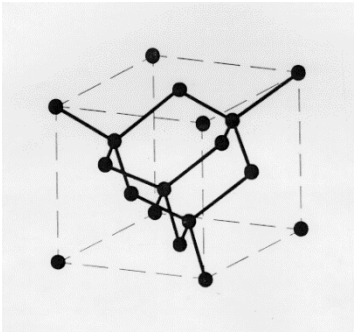
What is Nanotechnology: definition, fields of science, special characteristics, **misconceptions**, relevance to science and technology

Misconceptions related to Nanotechnology



How much smaller is a nanometer than the width of the atom?





Misconceptions related to Nanotechnology

Misconceptions related to Nanotechnology

Nanotechnology is for physicists [only]

Misconceptions related to Nanotechnology

تقنية النانو.. متناهية الصغر؟

نانوية لا ثانوية

نانوية لا نووية

Misconceptions related to Nanotechnology

Nanotechnology is all good!!

Misconceptions related to Nanotechnology

Νανο ισ ιτ!

Can you read in Greek? ☺

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What is Nanotechnology: definition, fields of science, special characteristics, misconceptions, **relevance to science and technology**

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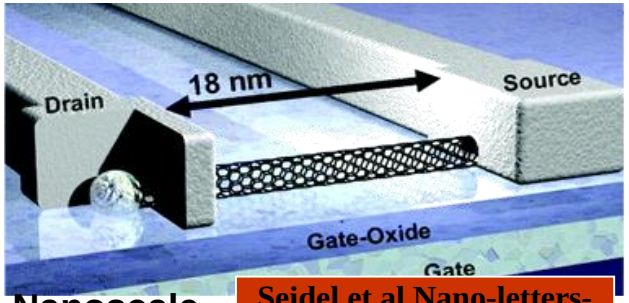
Nanotechnology in Electronics:



Nanoscale "vacuum tube"

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

Larger number of smaller devices that consume less energy

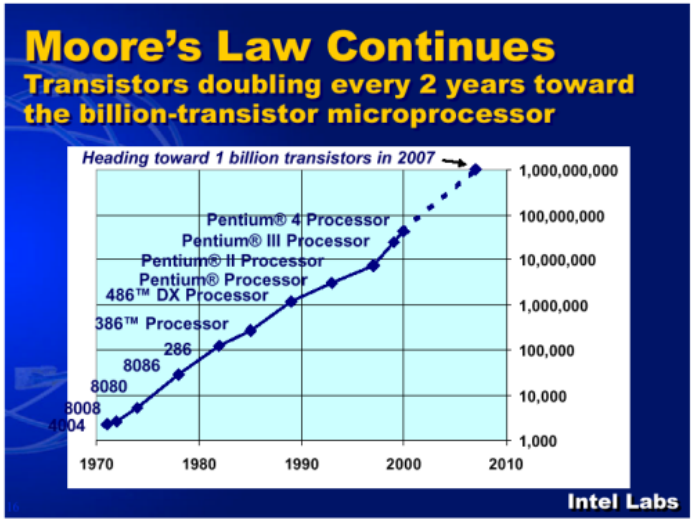
ENIAC, 1945

1800 vacuum tubes
27,000 kg; 140kW

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



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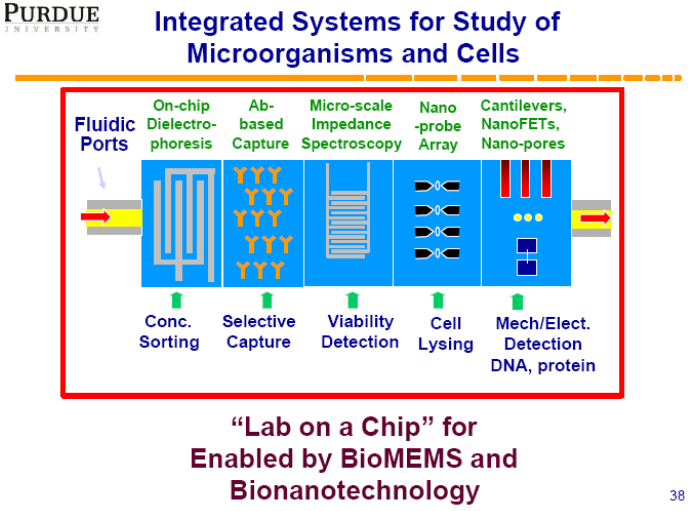
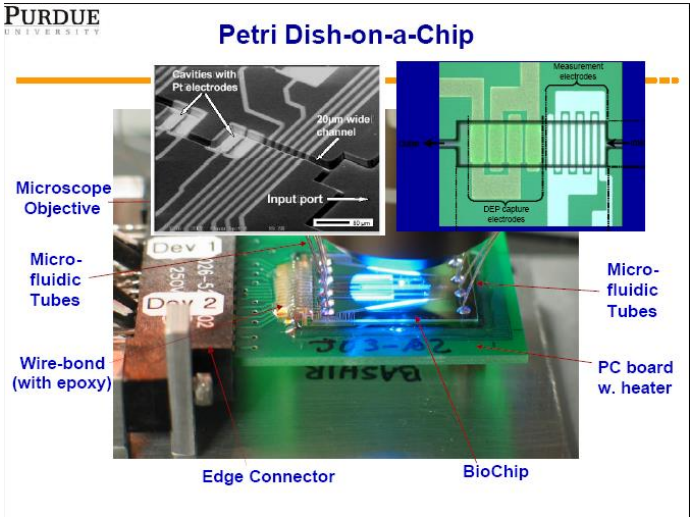
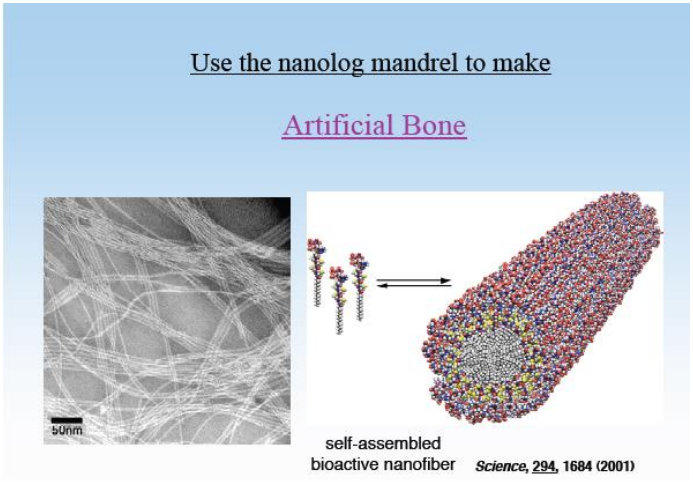
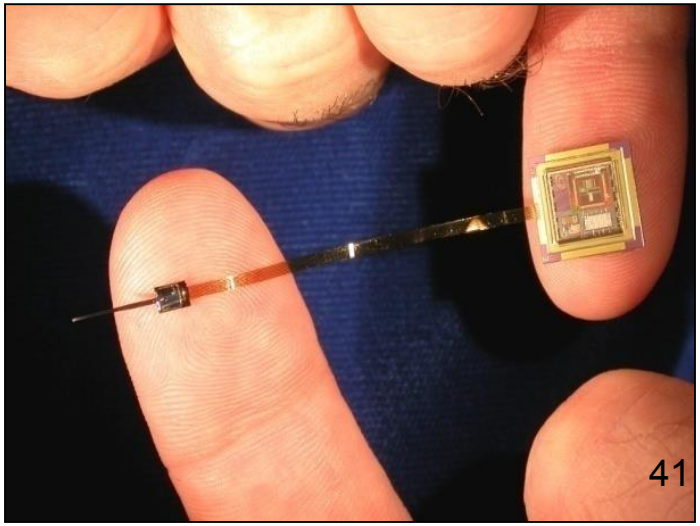
Nanotechnology in diagnostic and therapeutic medicine









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Energy/ photovoltaics

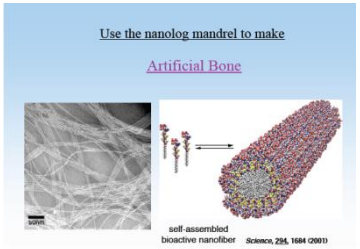
Membranes/ water purification

Add to Cart

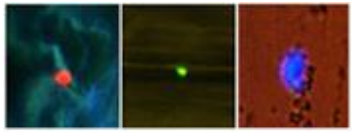
Porous material/ hydrogen storage

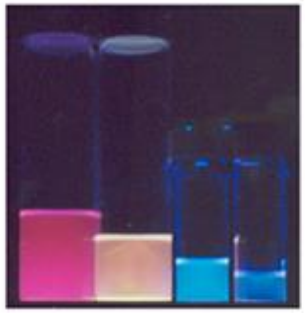
Nano-engineered catalysis

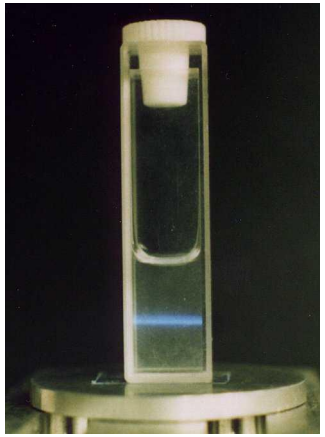
Petrochemicals/ fuel cells



Nayfeh Nanotechnology:

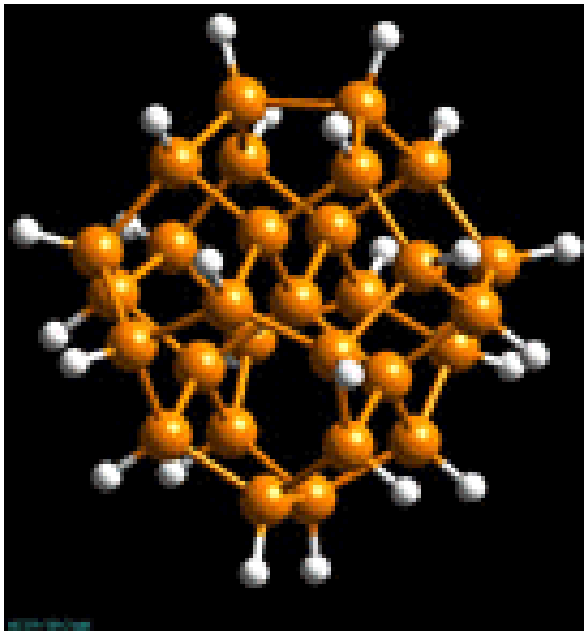






Nayfeh and Yamani; patent

29 Silicon (yellow)
24 Hydrogen (white)



1.03 nanometer

آلات تسير مع الدم في الجسم وتنفذ جراحة في القلب والدماغ

العالم العربي الأميركي منير نايفه
كتب بالذرة: أحب فلسطين...
أو الفيزياء... أو فتاة بيروت؟

□ لندن – من محمد عارف:

■ تحطيم الذرة انتج الطاقة النووية والقنابل الذرية. ماذا يمكن أن يحدث اذا استطعنا بدل تفجير الذرة التحكم بحركتها وتغيير مواقعها وإعادة ترتيبها كما نشاء. هذا السؤال طرحه قبل ٢٥ سنة واحد من أشهر علماء الفيزياء الأميركيين ريتشارد فاينمان، وتوقع تحقيق ذلك في مستقبل بعيد. لكن المستقبل البعيد قريب في حساب الفيزيائيين وبينهم العالم الفلسطيني الأصل منير نايفه الذي توصل قبل سنوات الى طريقة يحرك بها الذرة بواسطة المجهر الالكتروني. ويستخدم نايفه وهو استاذ الفيزياء في جامعة إيلينوي في الولايات المتحدة الذرة التي يلتقطها مثل قطرات الحبر وينتج بها أدق خط عرفه تاريخ الكتابة لا يزيد عرضه على خمسة بالمليون من المليمتر. واشتهرت صورة رسمها بواسطة الذرة تمثل القلب والى جانبه الحرف P وتناقلت الصورة وكالات الانباء، وافردت لنايفه صفحات في دأوئر المعارف العالمية مثل «إنسكلوبيديا بريتانيكا» البريطانية و«ماغروهيل» الأميركية.

وذكرت المجلة العلمية البريطانية «نيوسايتست» التي خصصت له غلافها انه اختار حرف P لانه يمثل بالانكليزية الحرف الأول من كلمة فيزياء وذلك تعبيراً عن حبه لهذا العلم الذي يعد أب العلوم. لكن العالم الفلسطيني الذي ولد في طولكرم ودرس الفيزياء في الجامعة الأميركية في بيروت ذكر في ندوة للعلماء العرب عقدت الاسبوع الماضي في اكسفورد أنه رمز الى فلسطين التي تبدأ بالانكليزية بالحرف نفسه، وقال ان العبارة تعني: «احب فلسطين». وأثار تصريحه ردود فعل قوية حتى بين زملاء عرب قالوا أنه يستفز الأوساط اليهودية ذات النفوذ العلمي الدولي «الخطير» وحذروا مولولين: «راحت عليك جائزة نوبل يا ابن نايفه»!.. وذهب بعضهم الى حد الطلب من «الحياة» عرض الموضوع بـ «خفة دم»، واقترحوا بدل ربط حرف P بفلسطين أو بالفيزياء، الإدعاء انه الحرف الأول من اسم فتاة وقع نايفه في غرامها ايام الدراسة في بيروت. لكن نايفه المتزوج من فتاة عربية اسمها هتاف «بنت البلد من طولكرم» قال لـ «الحياة» ان حكاية «غرام بيروت» تخيفه اكثر مما يخيفه فقدان جائزة نوبل!

نانوتكنولوجي
ومع كل المزح الذي

التتمة في الصفحة (٤)

ISSN 0967-5590

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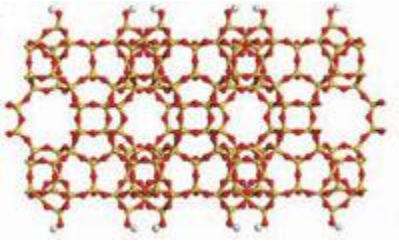
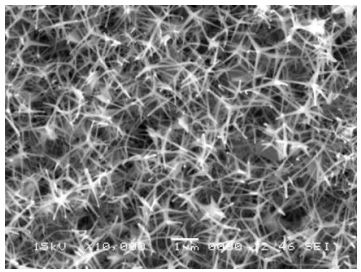
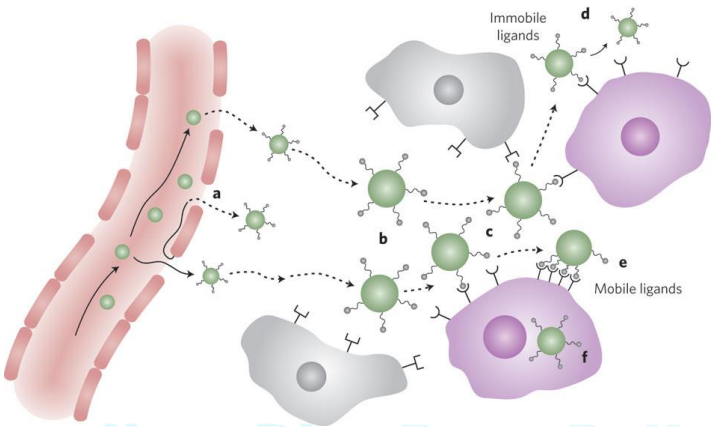
Nanotechnology is about the fabrication of nanometer-sized materials and devices exploiting their unique physical, chemical and biological properties.



