

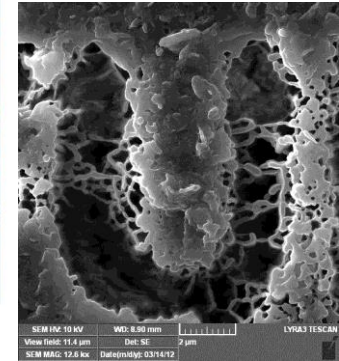
يسر نادي الهندسة الكيميائية دعوتكم لحضور محاضرة بعنوان

Research at KFUPM`s Center of Excellence in Nanotechnology:
Is There a Place for You ?

Tue 3rd Feb , 2014
Building 4 Room 125
12:00 - 1:00 p.m.

يقدمها الدكتور
زين حسن يماني

نادي الهندسة الكيميائية
Chemical Engineering Club



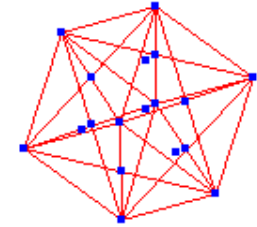
Zain Yamani

Center of Excellence in NanoTechnology, Director

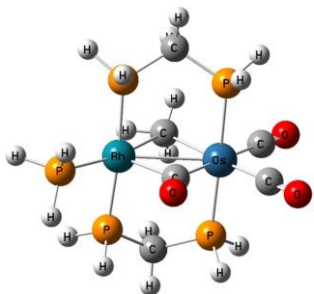
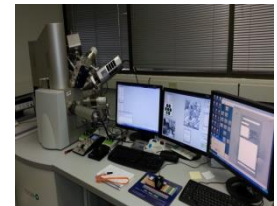
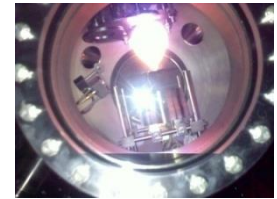
14 Rabi-II, 1436



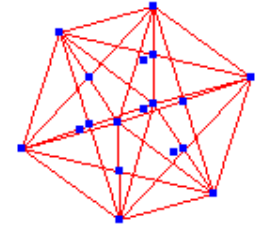
Talk Plan:



- ❖ Introduction on Nanotechnology
- ❖ CENT with a bit of history
- ❖ Research at CENT..
- ❖ Outlook for students



Talk Plan:

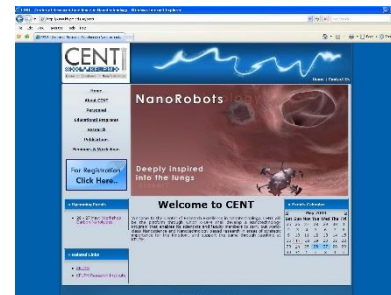
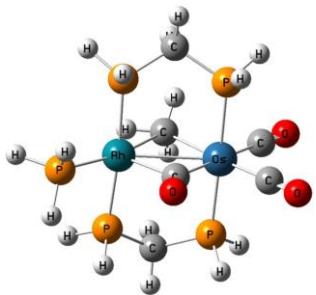
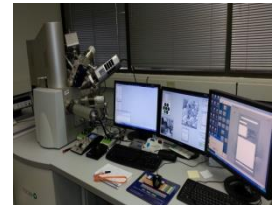
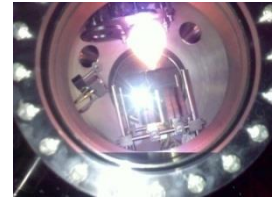


❖ Introduction on Nanotechnology

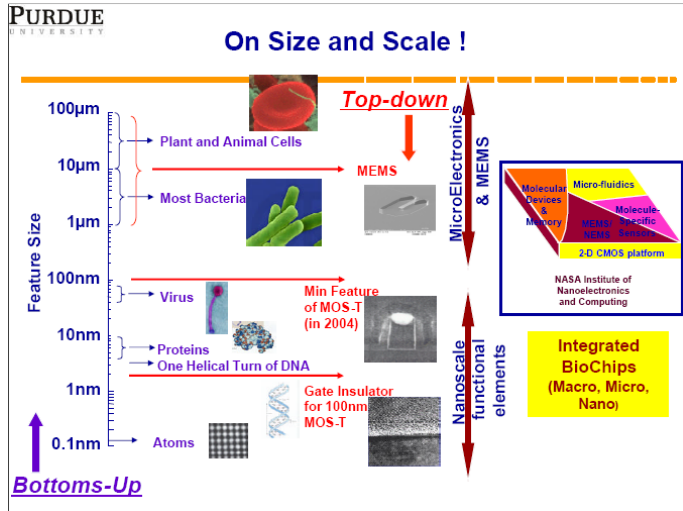
❖ CENT with a bit of history

❖ Research at CENT..

❖ Outlook for students



Introduction to Nanotechnology:

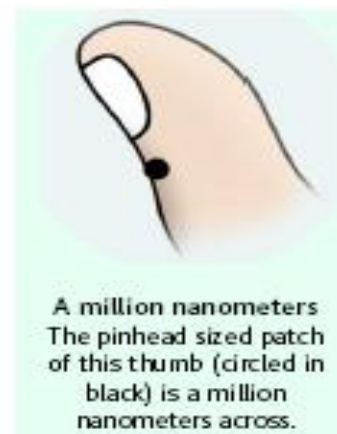
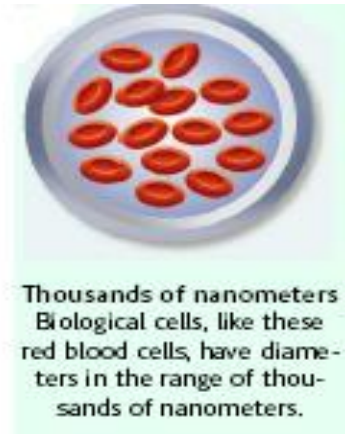
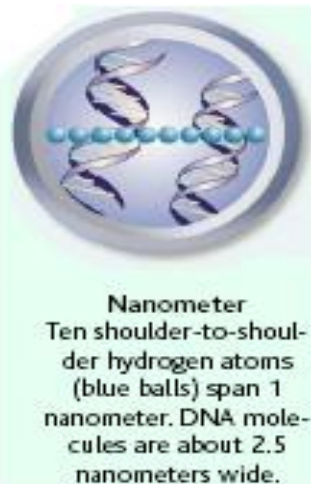
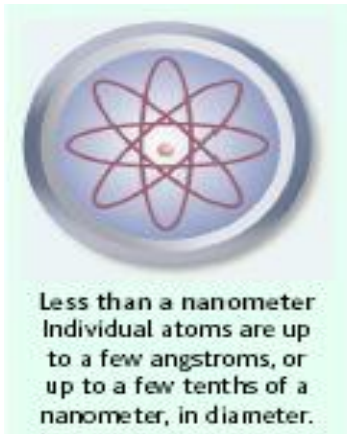


Nano: a prefix which means 1/1000,000,000

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

= 1/1000,000 of a millimeter

= 1/1000 of a micrometer



Introduction to Nanotechnology:

Nanotechnology definition:

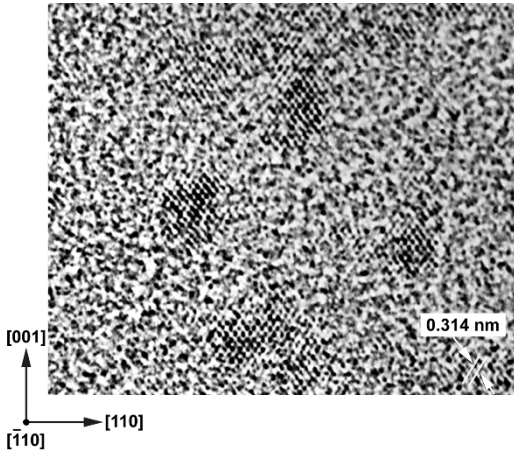
Nanotechnology is the understanding and control of matter at dimensions between approximately 1 and 100 nanometers, where unique phenomena enable novel applications.