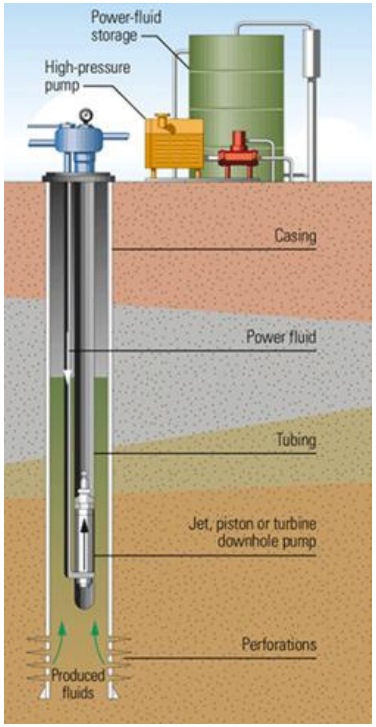


Nanomaterials



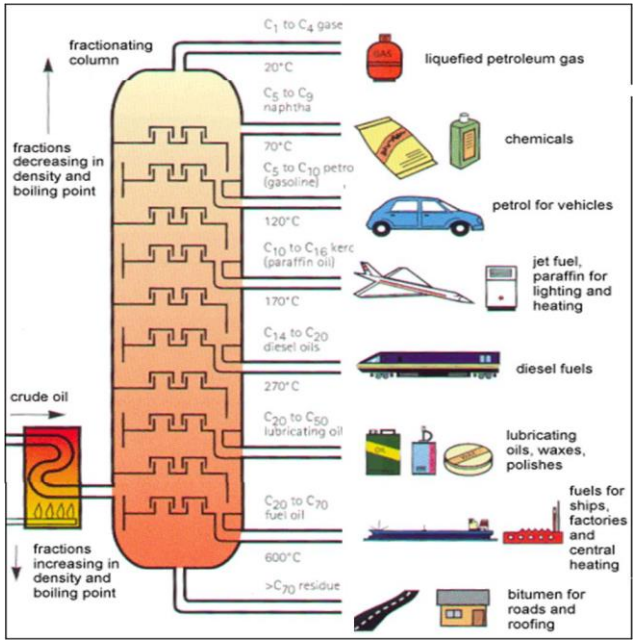
NanoBio: Drug Delivery

Source: Nature Materials 10 (2011) 342



Enhanced Oil Recovery

Source: Schlumberger



Oil Refinery

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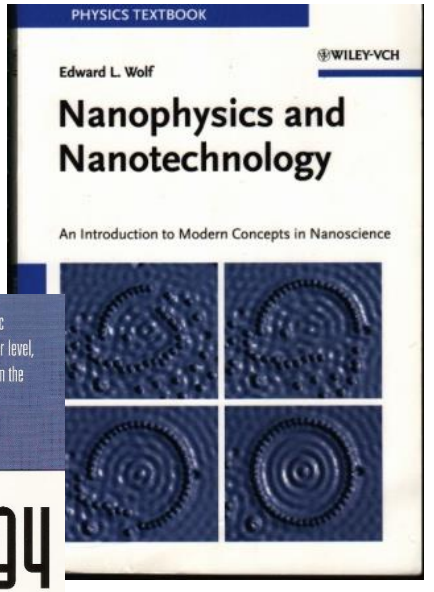
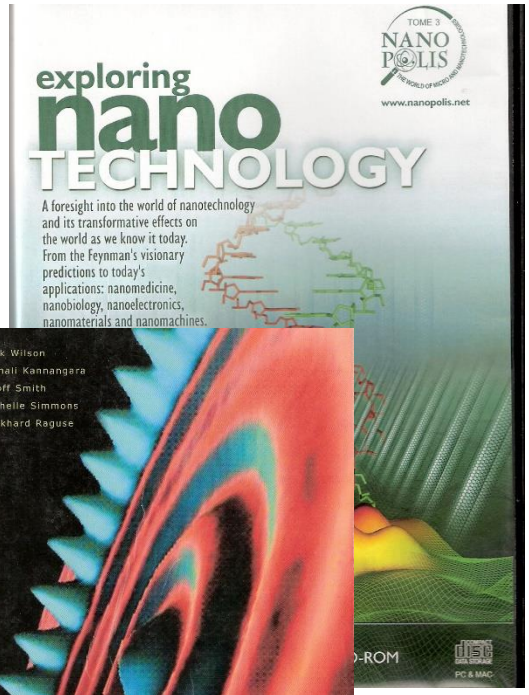
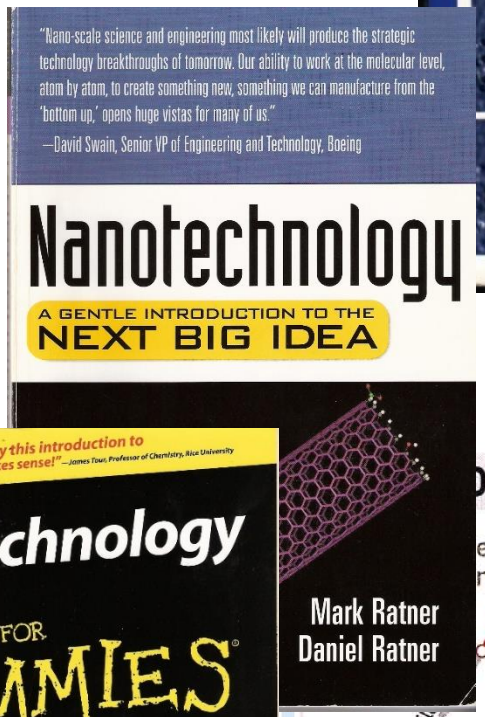
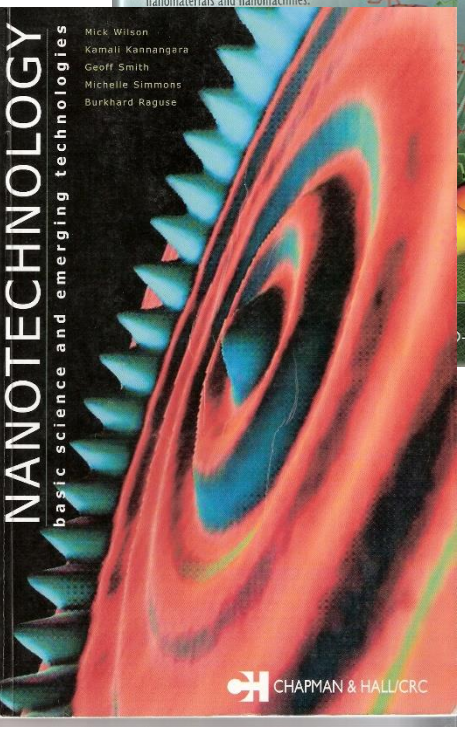
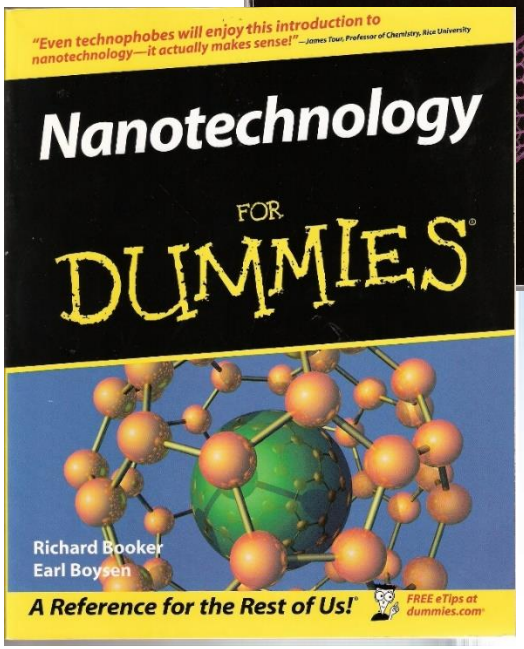
The path to nanotechnology

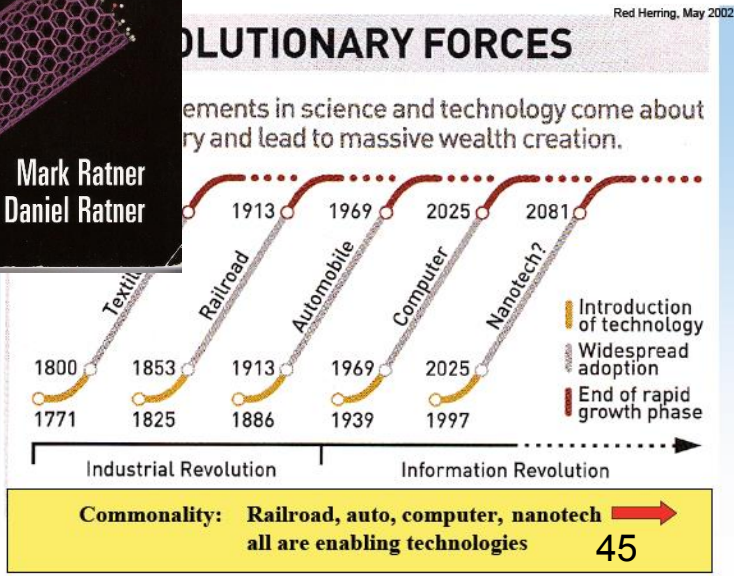












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Synthesis and Characterization of Nanomaterials

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Synthesis and Characterization of Nanomaterials

Potentiostat/galvanostat

Autoclave

Automatic Sputter coater

Ultra Sonicator

Planetary Ball Mill Machine

Microwave reactor

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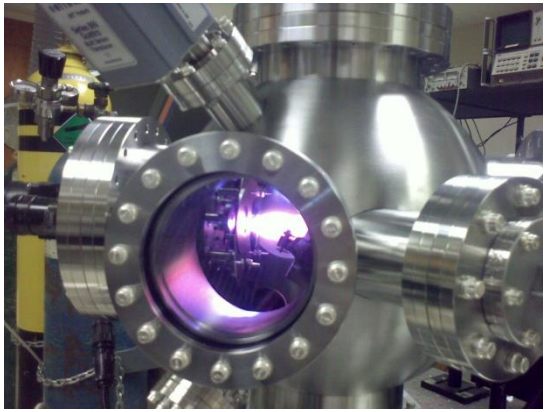

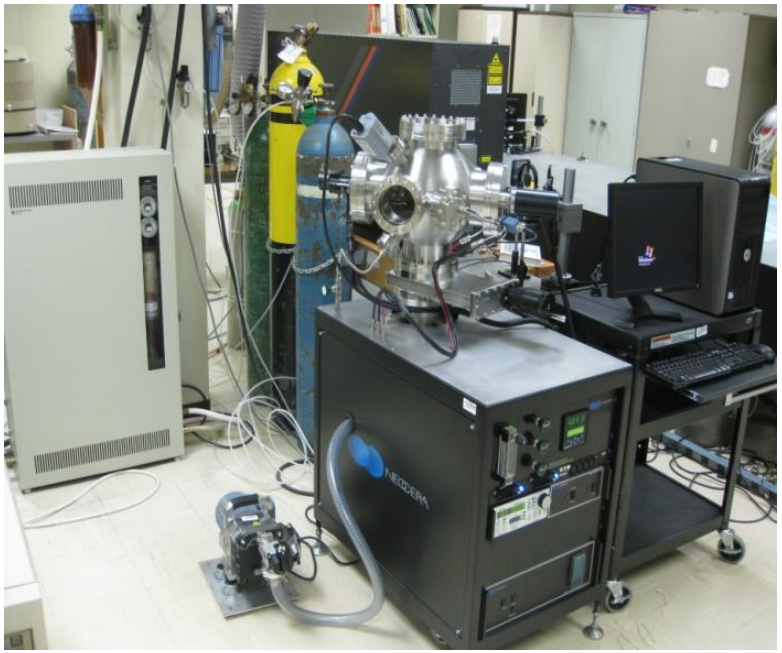

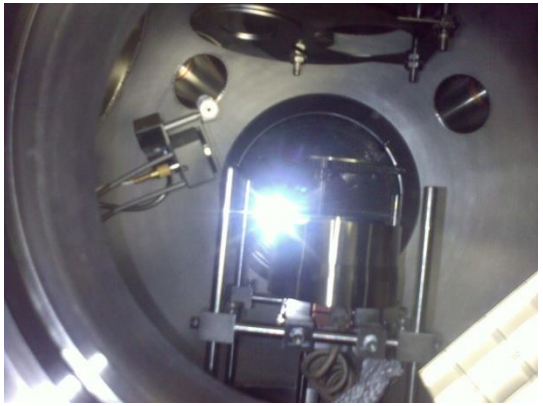

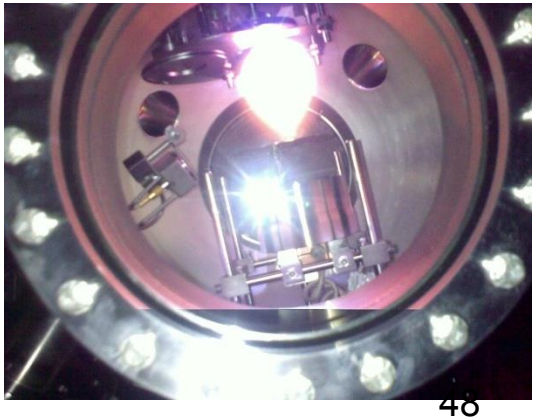

Pulsed Laser Deposition

The quartet in nanopowder metallurgy lab

Hot Isostatic Press

Spark Plasma Sintering

Cold Isostatic press

μ-wave sintering

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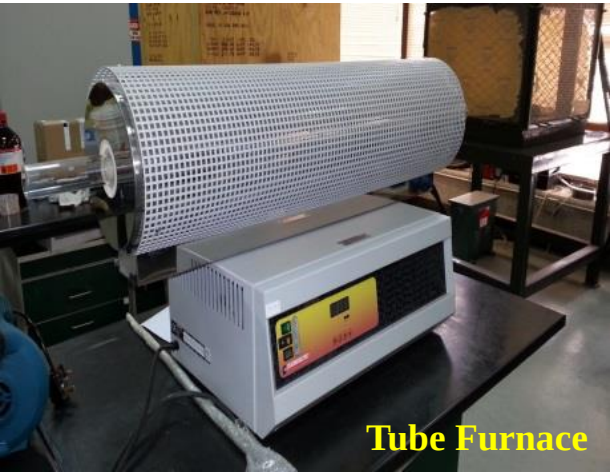
Furnace


Tube Furnace

Brabendor

Microwav

Hot Press

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Synthesis and **Characterization** of Nanomaterials

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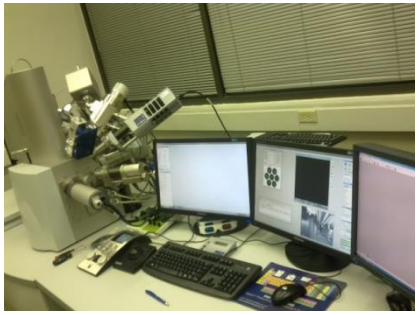
Microscopy

Focused Ion Beam Stations



AFM
(Nanopolis)

STM for Nobel prize (1986)

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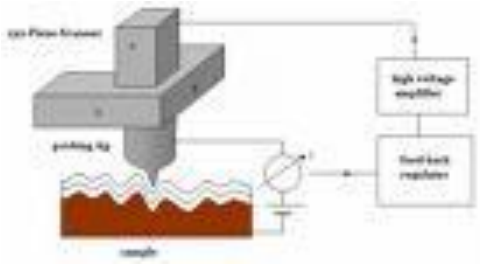
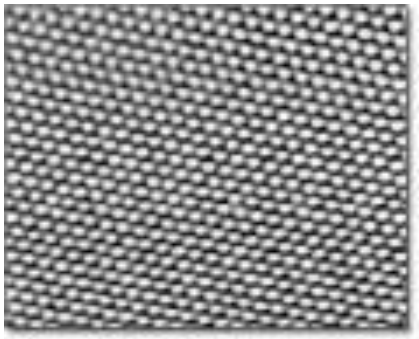
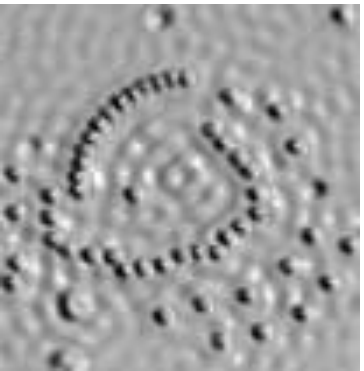
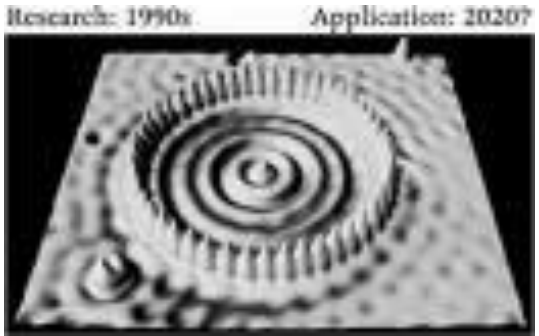
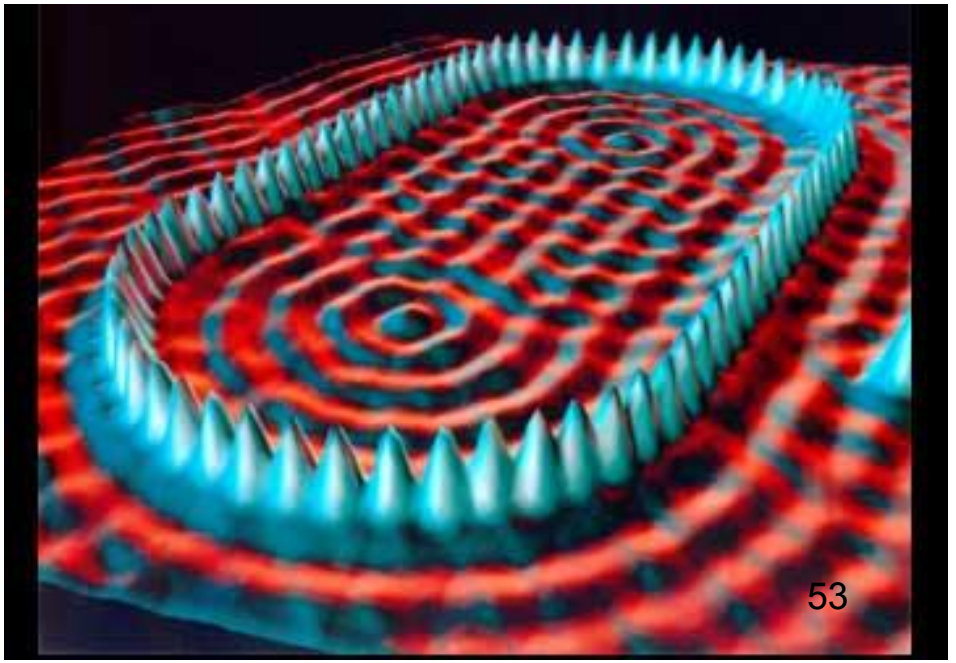


Moving atoms around!!