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>

Nanometer, Nanogram, Nanonewton, Nanojoule, Nano..

Nanotechnology and Microscopy:



Conventional (Sample A)

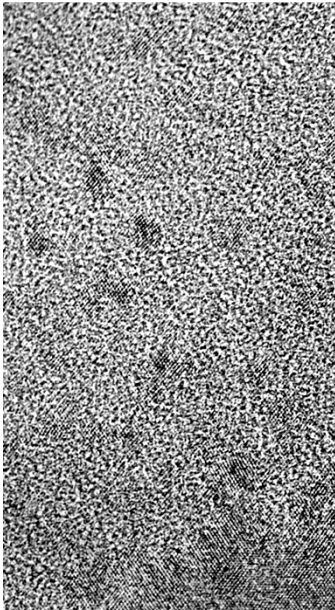
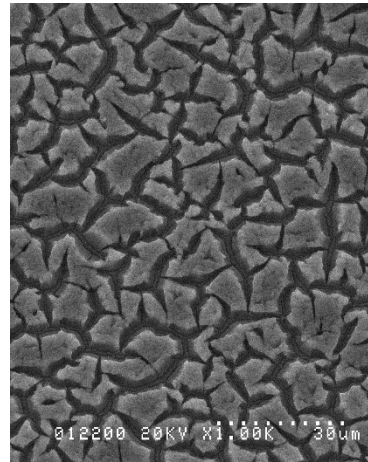


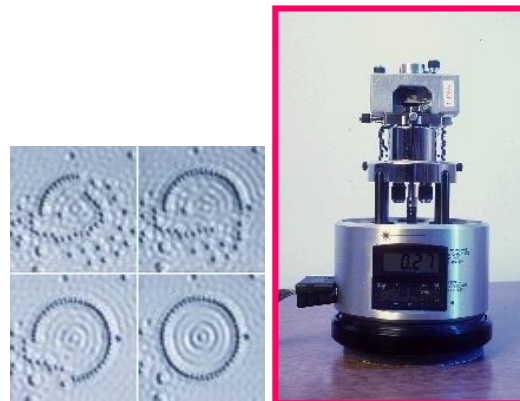
Figure 3 (Larger)



SEM image of porous silicon

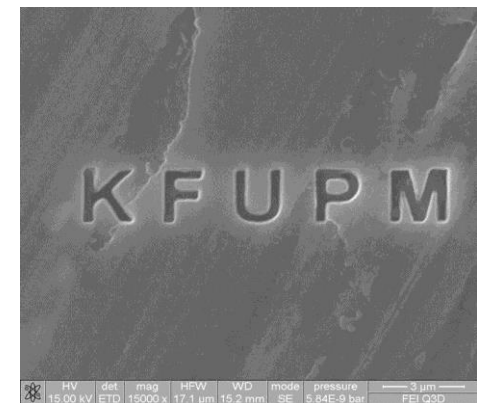


CENT's Dual Beam

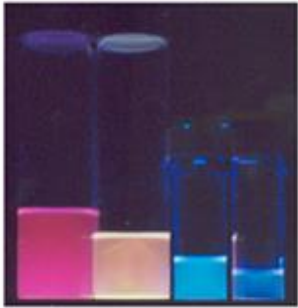
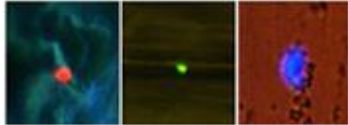


STM for Nobel prize (1986)

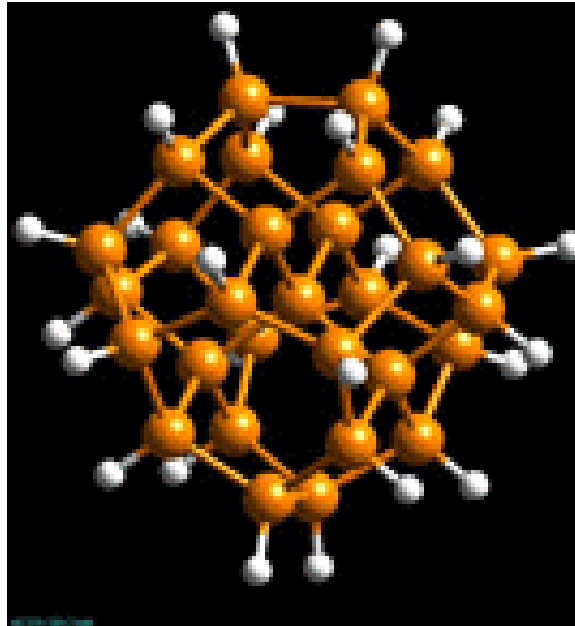
Dual Beam; engraving of University acronym



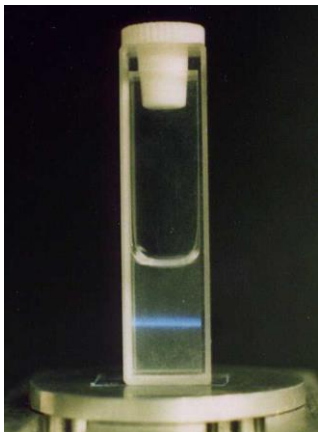
Nayfeh Nanotechnology:



29 Silicon (yellow)
24 Hydrogen (white)



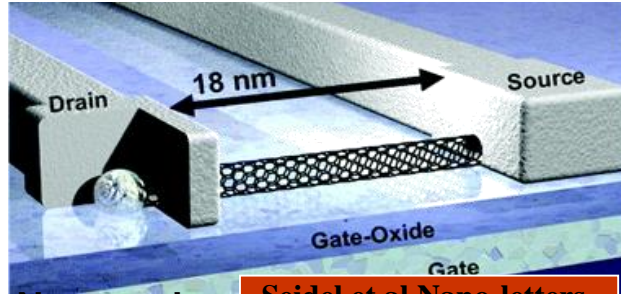
1.03 nanometer



Nayfeh and
Yamani; patent



Nanotechnology in Electronics:



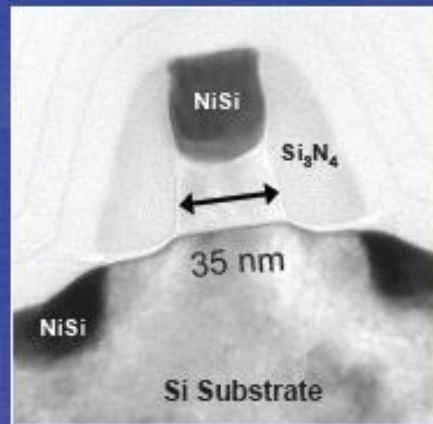
Nanoscale
“vacuum tube”

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

Larger number of
smaller devices
that consume
less energy

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

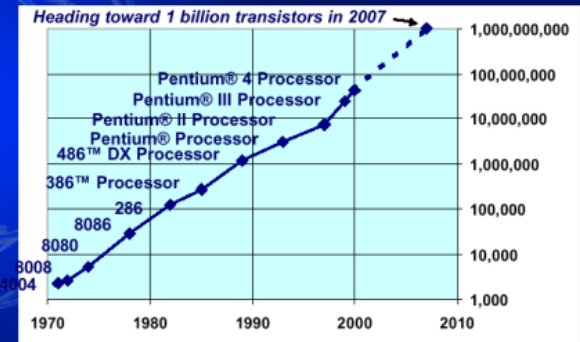
ENIAC, 1945



1800 vacuum tubes
27,000 kg; 140kW

Moore's Law Continues

Transistors doubling every 2 years toward the billion-transistor microprocessor

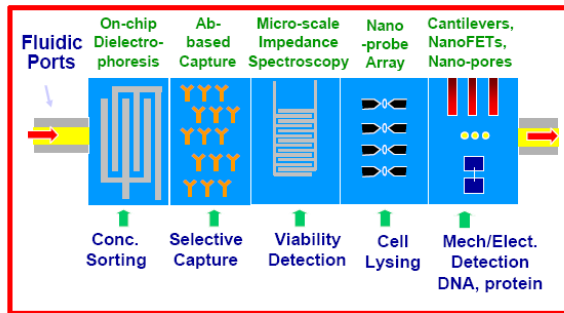


Intel Labs

Nanotechnology in diagnostic and therapeutic medicine

PURDUE
UNIVERSITY

Integrated Systems for Study of Microorganisms and Cells

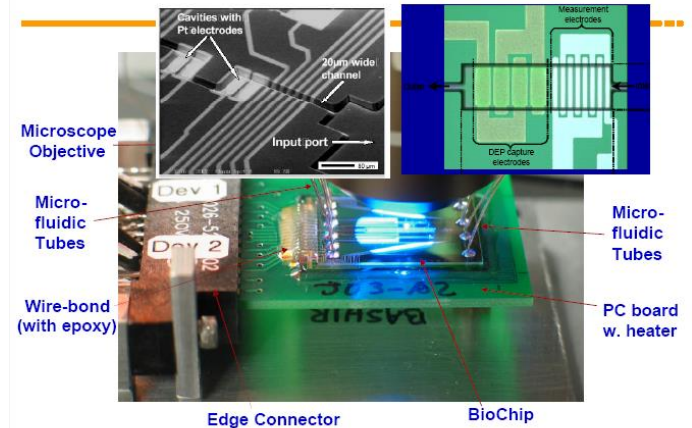


“Lab on a Chip” for Enabled by BioMEMS and Bionanotechnology

38

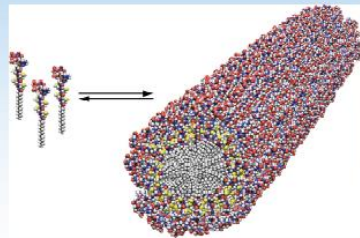
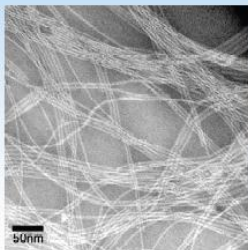
PURDUE
UNIVERSITY

Petri Dish-on-a-Chip

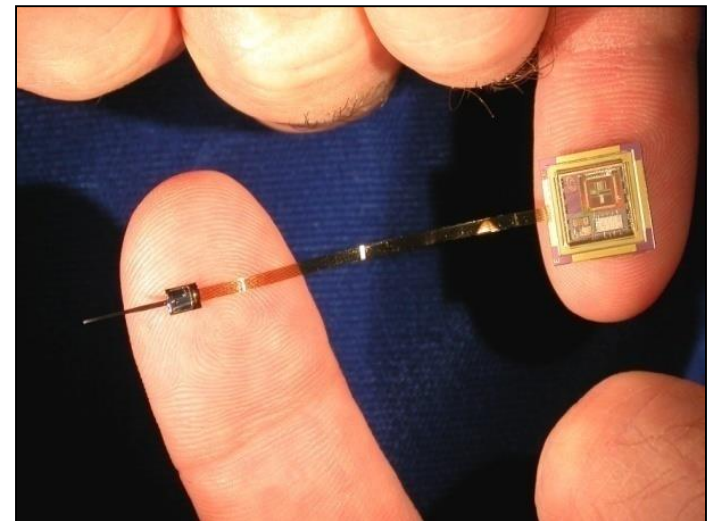


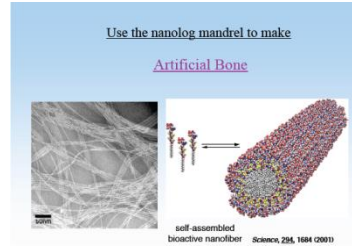
Use the nanolog mandrel to make

Artificial Bone



self-assembled bioactive nanofiber *Science*, 294, 1684 (2001)





Add to Cart



Energy/ photovoltaics

Membranes/ water purification

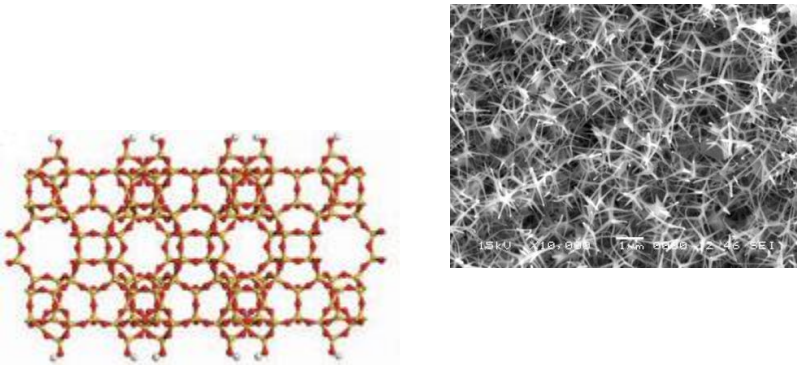
Porous material/ hydrogen storage

Nano-engineered catalysis

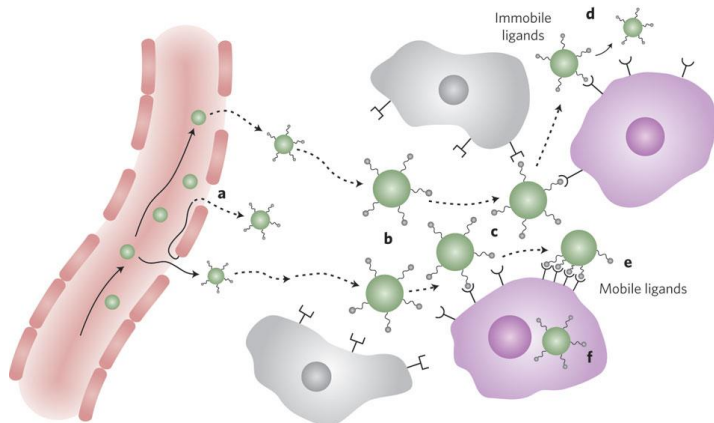
Petrochemicals/ fuel cells

In short:

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

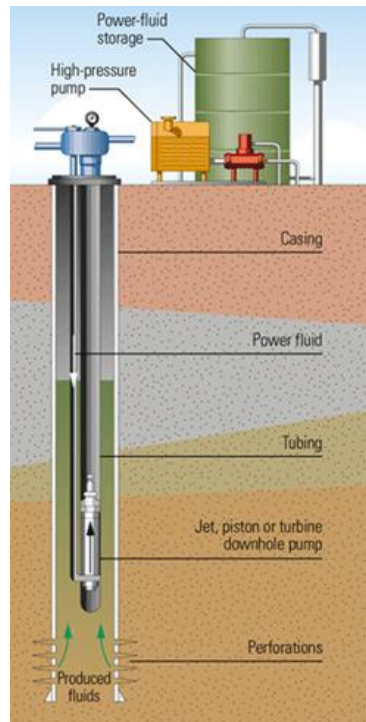


Nanomaterials

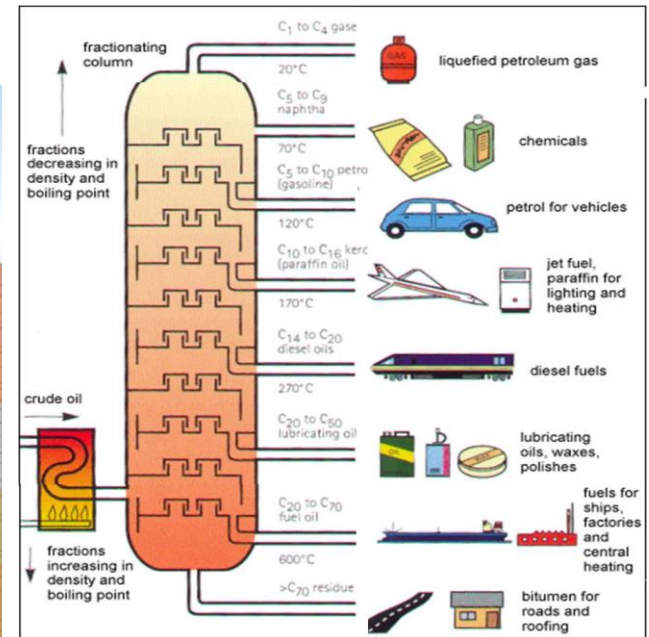


NanoBio: Drug Delivery

Source: Nature Materials 10 (2011) 342



Source: Schlumberger



Oil Refinery

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/>

How is nanotechnology 'special'?

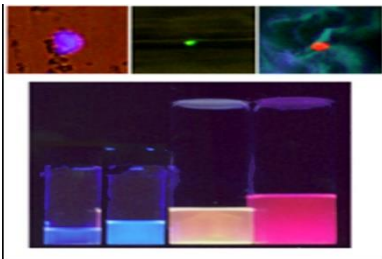
[Optical] Qualities & Quantum Effects



Bulk Gold = Yellow



Nanogold = Red



Z. Yamani and M. Nayfeh

Specific Surface

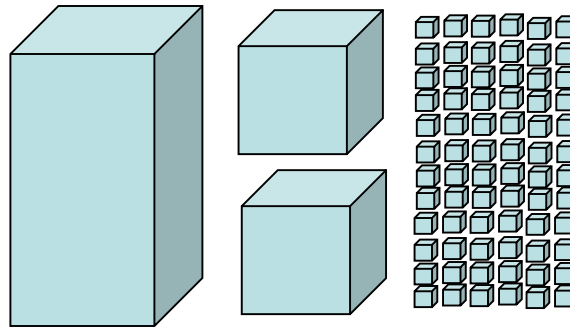
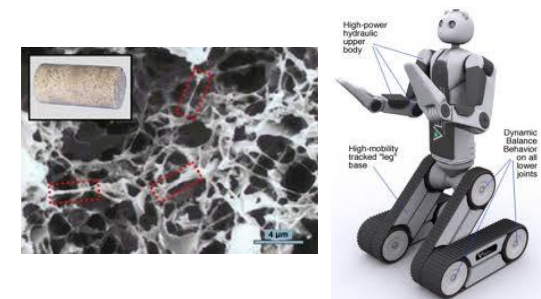


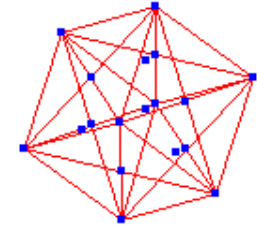
Table 1
 The relation between the total number of atoms in full shell clusters and the percentage of surface atoms (reprinted from [5] with permission from John Wiley & Sons)

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

Far Reaching

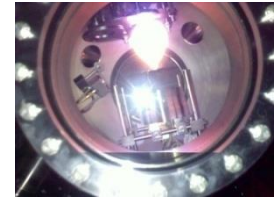


Talk Plan:

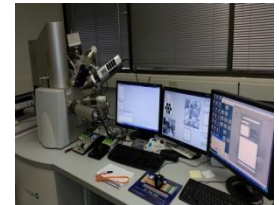


❖ Introduction on Nanotechnology

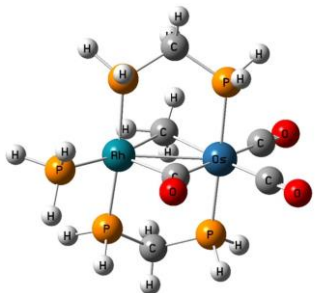
❖ CENT with a bit of history



❖ Research at CENT..



❖ Outlook for students

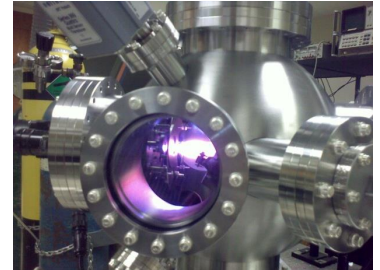


CENT with a bit of history

Center of Excellence in Nanotechnology

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.