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Surface area analyzer

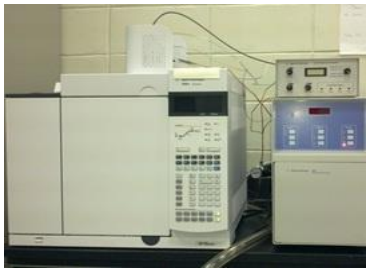
Analytical Characterization

DLS

Contact Angle Measuring Device

TGA-DSC-MS

Ultra Performance LC



GC

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UV-Vis (Nanopolis)

Optical Characterization

FTIR (Nanopolis)

Raman spectroscopy

Spectrofluorometer with combined steady state and lifetime capabilities

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Nanotechnology at KFUPM and in the Kingdom

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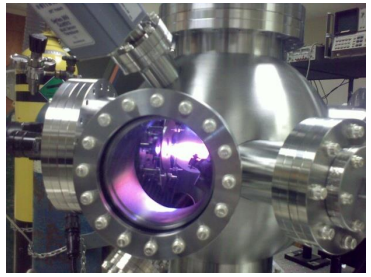
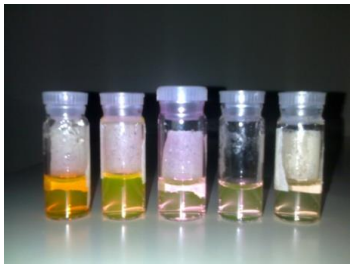
Nanotechnology **at KFUPM** and in the Kingdom

What is CENT, and what are its research activities?



Center of **E**xcellence in **N**ano**t**echnology

CENT is a KFUPM unit founded in November 2007, based on a Royal Fund donation in Nov. 2006



A KFUPM research center committed to developing nanomaterials for applications in petroleum and petrochemicals

CENT: Vision and Mission

VISION

CENT shall be an internationally recognized leading research center that develops innovative research and produces 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 world-class human resources research capacity including highly qualified research scientists, staff and trained graduate students in the field of nanomaterials synthesis, their characterization and relevant applications.

2. To develop research infrastructure including state of the art facilities that enables the Center to achieve its goals.

3. To create innovative nanotechnology-based solutions in strategic areas in petroleum and petrochemical industries relevant to the Kingdom.

4. To establish Industrial Partnerships with relevant companies and entrepreneurships as a step toward commercialization, in coordination with DTV.

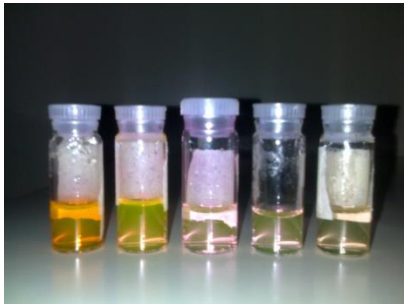
5. To contribute to the development of teaching graduate programs and training students in the field of nanotechnology.

6. To promote public awareness regarding the benefits and the risks of nanotechnology.

CENT Research Focus Areas

Focus on the *petroleum and petrochemical industries*

1. **Nano-engineered Catalytic and Photo-catalytic Materials**
2. **Nano-structured Materials for Sensing Applications**
3. **CNT Production and Applications**
4. **Nanopowder Engineering**

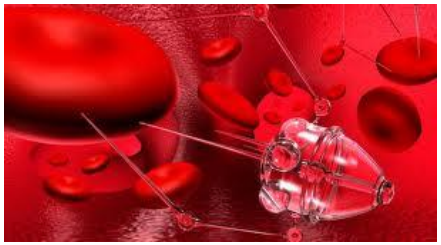


Nanotechnology applications in the Petroleum Industry

Downstream: transportation, refining, environment, carbon management, sub-quality 'natural' gas treatment, corrosion.

Upstream: exploration, drilling fluids and bits, production

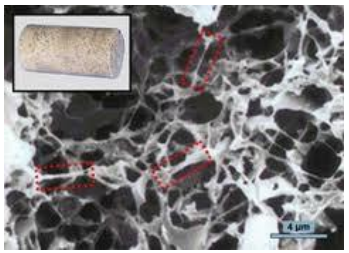
Sensing in Oil Reservoirs (Nanoagents)

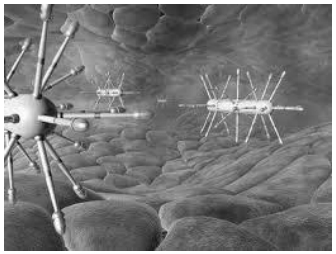


It used to be robots in blood arteries?!!

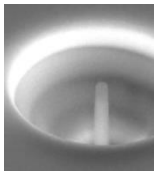
S. Aramco (2008) shock!!

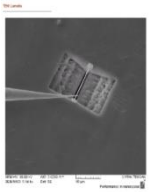
Robots 7000 ft below ground in complete darkness, wandering 'inside' rocks.

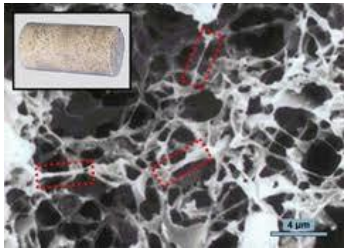




Sensing in Oil Reservoirs (Nanoagents)



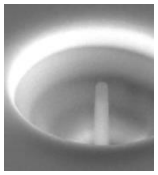


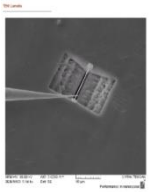


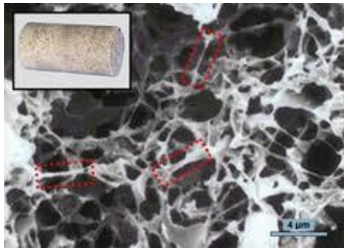
2 years later:
Novel Hybrid Reservoir Nano-Agents for Enhanced Oil Recovery
Proposal submitted by Z. Yamani et. al. (with American collaborators) for S. Aramco EXPEC ARC funding!!

Goal: *smart tracing, sensing, and sniffing devices for on-line implementation in oil fields*!!!

Sensing in Oil Reservoirs (Nanoagents)







Challenging problem:

- “Right” size,

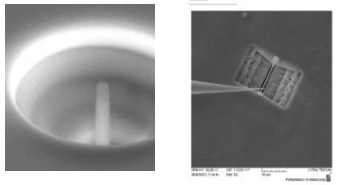
- Dispersibility,

- Functionalization,

- Harsh environment,

- Choice of markers/ sensitive detection (chemical, optical, electrical, magnetic)

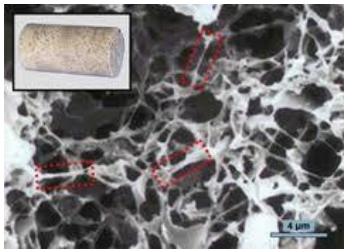
Sensing in Oil Reservoirs (Nanoagents)

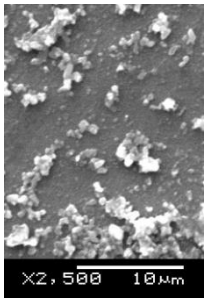


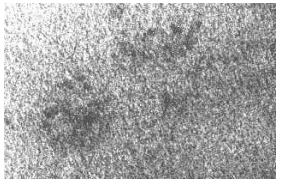
Then
what..??

Bring resbot to life?? (active vs. passive)

PROPULSION;
NAVIGATION;
COMMUNICATION;
AMMUNITION..!!



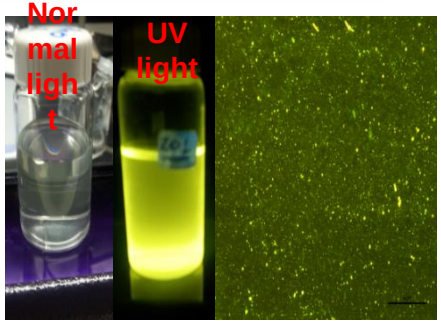


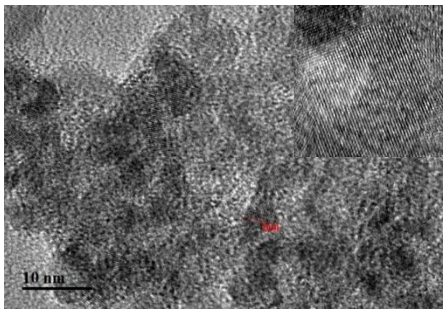


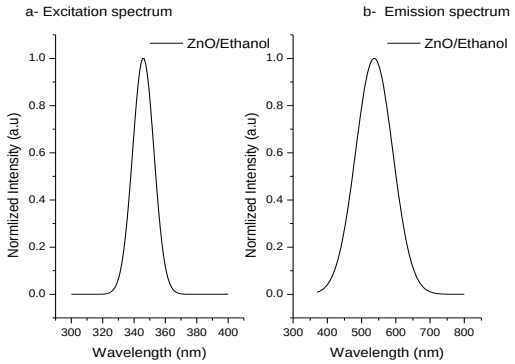
(for now!!)

The resbots are not 'really' robots.. but rather (just) 'agents'

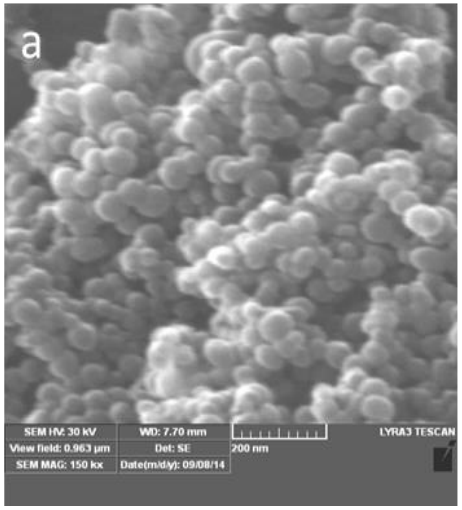
Sensing in Oil Reservoirs (Nanoagents)

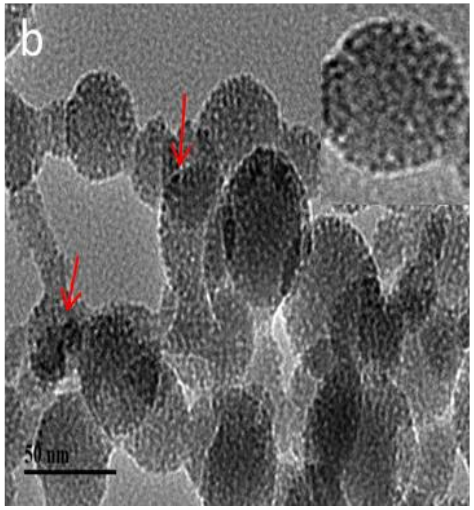


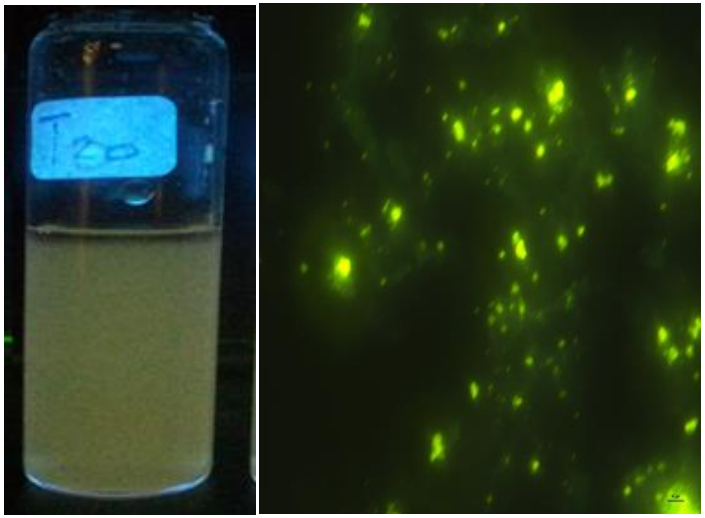




ZnO QD (simple method, right size, brightly fluorescing); Excitation 320-370 (350) nm; Emission 400-650 (520) nm

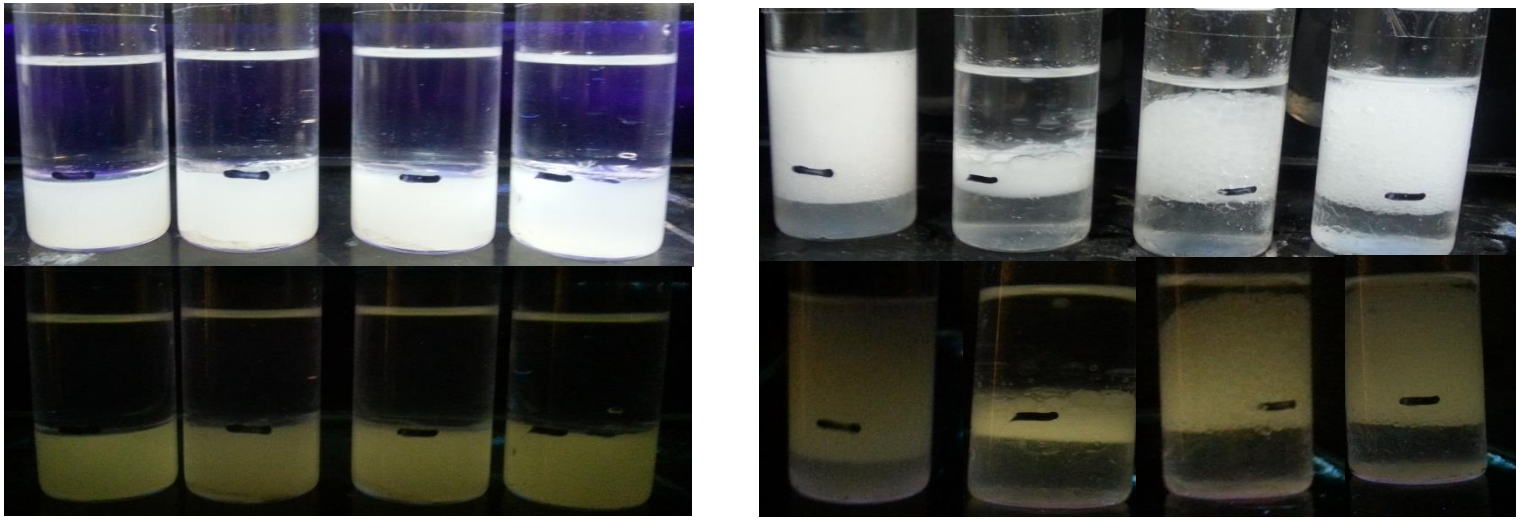




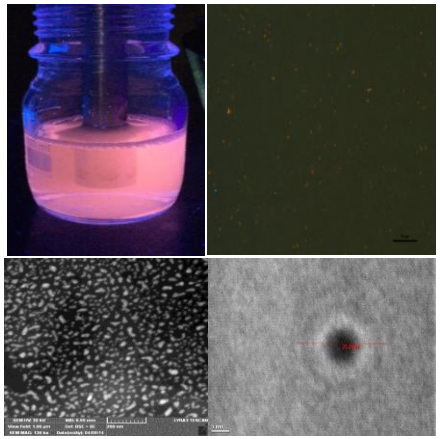


Silica encapsulated ZnO QD; right size (~ 45 nm) properly fluorescing; well dispersed

Sensing in Oil Reservoirs (Nanoagents)



Core-shell systems after functionalization for Oil Sniffing



We are not there yet!