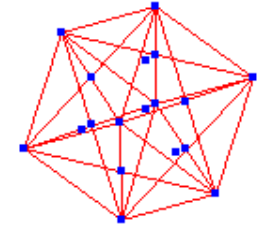
**academic affiliates,
RAs, collaborators..
and expanding**



CENT Affiliates

Sl. No.	Affiliate Name	Department	Email Address	Phone
1.	Dr. Abdullah Al-Sultan	PETE/ CPM	sultanas@kfupm.edu.sa	3888
2.	Dr. Abdullah Al-Sunaidi	Physics	asunaidi@kfupm.edu.sa	3752
3.	Dr. Abdul-Nasir Kawde	Chemistry	akawde@kfupm.edu.sa	2145
4.	Dr. Amjad Khalil	Biological Sciences	amjadb@kfupm.edu.sa	7152
5.	Dr. Anwar-ul-Hamid	CER	anwar@kfupm.edu.sa	2017
6.	Dr. Basheer Chanbasha	Chemistry	cbasheer@kfupm.edu.sa	7344
7.	Dr. Bassam Tawabini	Earth Sciences	bassamst@kfupm.edu.sa	7643
8.	Dr. Isam Al-Jundi	Chemical Engineering	aljundi@kfupm.edu.sa	2219
9.	Dr. Khalid Al-Hooshani	Chemistry	hooshani@kfupm.edu.sa	3065
10.	Dr. Mohamed Faiz	Physics	mmfaiz@kfupm.edu.sa	2284
11.	Dr. Mohammad Ashraf Gondal	Physics	magondal@kfupm.edu.sa	3274
12.	Dr. Mohammed Hassan Zahir	Renewable Energy	hzahir@kfupm.edu.sa	3863
13.	Dr. Mozahar Hussain	CHEME	mhossain@kfupm.edu.sa	1478
14.	Dr. Nabeel Maalej	Physics	maalej@kfupm.edu.sa	1340
15.	Dr. Nahidh Siddiqui	Chemistry	mnahid@kfupm.edu.sa	2529
16.	Dr. Nasser Al-Aqeeli	Mech. Eng.	nageeli@kfupm.edu.sa	3200
17.	Dr. Nisarullah	Chemistry	nullah@kfupm.edu.sa	7527
18.	Dr. Saheb Nouari	Mech. Eng.	nouari@kfupm.edu.sa	7529
19.	Dr. Saleh Al-Quraishi	Physics	salehq@kfupm.edu.sa	2860
20.	Dr. Shakeel Ahmed	CRP	shakeel@kfupm.edu.sa	3428
21.	Dr. Syed Ahmed Ali	CRP	ahmedali@kfupm.edu.sa	3083
22.	Dr. Tahar Laoui	Mech. Eng.	tlaoui@kfupm.edu.sa	1379
23.	Dr. Zain H. Yamani	Physics/CENT	zhyamani@kfupm.edu.sa	4364
24.	Dr. Zuhair Malibari	CHEME	zuhairom@kfupm.edu.sa	1530

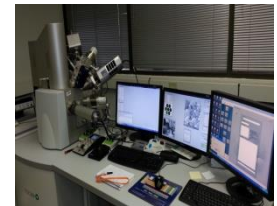
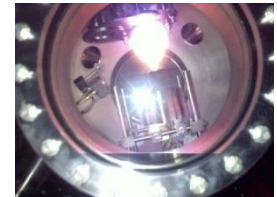
Talk Plan:



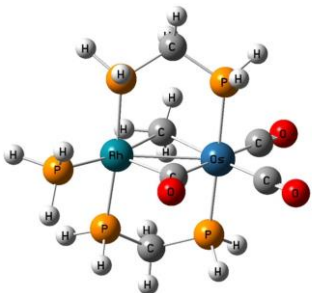
❖ Introduction on Nanotechnology

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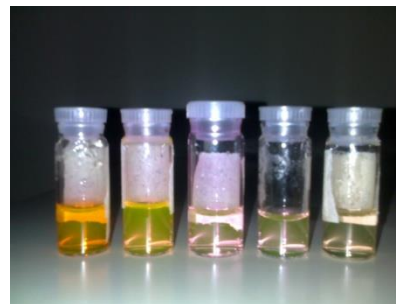
❖ Outlook for students



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**



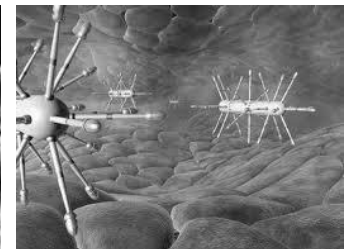
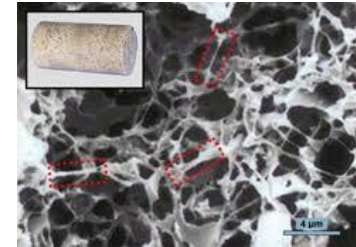
Sensing in Oil Reservoirs (Nanoagents)

Center



It used to be robots in blood arteries?!!

S. Aramco (2008) shock!!
Robots 7000 ft below ground in
complete darkness, wandering
'inside' rocks.



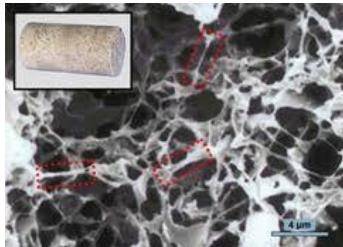
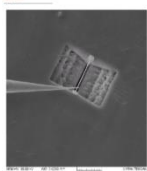
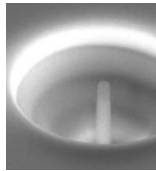
Sensing in Oil Reservoirs (Nanoagents)

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!!

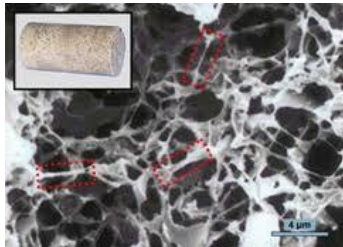
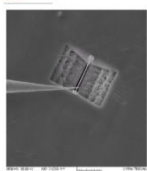
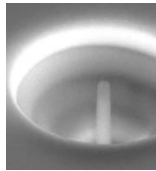
Goal: *smart tracing, sensing, and sniffing devices for on-line implementation in oil fields!!!*



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)

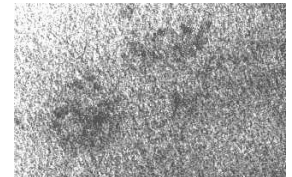
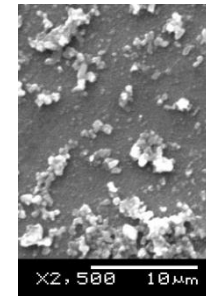
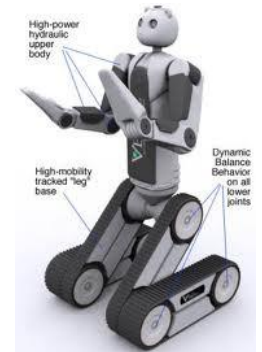
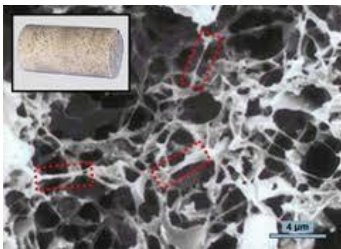
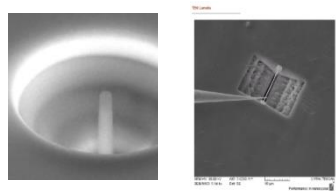
Then what..??

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

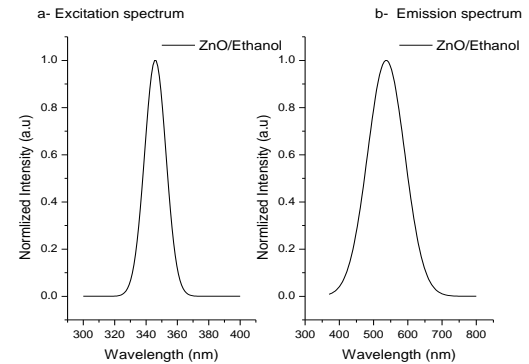
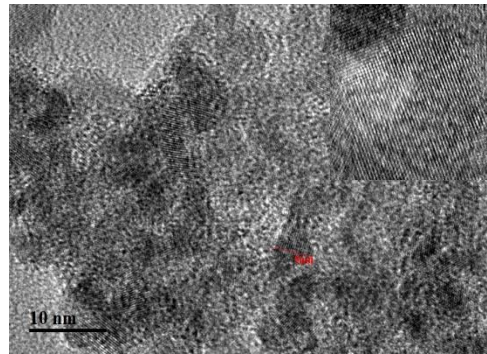
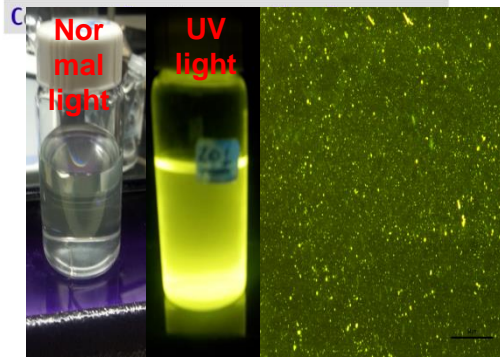
**PROPULSION;
NAVIGATION;
COMMUNICATION;
AMMUNITION..!!**

(for now!!)

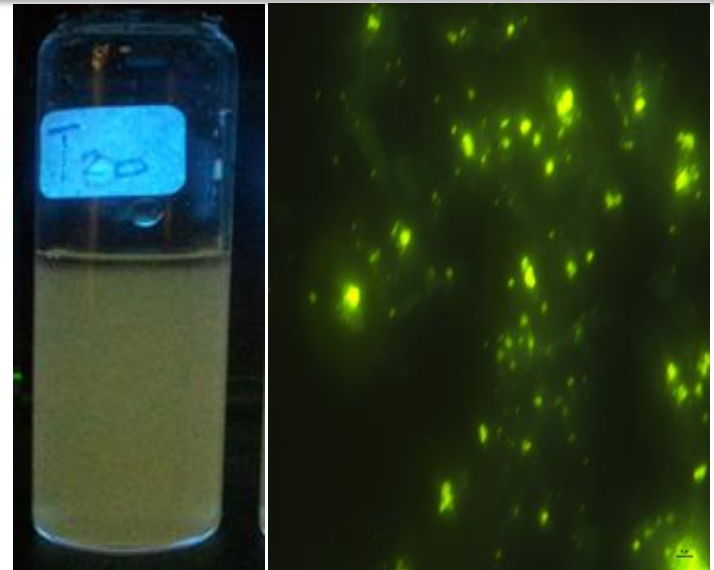
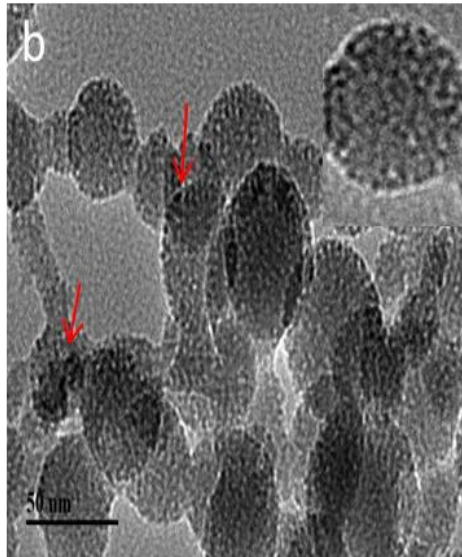
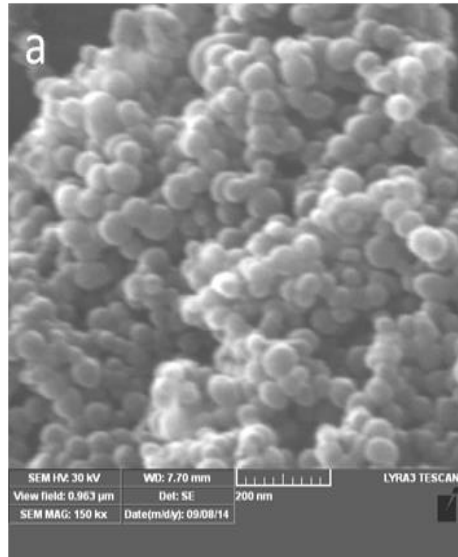
The resbots are not 'really' robots..
but rather (just) 'agents'



Sensing in Oil Reservoirs (Nanoagents)

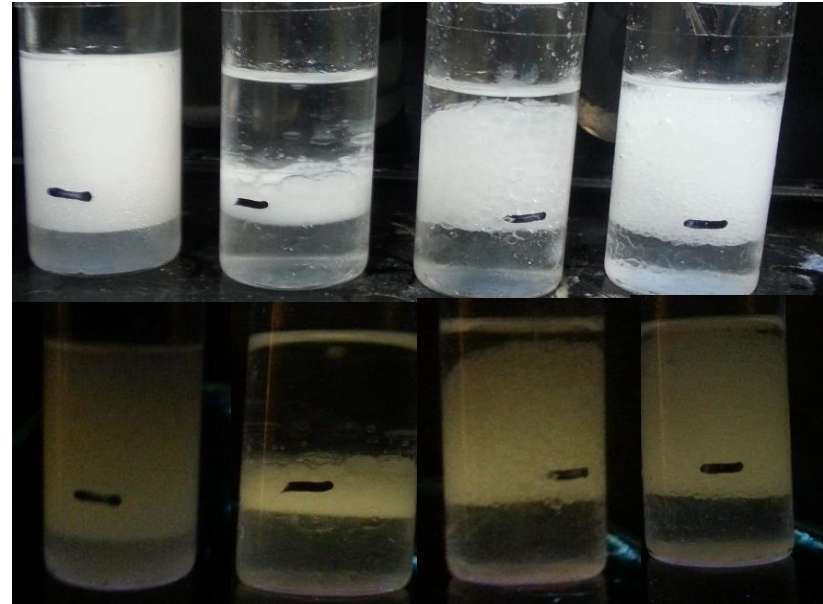
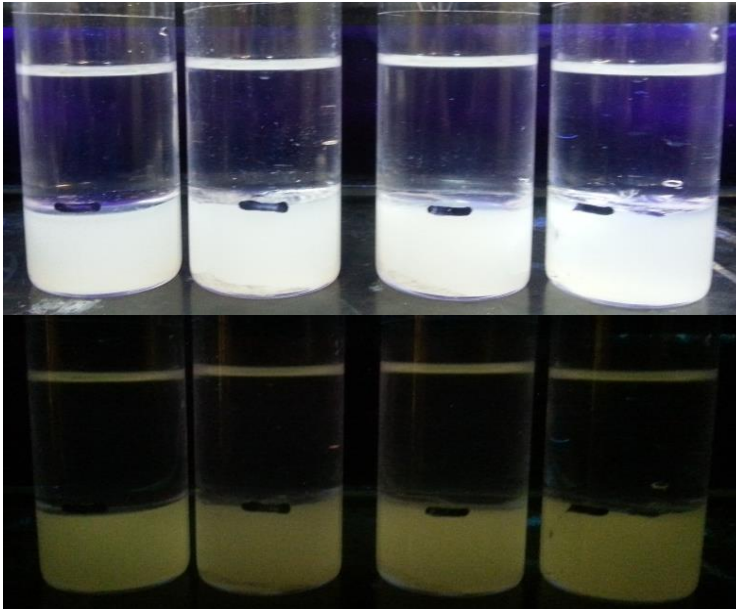