- Better markers (fluorescent or otherwise)
- Harsh environment (salinity and temperature)
- Core flooding results
- Modeling for ideal (oil sniffing) partition functions

Chemical Gas Sensing in the Ambient

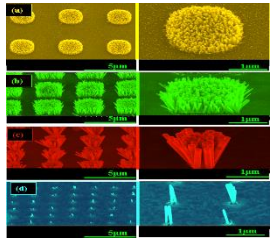
Objectives:

Fast, in-situ and online detection and metering of various pollutants in Chemical, petrochemical & petroleum industries in Saudi Arabia.
[HCs, SOx, NOx and H2S (room temp. – high temp.)]

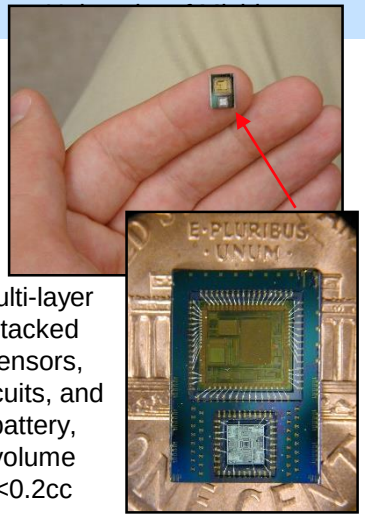
Key Features:

- High selectivity, enhanced sensitivity, stability and short response time (S4).

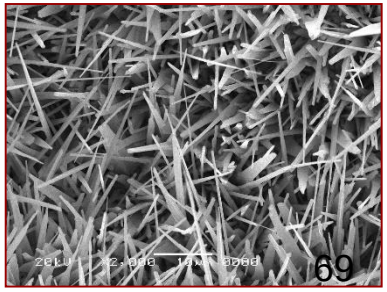
- Small grain size, large surface area, and, open/connected porosity are targeted, since the sensing mechanism and catalytic activity are largely microstructure-dominated.



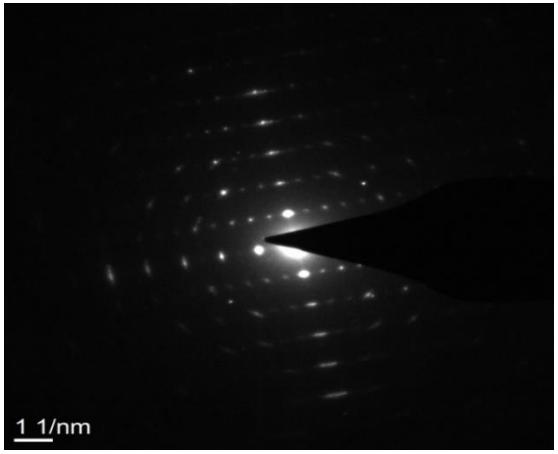
µSystem for Environmental Monitoring

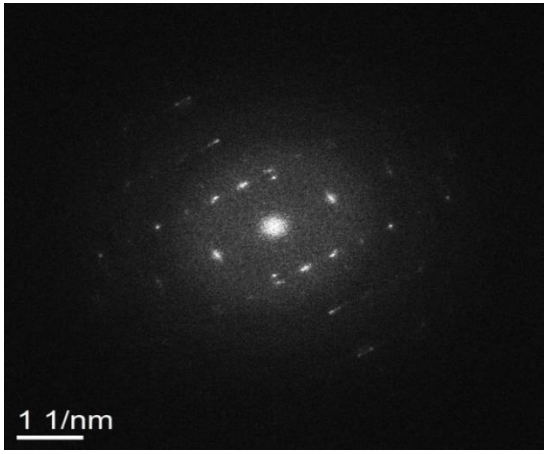


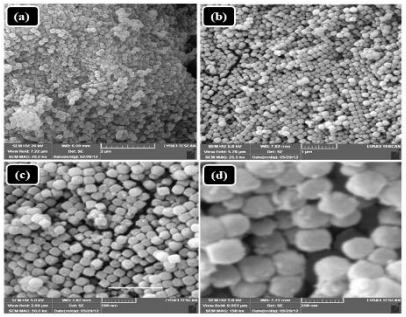
Multi-layer stacked sensors, circuits, and battery, volume <0.2cc



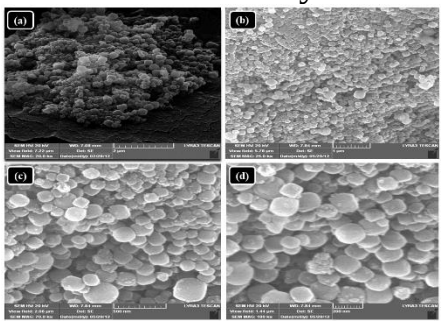
Chemical Gas Sensing in the Ambient



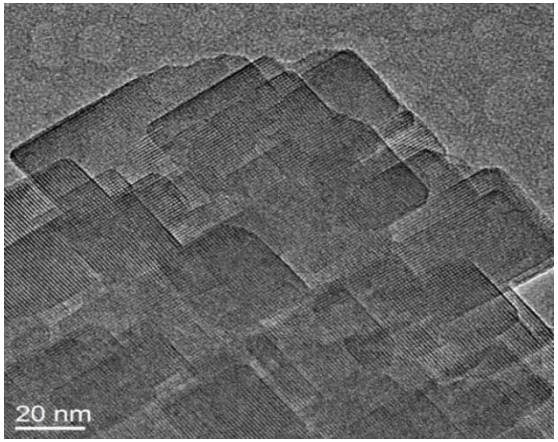


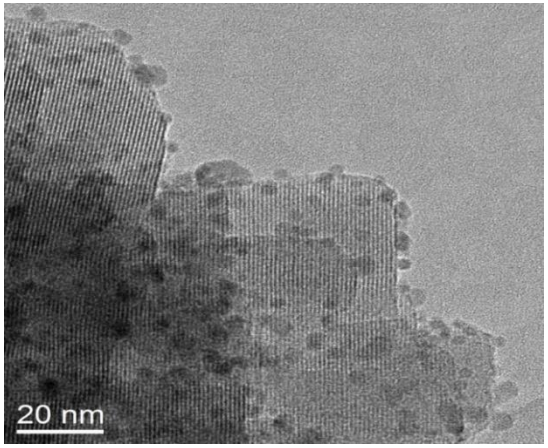


Zeolite Y nanocrystals



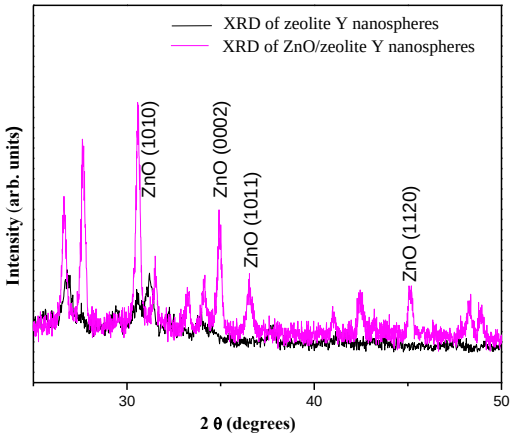
ZnO/Zeolite nanocrystals





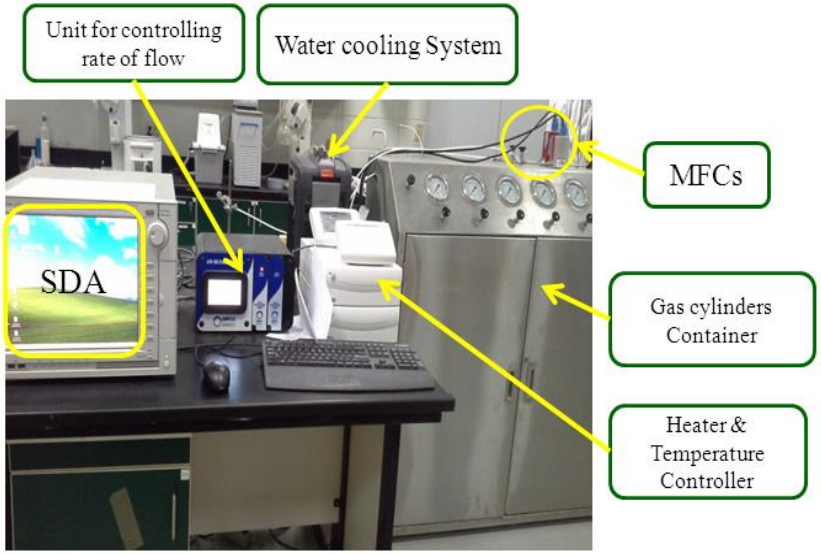
ZSM 5

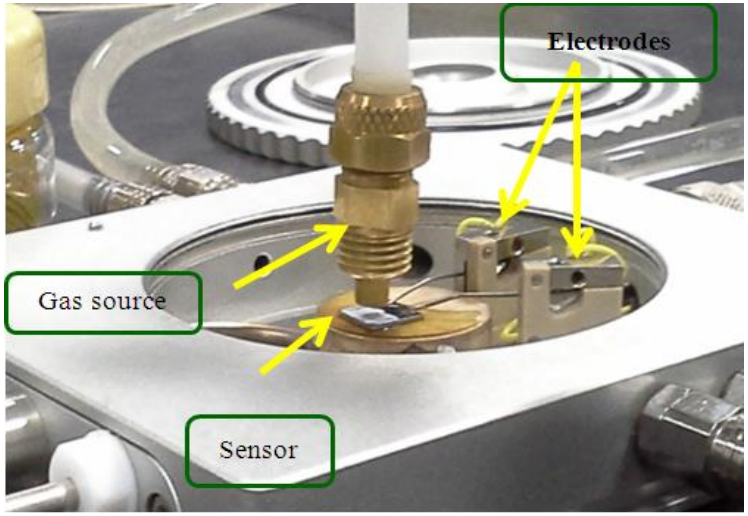
SnO_2-ZSM 5

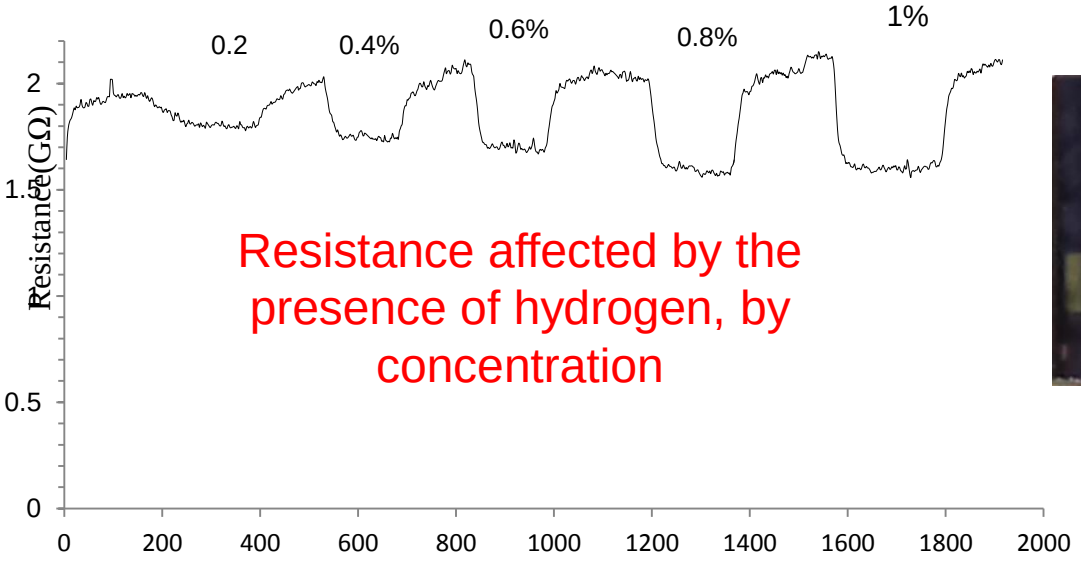


MOZN: specific surface area framework + active material

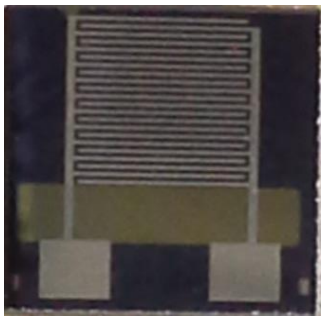
Chemical Gas Sensing in the Ambient

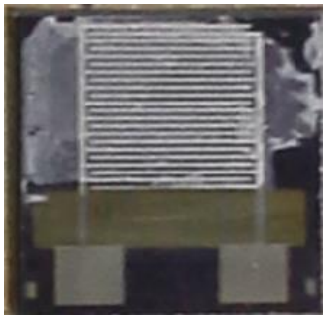






Resistance affected by the presence of hydrogen, by concentration





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Center of Excellence in NanoTechnology

Electro-Photo-Catalysis for Hydrogen Production


Contents lists available at ScienceDirect
Catalysis Communications
journal homepage: www.elsevier.com/locate/catcom

Synthesis of highly active nanocrystalline WO_3 and its application in laser-induced photocatalytic removal of a dye from water

M. Qamar[a], M.A. Gondal[a,b,*], Z.H. Yamani[a,b]

[a] Center of Excellence in Nanotechnology, King Fahd University of Petroleum and Minerals, KFUPM Box 741, Dhahran 31261, Saudi Arabia
[b] Laser Research Laboratory, Physics Department, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia

ARTICLE INFO | ABSTRACT


Contents lists available at ScienceDirect
Journal of Hazardous Materials
journal homepage: www.elsevier.com/locate/jhazmat

Laser-induced removal of a dye C.I. Acid Red 87 using n-type WO_3 semiconductor catalyst

M. Qamar[a], M.A. Gondal[a,b,*], K. Hayat[c], Z.H. Yamani[a,b], K. Al-Hooshani[a,c]

[a] Center of Excellence in Nanotechnology, King Fahd University of Petroleum and Minerals, KFUPM Box 741, Dhahran 31261, Saudi Arabia
[b] Laser Research Laboratory, Physics Department, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia
[c] Chemistry Department, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia

ARTICLE INFO | ABSTRACT


Contents lists available at ScienceDirect
Catalysis Communications
journal homepage: www.elsevier.com/locate/catcom

Synthesis of nano-WO_3 and its catalytic activity for enhanced antimicrobial process for water purification using laser induced photo-catalysis

M.A. Gondal *, M.A. Dastageer, A. Khalil

Physics Department and Center of Excellence in Nanotechnology, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia

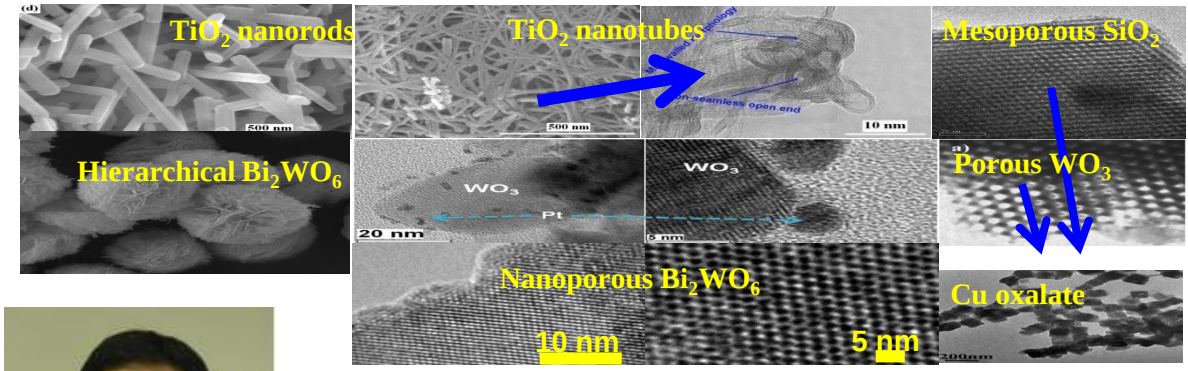
ARTICLE INFO | ABSTRACT


Contents lists available at ScienceDirect
Applied Surface Science
journal homepage: www.elsevier.com/locate/apsusc

Spectroscopic characterization approach to study surfactants effect on ZnO_2 nanoparticles synthesis by laser ablation process

Q.A. Drmosh[a,b], M.A. Gondal[a,b,*], Z.H. Yamani[a,b], T.A. Saleh[b,c]

[a] Laser Research Group, Physics Department, King Fahd University of Petroleum & Minerals, Dhahran 31261, Saudi Arabia
[b] Center of Excellence in Nanotechnology (CENT), King Fahd University of Petroleum & Minerals, Dhahran 31261, Saudi Arabia
[c] Chemistry Department, King Fahd University of Petroleum & Minerals, Dhahran 31261, Saudi Arabia



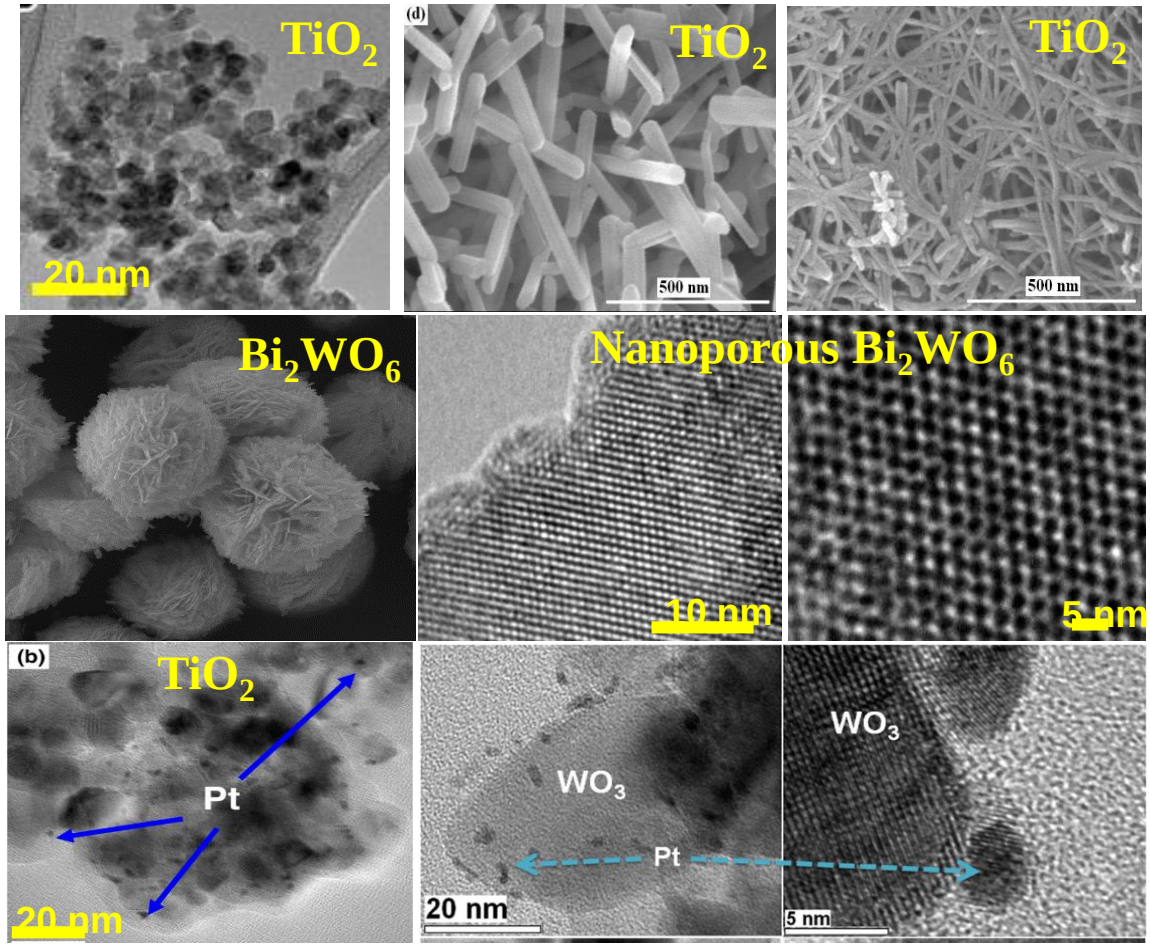
M. Qamar, et al., Catalysis Today 230 (2014) 158-165.
M. Qamar, et al., Catalysis Communications 11 (2010) 768-772.
M. Qamar, et al., Nanotechnology 20 (2009) 455703.
M. Qamar, et al., Langmuir 25 (2009) 6469-6475.

Qamar Azmi; Aligarh 2007; Post Doctoral Fellow in Sejong Univ.- S. Korea

H_2 generation, CO_2 reduction, Water purification, Selective organic functional group transformation

Electro-Photo-Catalysis for Hydrogen Production

Control of size, doping, structure and interface



Nanoparticle, Nanorods, nanotubes

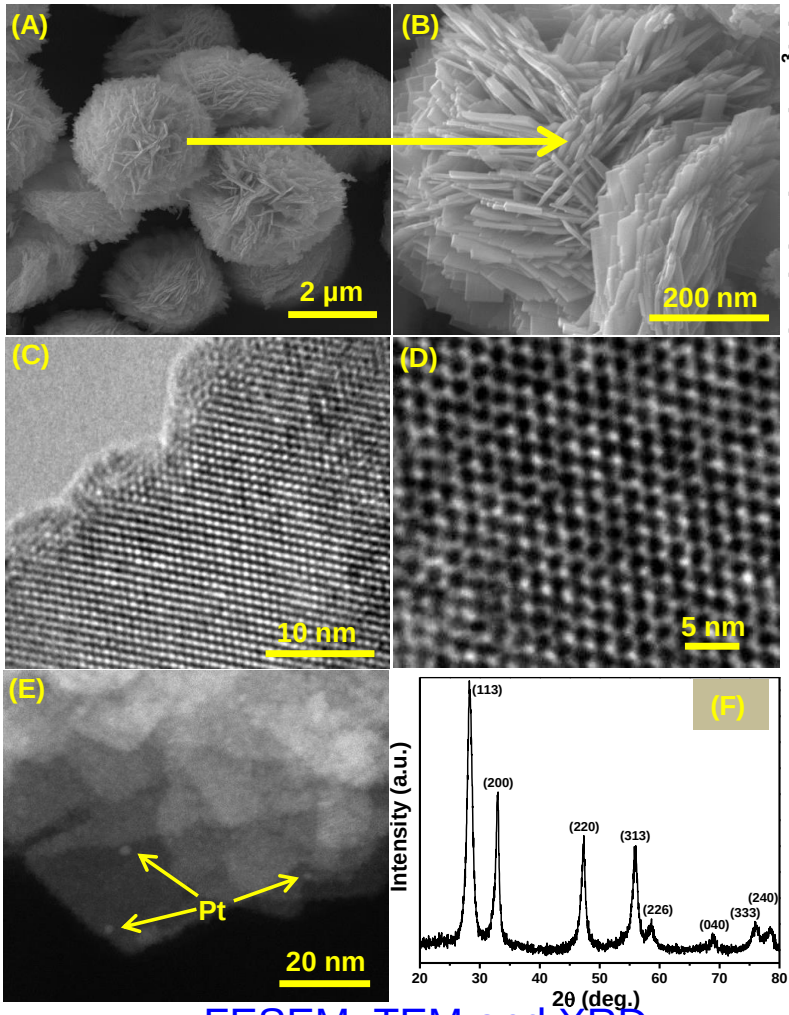
Hierarchical and mesoporous

Generation of interface

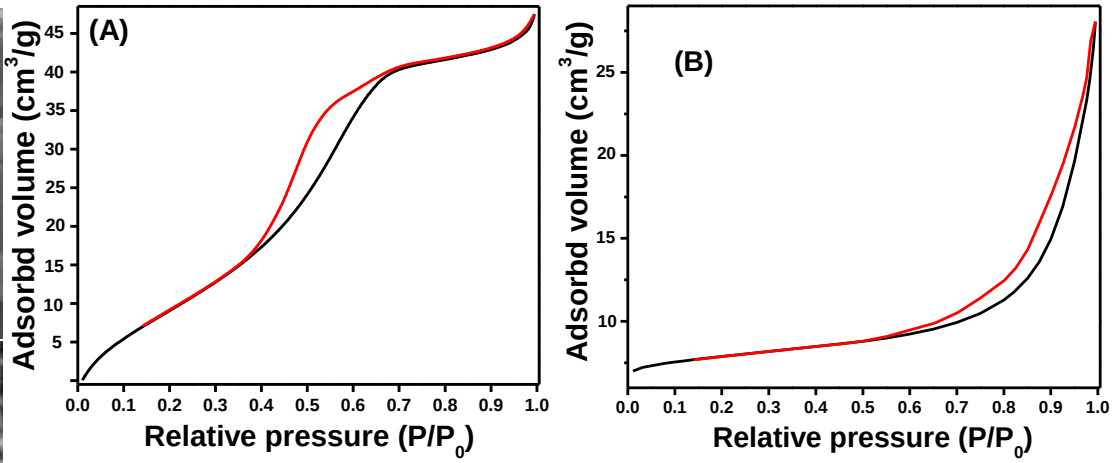
M. Qamar et. al., Langmuir, Nanotechnology, RSC Advances, Catalysis Today, Catalysis Communications, J. Molecular Catalysis A, Solid State, Sciences, J. Hazardous Materials etc.

Electro-Photo-Catalysis for Hydrogen Production

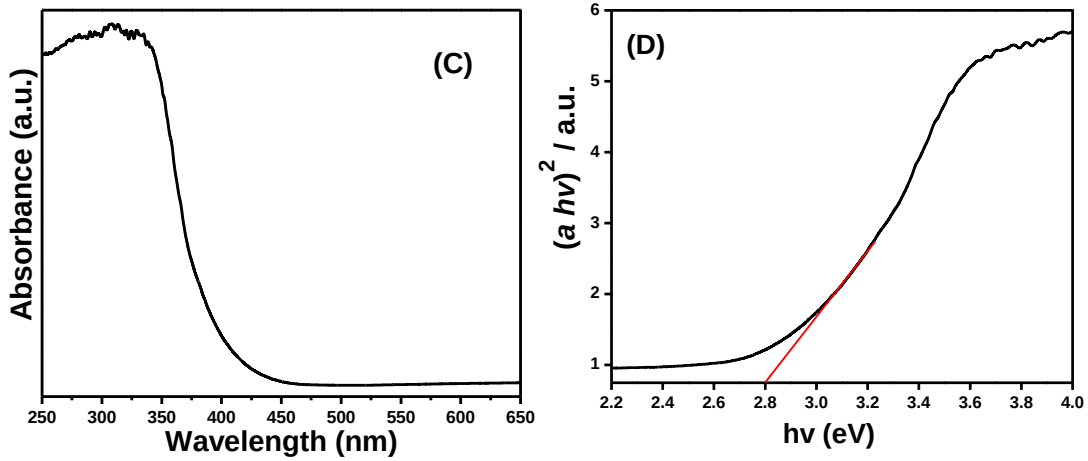
Development of Nanoporous Hierarchical Pt/Bi_2WO_6 for Selective and Highly Efficient Oxidation of Alcohols under Visible Light



FESEM, TEM and XRD



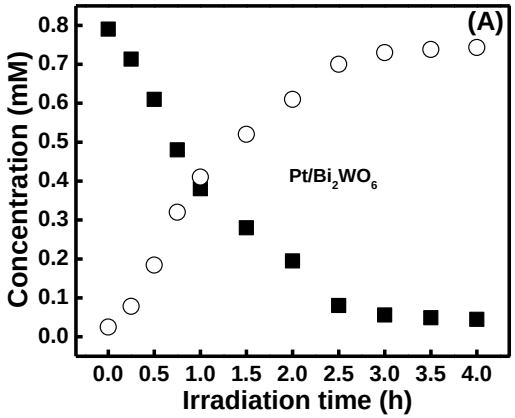
BET – N_2 adsorption-desorption isotherms showing porosity

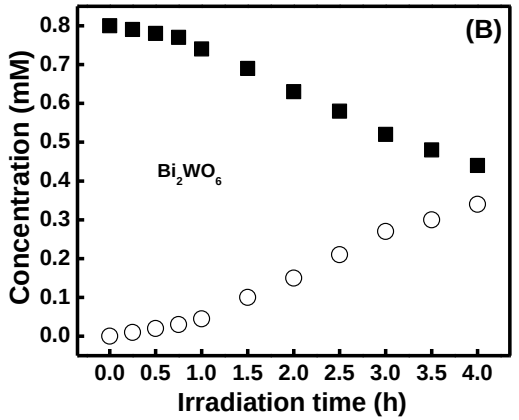


Absorption spectra and band gap calculation

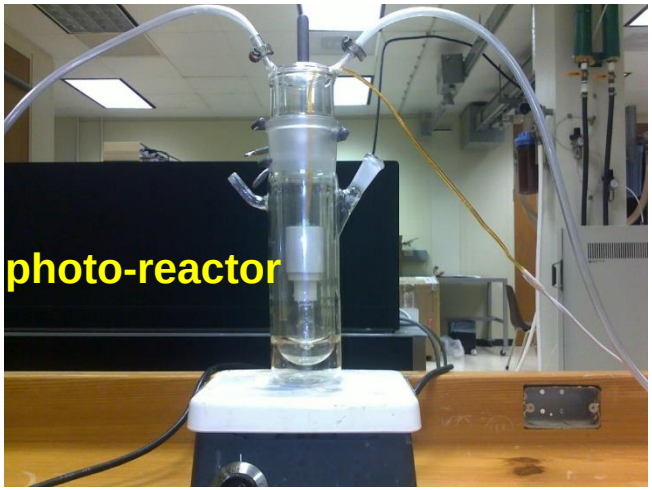
M. Qamar et. al. ACS Applied Materials & Interfaces (submitted)

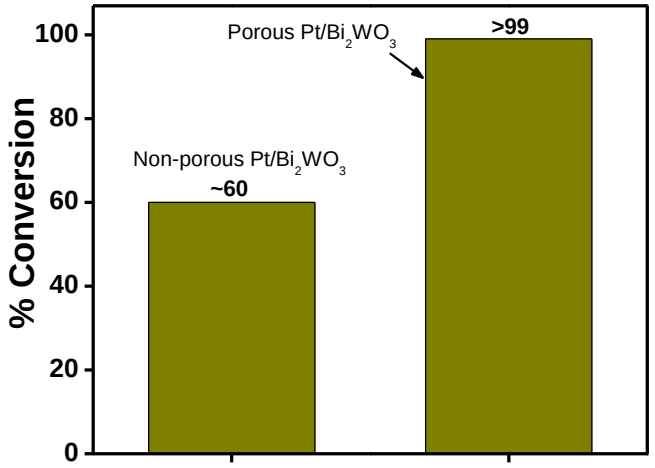
Electro-Photo-Catalysis for Hydrogen Production





(A) Oxidation of 4-MBA into *p*-anisaldehyde using Pt/Bi_2WO_6, (B) Oxidation of 4-MBA into *p*-anisaldehyde using Bi_2WO_6