ZnO QD (simple method, right size, brightly fluorescing); Excitation 320-370 (350) nm; Emission 400-650 (520) nm

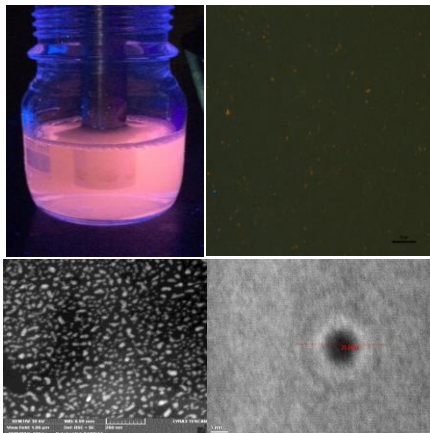


Silica encapsulated ZnO QD; right size (~ 45 nm) properly fluorescing; well dispersed

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

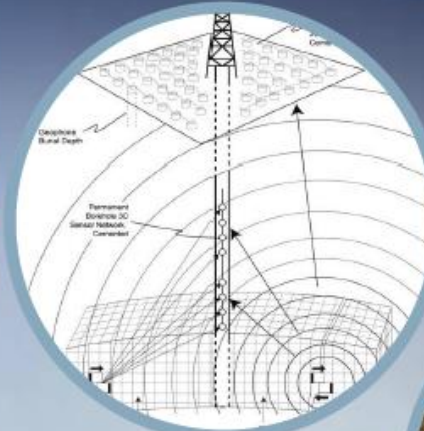
Initiative by Saudi Aramco



Extreme Reservoir Contact



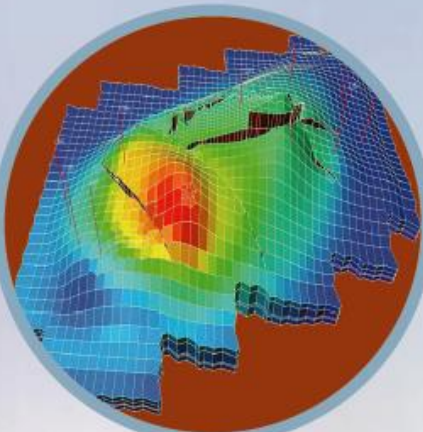
i-Field



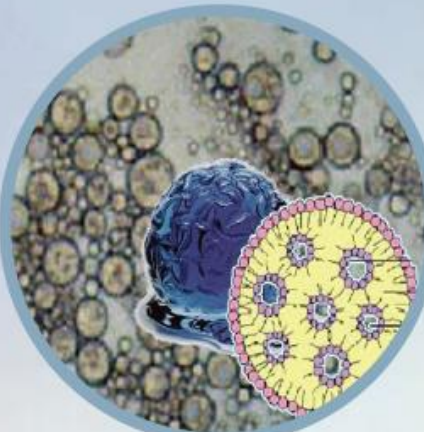
Passive Seismic



Nanorobots



Gigacell Simulation



Smart Fluids



Bionic Wells

OTHER EXAMPLES OF CENT RESEARCH

Project Title: Study of the Structural Properties and Hydrodesulfurization Activity of MoS₂ and Co/Ni/MoS₂ Catalysts Prepared by Laser Pyrolysis

Fabrication of NP
Impregnation
Characterization
Testing for HDS

Investigators:	PI: Zain Yamani ⁽¹⁾ Co-I: N. Tabet ⁽¹⁾ , Co-I: S. Ali ⁽²⁾ Frederick Schuster ⁽³⁾ Hicham MASKROT ⁽³⁾ (1) Center of Excellence in Nanotechnology and Physics Department, KFUPM (2) Center for Refining and Petrochemicals, KFUPM (3) Advanced materials Program, CEA-France
-----------------------	--

A 3-way collaboration, a subject that is important to the Kingdom, potentially supported by the Industry, potential IP ownership, not that much overhead

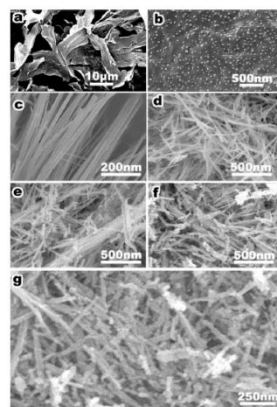


Figure 1. SEM images of a) 2H-MoS₂ powder, b) 2H-MoS₂ powder with 5.8 wt% Ni, c) MoS₂ nanotubes, d) MoS₂ nanotubes with 5.3 wt% Ni, e) MoS₂ nanotubes with 25.5 wt% Ni, f) MoS₂ nanotubes with 5.3 wt% Ni, g) MoS₂ nanotubes with 25.5 wt% Ni.

Adv. Mater. 2006, 18, 2561–2564

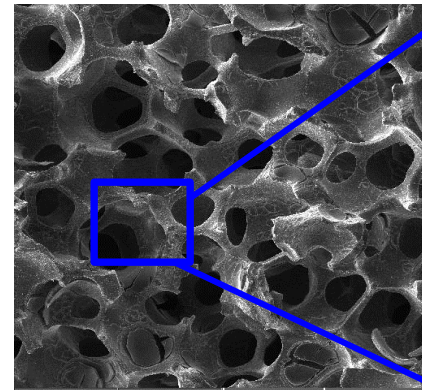
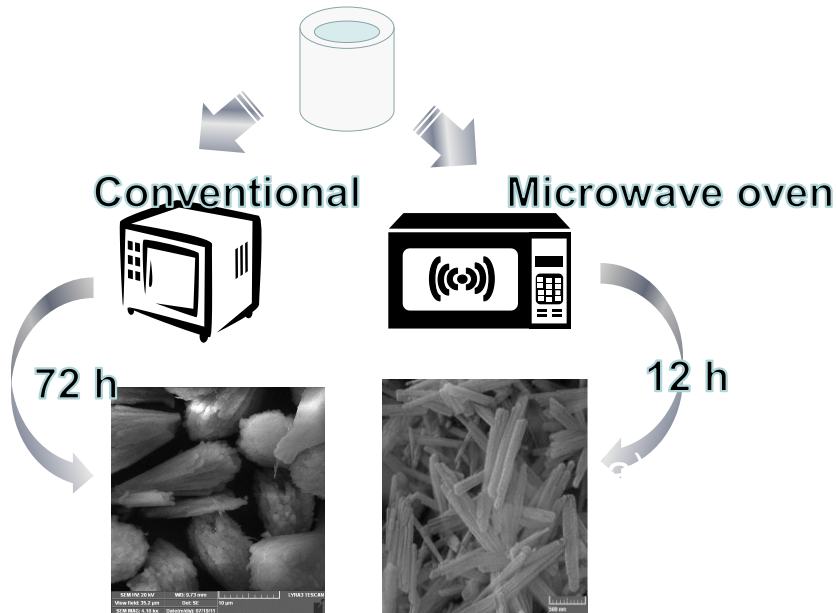
By Fangyi Cheng, Jun Chen,* and Xinglong Gou