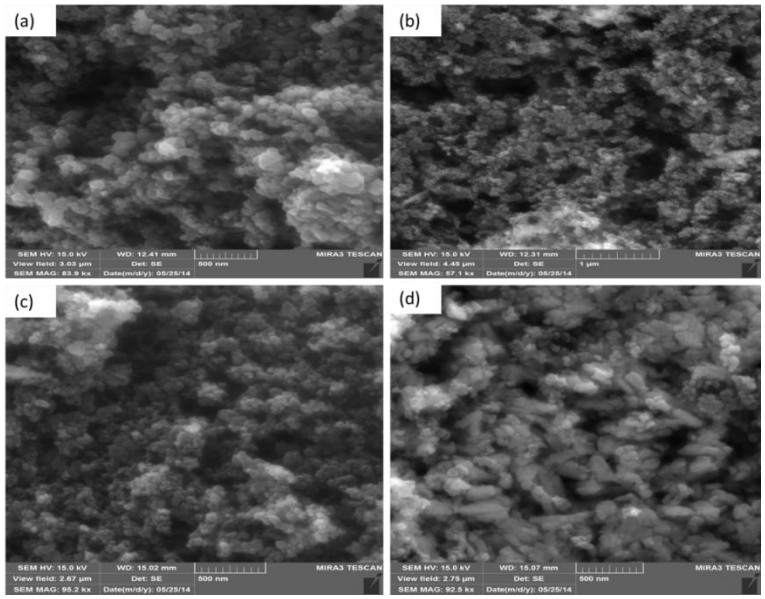


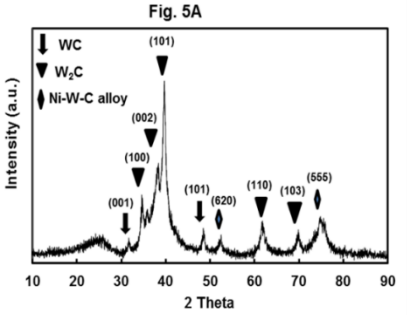


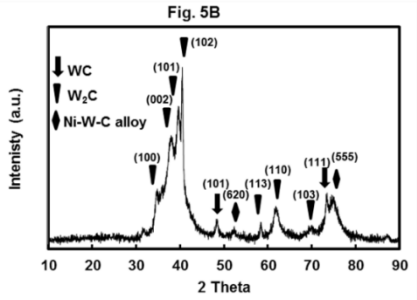
Improvement of photocatalytic activity due to porosity

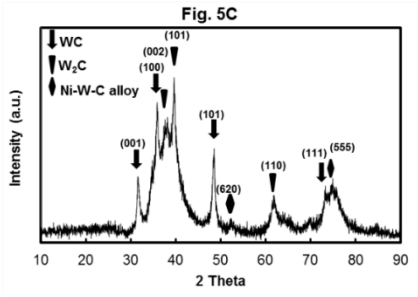
Electro-Photo-Catalysis for Hydrogen Production

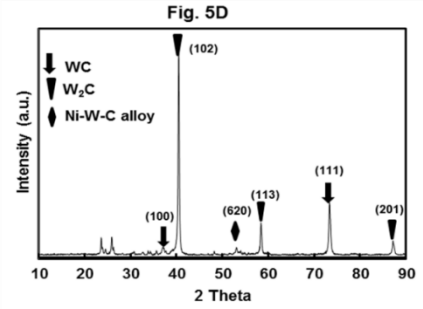
Development of W-Ni-C Nanocomposite (as an *alternative* to Pt) for Efficient H_2 Evolution from Water

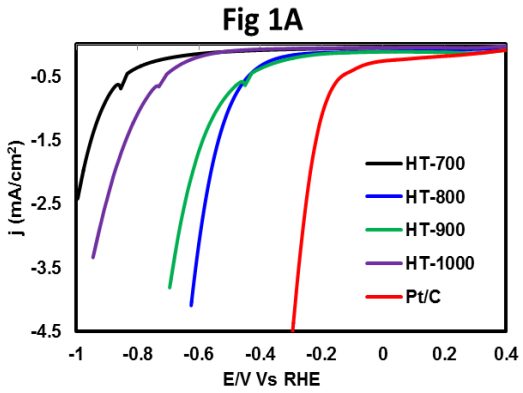


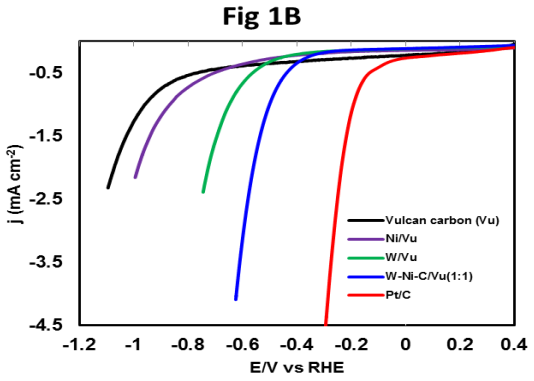


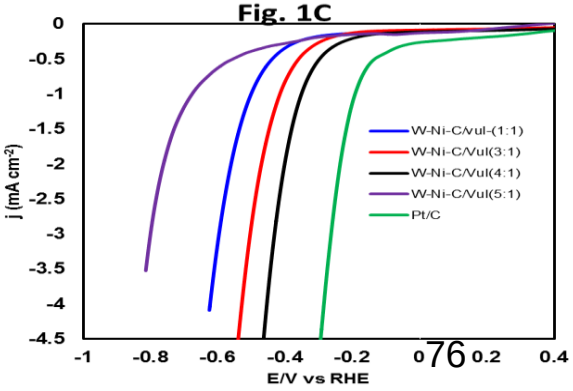






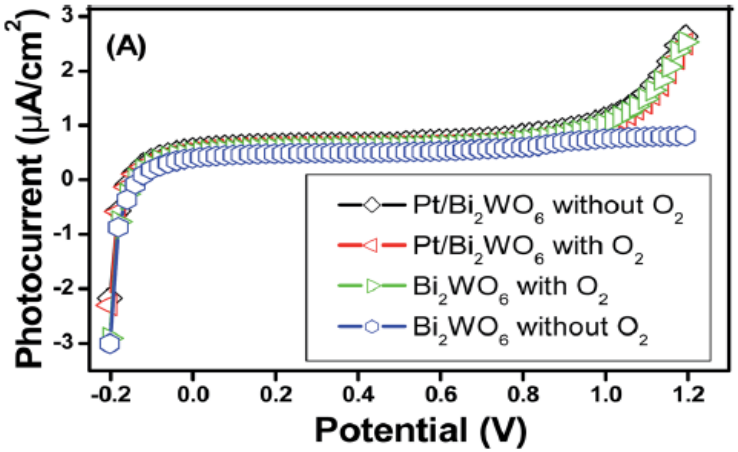


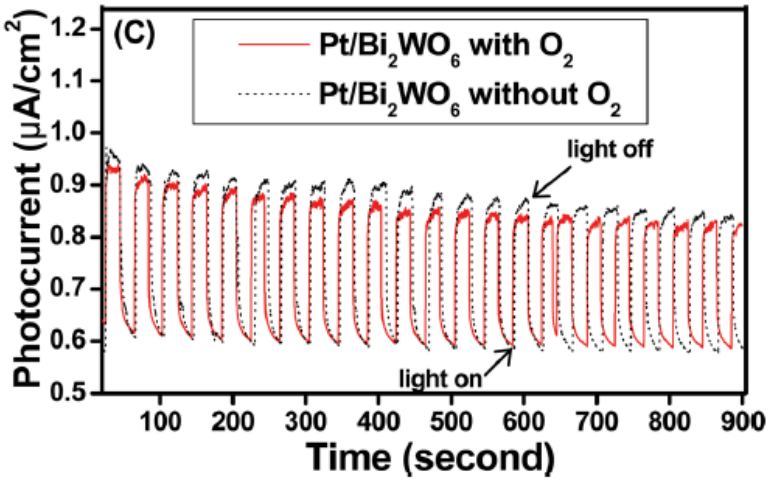




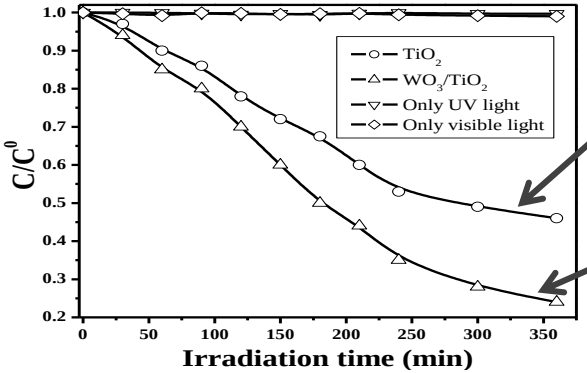
Electro-Photo-Catalysis for Hydrogen Production

Development of Porous Nanostructured Materials for H_2 Generation, CO_2 and O_2 Reduction Reaction Using Photo/Electrochemical Cells





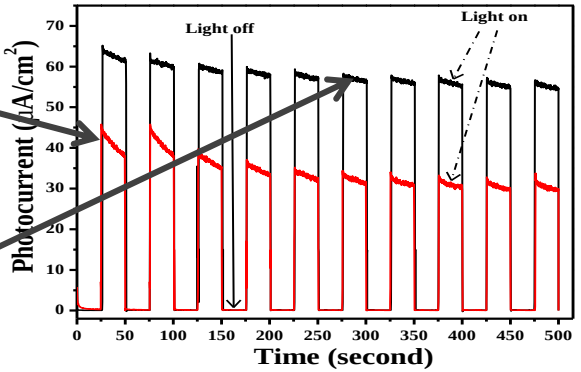
Photocatalytic activity



Pure TiO_2

Bilayers of WO_3/TiO_2

Photoelectrochemical activity



M. Qamar et al., RSC Advances 4 (2014) 9542.

Nanostructured Zeolites for Hydrocarbon Conversion

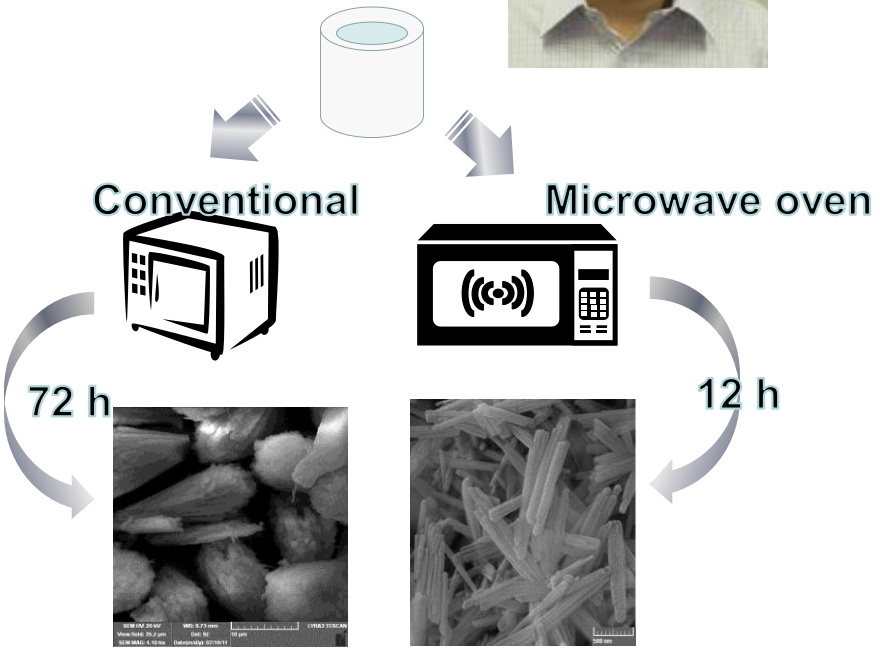
Funding sources:

NSTIP/KACST: 4 projects (approx. 8 Million SAR)

Saudi Aramco: 6.5 Million SAR

Objectives:

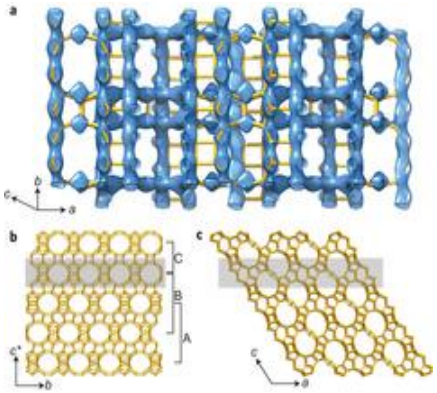
To develop nano structured silico-aluminates having high surface area for commercially important processes such as catalytic cracking, methanol-to-propylene, heavy oil upgrading, natural gas valorization and CO_2 dry reforming.



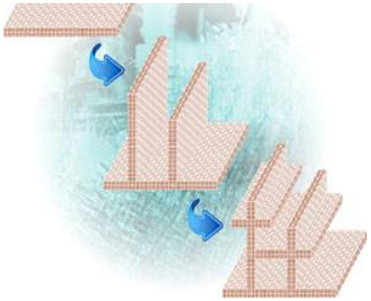
Muraza et al., Chem. Eng. J. 226 (2013)
Fuel 135 (2014)
US14/151498 Patent Pending

Nanostructured Zeolites for Hydrocarbon Conversion

To develop novel nanocatalysts



Corma et al., Nature Chem. 2012
Novel Zeolites



Tsapatsis et al., Science 2012
Novel Morphologies

To contribute to Industry in Kingdom

ارامكو السعودية
Saudi Aramco

Valorization of oil in refinery
→ Naphtha to propylene

Valorization of natural gas derivatives
→ Methanol to propylene

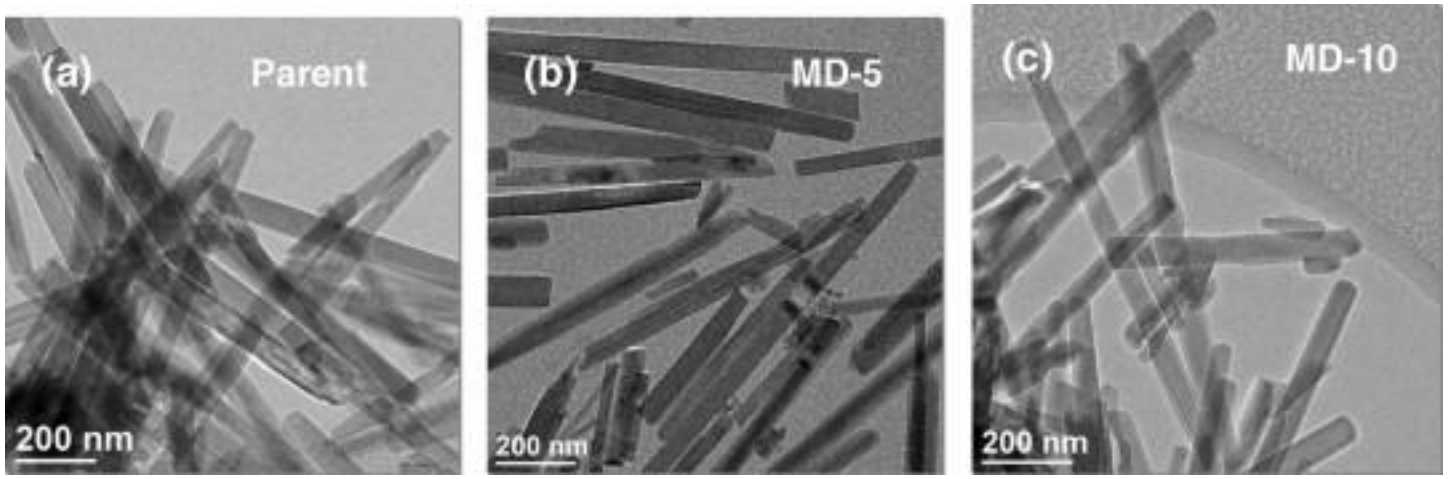
To train for scientists & engineers

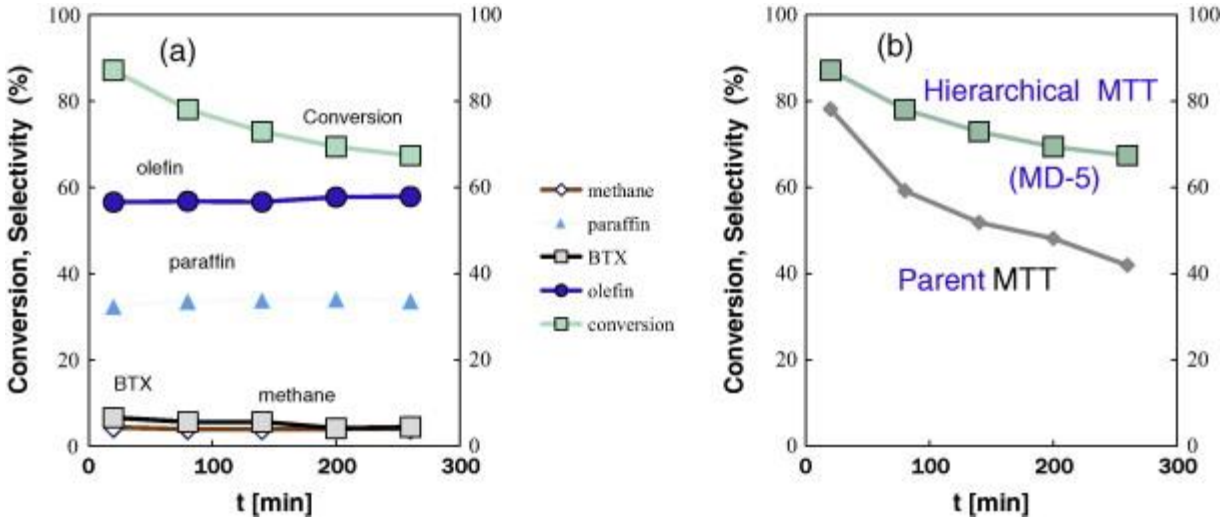
صدارة
Sadara

$20 billion projects
26 manufacturing plants

Nanostructured Zeolites for Hydrocarbon Conversion

Hierarchical MTT zeolites as catalyst for naphtha to propylene



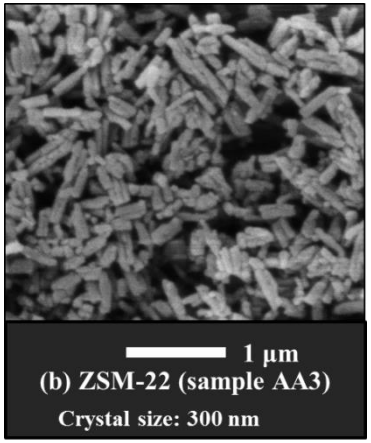


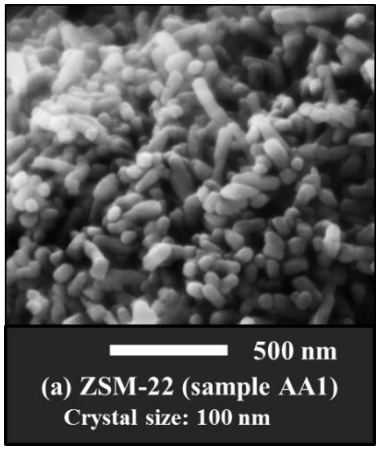
Muraza, Bakare, Tago, Konno, Taniguchi, Al-Amer, Yamani, **Fuel** 135 (2014)

Nanostructured Zeolites for Hydrocarbon Conversion

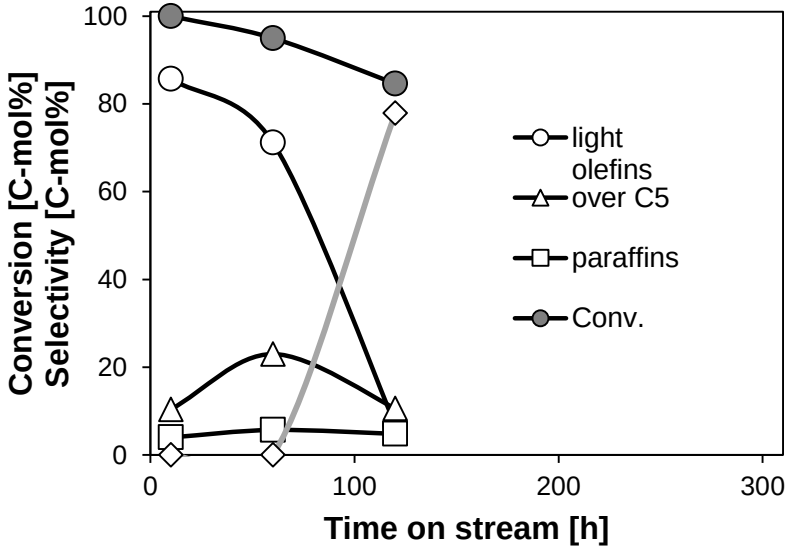
Selective production of propylene from methanol over nanosized ZSM-22 zeolites

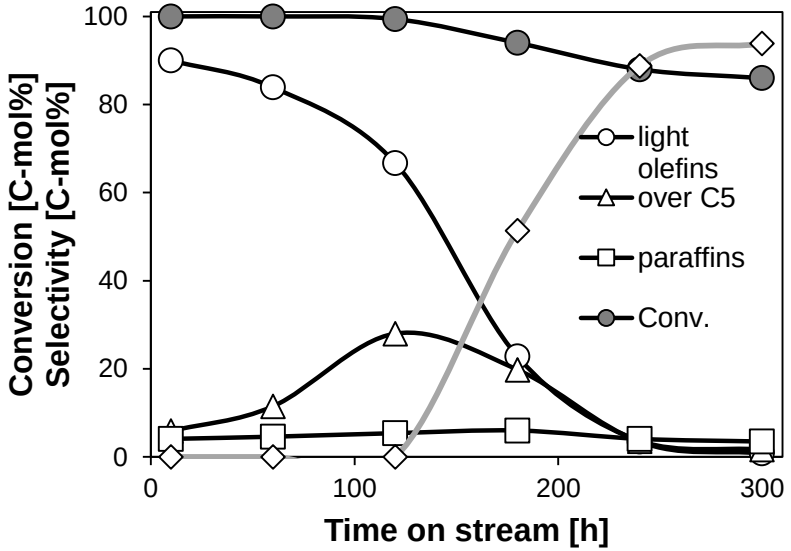
(a) Sample AA3 (300 nm)





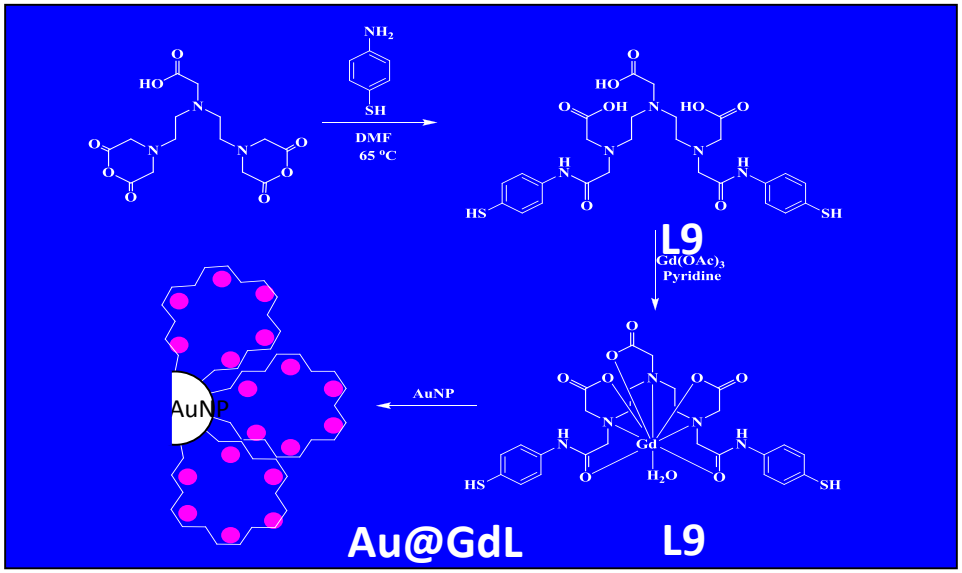
(b) Sample AA1 (100 nm)



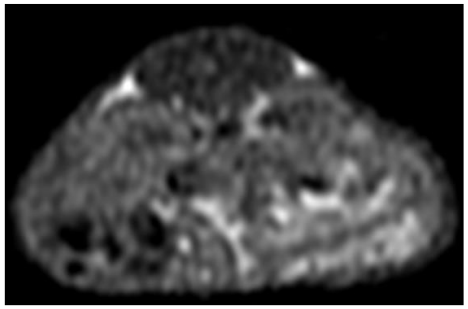


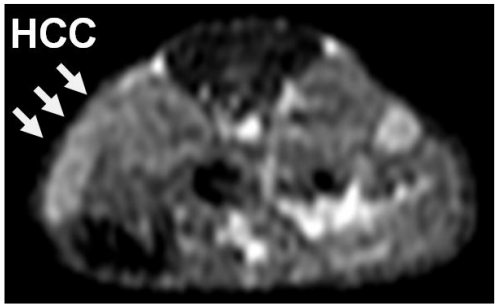
Jamil, Muraza, Yoshioka, Al-Amer, Yamani, Yokoi, **IECR** (2014).

Gd-Chelate Coated Gold Nanoparticles as Super High Relaxivity Bimodal MRI and CT Contrast Agent



Next: rocks instead of tissues



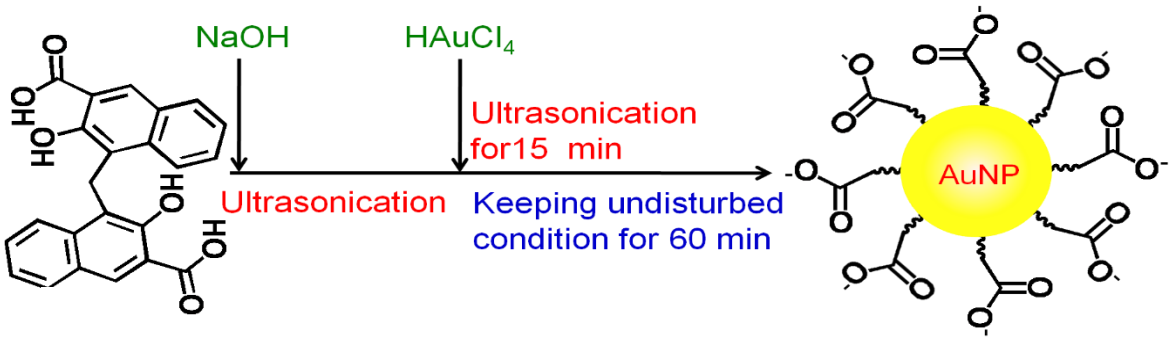


MRI

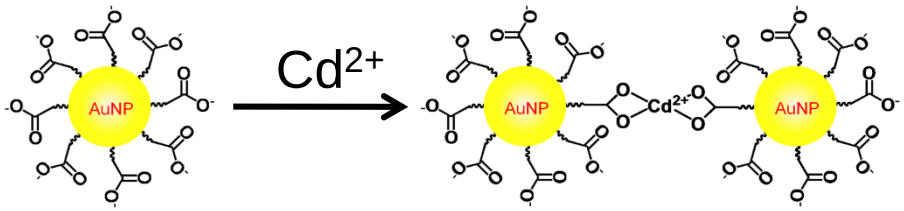
158.6 128 80 48 31.7 15.8

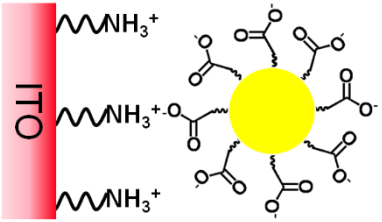
CT Contrast

Catalytic/ electro-catalytic sensing



CAuNP using PA

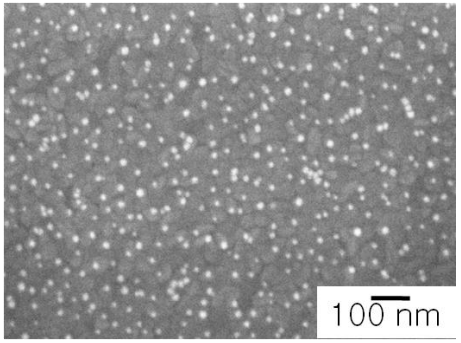




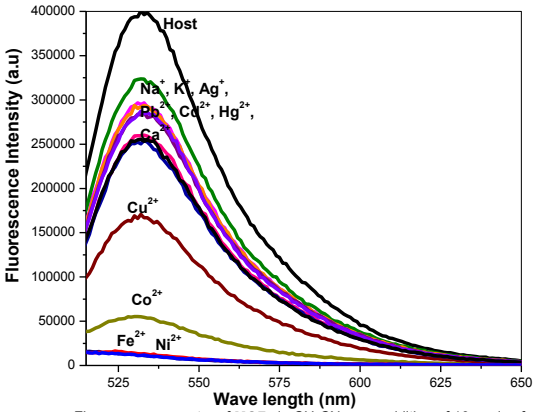
CAuNP (aq.)

Aggregated CAuNP (aq.)

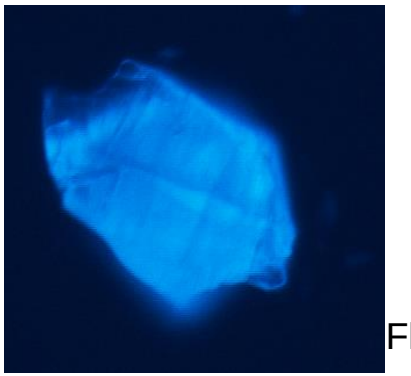
Carboxylated gold nanoparticles.. *well dispersed*



MOFs for carbon capture or sensing



Fluorescence spectra of **MOF5** in CH_3CN upon addition of 10 equiv of various metal ions. λ_{ex} = 350 nm.



Fluorescence Microscope image of MOF5

Spark Plasma Sintering for cutting tools

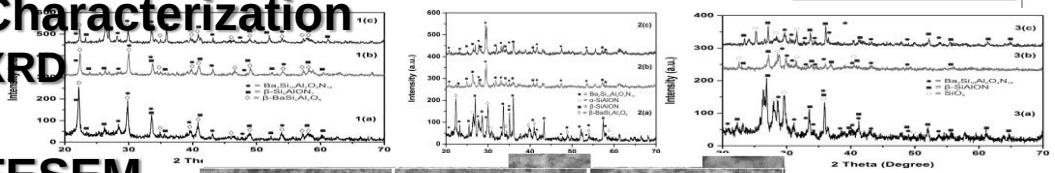
Synthesis

SPS @ 50 MPa, atm. N_2, 1600 °C with 100

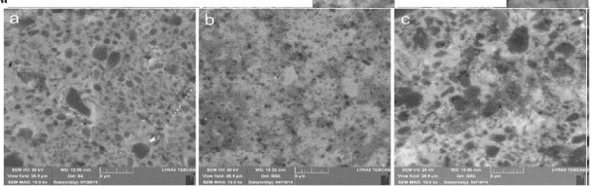
Sample ID	Starting Composition	BaO	A*-Si_3N_4	β-Si_3N_4	A*-SiO_2	Al_2O_3	AlN	Al
1a	$BaSi_4Al_2O_2N_6$	34	31	---	13	22	---	
1b	$BaSi_4Al_2O_2N_6$	34	31	---	13	21	---	1
1c	$BaSi_4Al_2O_2N_6$	34	---	31	13	21	---	1
2a	$BaSi_4Al_6O_3N_{12}$	22	40	---	---	15	23	
2b	$BaSi_4Al_6O_3N_{12}$	22	40	---	---	15	21	2
2c	$BaSi_4Al_6O_3N_{12}$	22	---	40	---	15	21	2
3a	$BaSi_2AlO_2N_3$	33	48	---	7	---	10	
3b	$BaSi_2AlO_2N_3$	33	48	---	7	---	9	1
3c	$BaSi_2AlO_2N_3$	33	---	48	7	---	9	1

Characterization

XRD



FESEM



Results

Density and Hardness Test

1a	3.392	9
1b	3.291	7
1c	3.392	8
2a	3.425	11
2b	3.488	11
2c	3.412	13
3a	3.346	10
3b	3.074	10
3c	3.037	12

CENT

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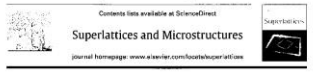
Publications and Patents

Book/Book chapters/Book edited – 06
Published Papers – > 230
Conference Presentations– > 100
Patents Issued – 04
Patents applied for at KFUPM – > 20


Superlattices and Microstructures 45 (2009) 598–603

Contents lists available at ScienceDirect

Superlattices and Microstructures

journal homepage: www.elsevier.com/locate/superlattices

Ultra fast synthesis of zinc oxide nanostructures by microwaves

N. Tabet[a,*], R. Al Ghashani[a], S. Achour[b]

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[b] Ceramics Laboratory, University Mentouri, 25000 Constantine, Algeria

ARTICLE INFO

Article history:
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ZnO
Nanostructures
Nanopowder
Microwave
SiC

ABSTRACT

We describe a novel route for the synthesis of nanocrystalline zinc oxide powder using a modified kitchen microwave oven. A composite showing a very strong absorption of microwaves was used as a microwave heater. Tests showed that a temperature exceeding 1100 °C can be reached in less than 10 min of exposure of the composite material of zinc powder and SiC nanopowder was obtained by evaporation and condensation of metallic zinc in the ambient atmosphere. Scanning Electron Microscopy (SEM) and X-ray diffraction (XRD) techniques revealed the prepared powder to be composed of a variety of nanostructures including nanopowders, nanowires, nanobelts, nanosaws and tetrapods.

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1. Introduction

The synthesis of nanostructured ZnO of various shapes has been the subject of many publications in the last decade. A wide variety of techniques have been used by various groups, including catalyst-assisted Vapor Liquid Solid (VLS) [1–3] and thermal evaporation using a tube furnace [4–6]. Recently, ZnO micro- and nano- structures including nanorods and nanotubes have been successfully synthesized by using microwave thermal evaporation deposition on sapphire and silicon substrates [7]. In this work, we have developed a very simple method to synthesize nanostructured ZnO powder using a new SiC-based composite as a heater which can reach temperatures as high as 1100 °C in less than 100 s exposure to microwaves.

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E-mail address: nabil@kfupm.edu.sa (N. Tabet).

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nwpii.com/ajbms

Moving Enzyme-Linked ImmunoSorbent Assay to the Point-of-Care Dry-Reagent Strip Bi

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[2]Center of Excellence in Nanotechnology, and Department of C
Minerals, Dhahran 31261, Saudi Arabia
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Received: 10 May 2009; / Revised: 13 July 2009; / Accepted: 27 Ju

Abstract

In this work, we described a point-of-care (POC) dry-reagent strip biosensor (DRSB) based on enzyme tracers and portable strip reader for simple, low-cost and sensitive assay of protein detection in minutes. Horseradish Peroxidase (HRP) and Rabbit IgG (R-IgG) were used as a model system for the demonstration of the proof-of-concept. The sandwich-type immunoreactions were performed on the DRSB and the HRP tracers were captured on the test zone of the biosensor. The excess of HRP tracers were captured on the control zone of the biosensor through the immobilized secondary antibody. Subsequent enzymatic reaction in the presence of the substrate produced insoluble enzymatic products, which deposited on both test and control zones of the DRSB and formed two characteristics blue bands. While qualitative tests are realized by observing the color change of the test zone, quantitative data are obtained by recording the intensities of the test zone with a portable "strip reader". The quantitative response of the optimized DRSB over the range of 0.1-50 ng mL^{-1} IgG in association with a 10-min assay time is obtained, and the limit of detection is estimated to be 0.05 ng/mL, which is ten times lower than that of the gold nanoparticle (GNP)-based DRSB. The enzyme-based DRSB was used to detect Carcinoembryonic Antigen (CEA) biomarker in human plasma successfully. Such enzyme-based DRSB offers a simple and fast tool for point-of-care protein assay and a potential substituent for the traditional Enzyme-linked Immunosorbent Assay (ELISA).

Keywords: ELISA; Biosensor; Enzyme; Point-of-care; Dry-reagent strip.

Am. J. Biomed. Sci. 2009, x(x), xxx-xxx © 2009 by NWPII. All rights reserved. xxx


Catalysis Communications

journal homepage: www.elsevier.com/locate/catcom

Synthesis of highly active nanocrystalline WO_3 and its application in laser-induced photocatalytic removal of a dye from w

M. Qamar[1], M.A. Gondal[1,2,*], Z.H. Yamani[1,2]

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Laser-induced photocatalysis
Nanocrystalline tungsten oxide
Sol–gel synthesis
Dye degradation

ABSTRACT

Tungsten oxide nanoparticles were synthesized using photocatalytic removal of a dye using a 355 nm laser. Effects of various parameters, such as calcination temperature and laser energy on the photocatalytic removal of dye, and atomic complete degradation of dye can be achieved even in presence of nanocrystalline WO_3 under ambient conditions with an appreciable rate constant. Crystal structure nature of WO_3 and the laser as an excitation source using large and economical microwave cavity

1. Introduction

Water is a prime source for all living organisms including human beings. The availability of clean (non-polluted) water is a major problem nowadays and expected to increase in future due to the global industrialization. A number of industrial effluents, agricultural runoff and chemical spills are directly released into water systems. Industrial effluents contain several non-biodegradable pollutants that can be harmful to the environment [1,2]. Their toxicity, stability to natural decomposition and persistence in the environment has been the cause of great concern to the societies and regulation authorities around the world [3]. The removal of organic pollutants from waters is very important for environmental protection and to fulfill the needs for drinking, irrigation and industrial use. Among processes proposed and/or being developed for the destruction of the organic contaminants, biodegradation has received the greatest attention [4]. However, many organic chemicals, especially those that are toxic or refractory, are not amenable to microbial degradation. So, biodegradation is not efficient for removal of organic pollutants. Recently considerable attention has been focused on the use of semiconductor catalysts as a means to oxidize toxic organic compounds and this process is considered to be one of the most economic and promising industrial effluent water treatment processes [5–11]. The mechanism constituting

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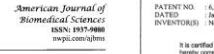
doi:10.1016/j.catcom.2009.07.014


American Journal of Biomedical Sciences
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nwpii.com/ajbms

Moving Enzyme-Linked ImmunoSorbent Assay to the Point-of-Care Dry-Reagent Strip Biosensors

Abdel-Nasser Kawde,[1,2,3*] Xun Mao,[1] Hui Xu,[1] Qingxiang Zeng,[1] Yuqing He,[1,4] Guodong Liu[1*]

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Abstract

In this work, we described a point-of-care (POC) dry-reagent strip biosensor (DRSB) based on enzyme tracers and portable strip reader for simple, low-cost and sensitive assay of protein detection in minutes. Horseradish Peroxidase (HRP) and Rabbit IgG (R-IgG) were used as a model system for the demonstration of the proof-of-concept. The sandwich-type immunoreactions were performed on the DRSB and the HRP tracers were captured on the test zone of the biosensor. The excess of HRP tracers were captured on the control zone of the biosensor through the immobilized secondary antibody. Subsequent enzymatic reaction in the presence of the substrate produced insoluble enzymatic products, which deposited on both test and control zones of the DRSB and formed two characteristics blue bands. While qualitative tests are realized by observing the color change of the test zone, quantitative data are obtained by recording the intensities of the test zone with a portable "strip reader". The quantitative response of the optimized DRSB over the range of 0.1-50 ng mL^{-1} IgG in association with a 10-min assay time is obtained, and the limit of detection is estimated to be 0.05 ng/mL, which is ten times lower than that of the gold nanoparticle (GNP)-based DRSB. The enzyme-based DRSB was used to detect Carcinoembryonic Antigen (CEA) biomarker in human plasma successfully. Such enzyme-based DRSB offers a simple and fast tool for point-of-care protein assay and a potential substituent for the traditional Enzyme-linked Immunosorbent Assay (ELISA).

Keywords: ELISA; Biosensor; Enzyme; Point-of-care; Dry-reagent strip.

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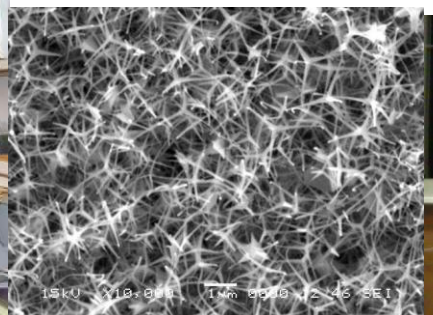
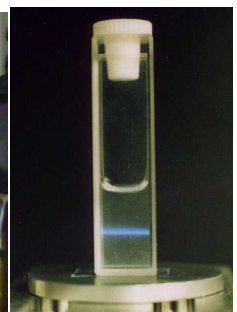


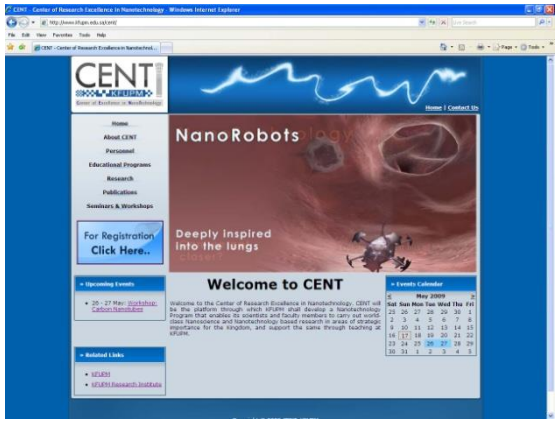


More at CENT...

Bi-weekly CENT Seminars

Visiting professors and students

Day	Date	Title of the Seminar	Speaker
Day	Date	Title of the Seminar	Speaker
Sunday	20/02/11	Pushing Forward with the KFUPM Research Initiatives [CENT as an Example]	Dr. Zain H. Yamani
Tuesday	1/03/11	Magnetism of Nanowires	Dr. Del Atkinson
Tuesday	08/03/11	Introduction Nano-Catalysts for Natural Gas Conversion to Aromatics	Dr. Syed Hussain Tajammul
Tuesday	22/03/11	Hydrogen Fuel Cells as Green Energy Sources: Dream or Reality	Dr. Bel3abass
Tuesday		Zeolite petroleum catalysis	Majnoni
Sunday		With physics department	Dr. Ayman
Tuesday			Asep Bayu
Tuesday			Al-Somali



www.kfupm.edu.sa/cent

Friends of CENT Mailing list

Outreach efforts

Student Mentorship program

- Recruit (a limited number of) young and ambitious undergraduates
- Identify their interest and affiliate them to a research group
- Train them on several nanotechnology related techniques
- We familiarize them with essential laboratory instruments

The student is expected to have the ability to eventually run some equipment

He is also anticipated to participate in conducting research work

Finally, he gives a short talk on what he has learnt at the end of the semester

The idea is for CENT to catch you young, and get you obsessed with research before Career Day!! ☺☺

CENT

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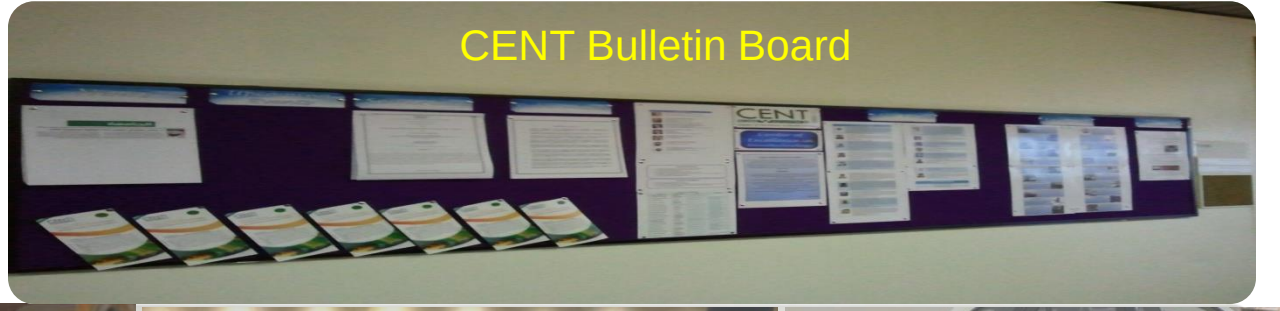
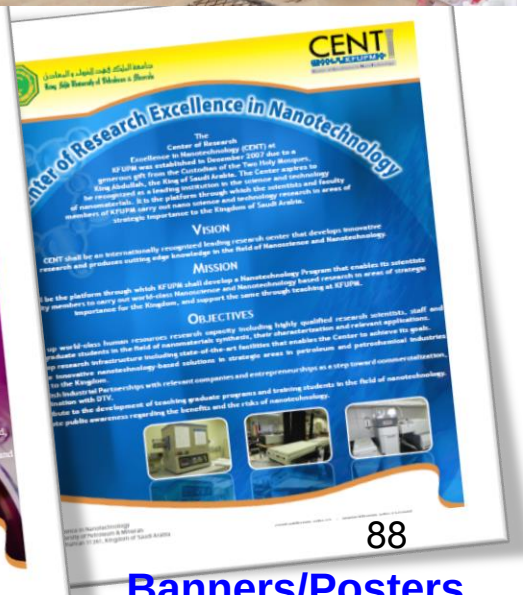


Scitech Festival, Al-Khobar 8th to 10th May, 2012

Desert picnic

CENT Fliers



88

Banners/Posters

CENT
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CENT Researchers

academic affiliates, RAs, collaborators.. and expanding

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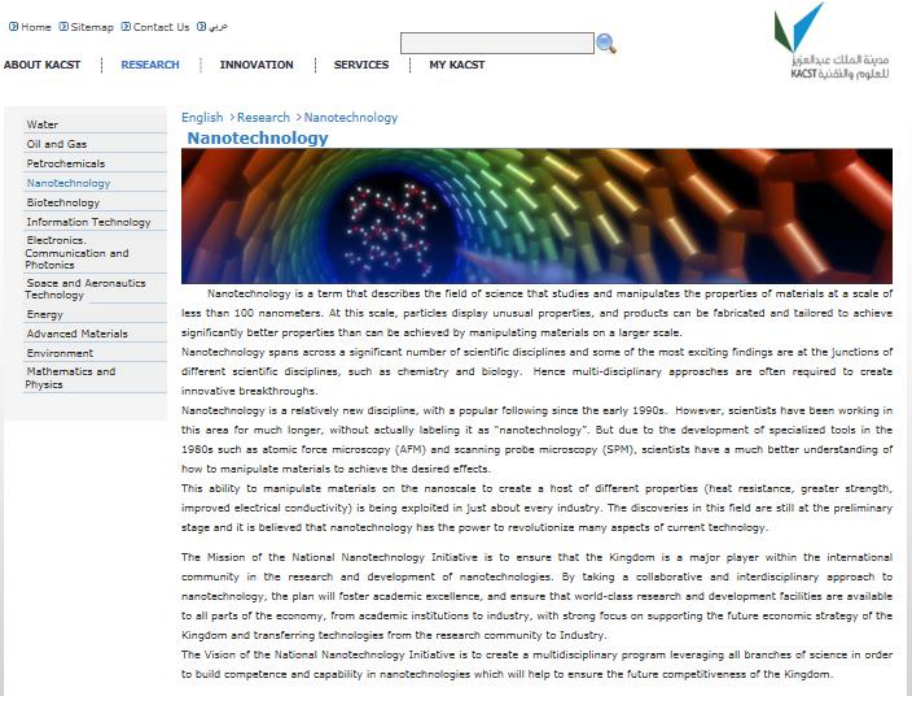
Nanotechnology at KFUPM and **in the Kingdom**

http://www.kacst.edu.sa/en/research/Pages/nanotechnology.aspx



Branches:

1- Quantum Structure & Nanodevices

- MEMS
- Nano-Bio
- Nano Photonics
- Nano Electronics
- Quantum Structure

2- Material & Synthesis

- Nanocatalyst
- Fuel additives
- Fuel extraction
- Thin films and Coatings
- Nanofiltration
- Composite material
- Thermal insulation
- Nanotubes (NTs) and nanowires (NWs)
- Material enhancement using nanoparticles, NWs or NTs
- Nanoparticles and quantum dots
- Textile: fire/water resistant
- Adhesives
- Energy harvesting
- Energy storage
- Lubrication
- Water purification, desalination, and decontamination
- Water quality monitoring
- Computational modeling, & theoretical analysis of nanosystems

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Hands on: atomic force microscopy (AFM) at CENT Labs

We need to conduct an exam!!

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.

http://nanogloss.com/nanotechnology/the-future-of-nanotechnology/

In closing..

CENT is committed to Developing Nanotechnology at KFUPM, especially related to petroleum and petrochemical applications.

I hope we were able to actualize the learning outcomes of this short course.

Do not hesitate to contact CENT if you like to get involved.

Thank you for your attention

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www.kfupm.edu.sa/cent