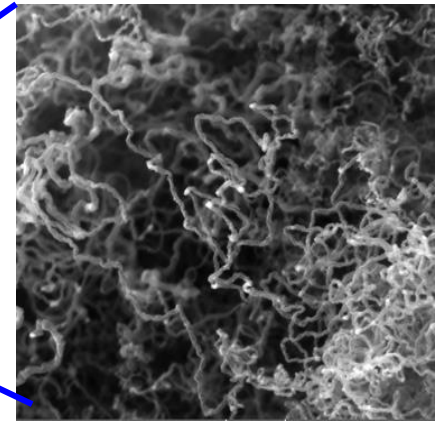
Schuster, CEA-France

IP under development for highly active HDS catalyst

Development of Nanozeolites and Nanofibers

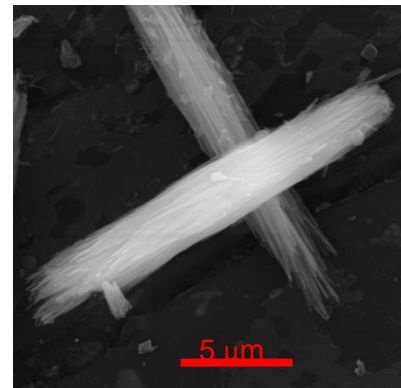


3D Solid Foams

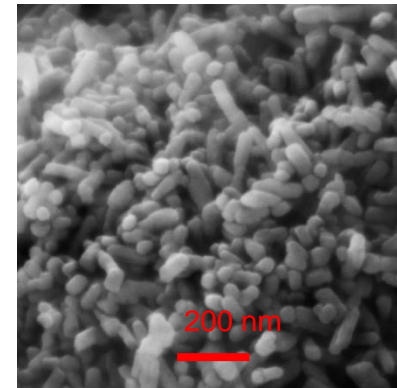


CNF/3D Carbon

Chemical Engineering J. (Submitted)



Conventional ZSM-22
 (20,000 nm)



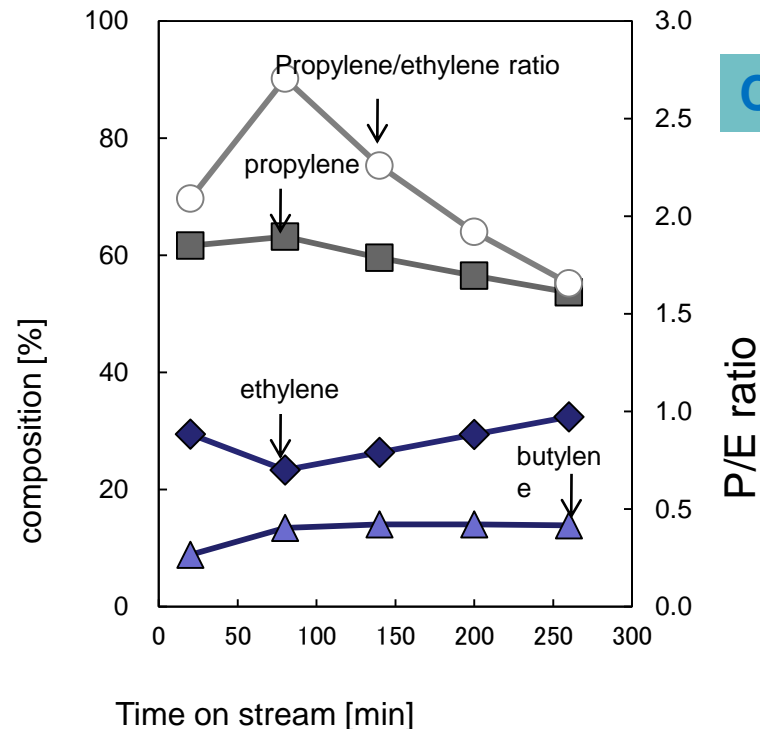
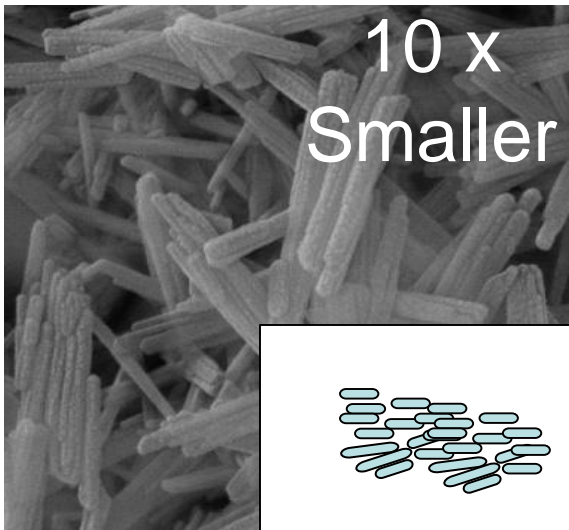
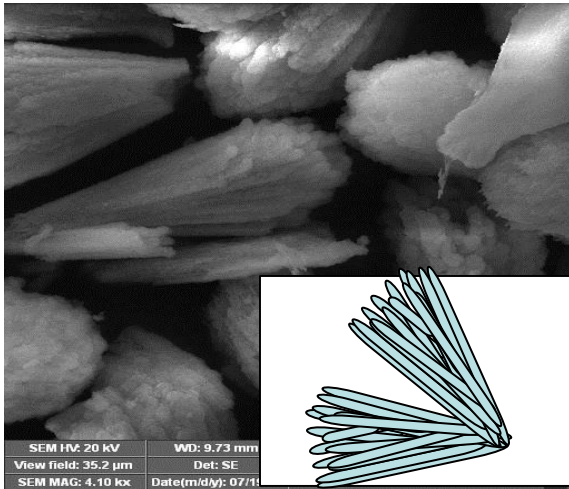
75 nm ZSM-22

J. Colloidal & Interface Sci. (Submitted)

Muraza et al., nano-sized ZSM_23,
Chemical Engineering J. 226 (2013)
US Patents (Submitted)

Micropor.Mesopor. Mater. (Submitted)

On-purpose Propylene over NanoZeolites



$$C_3/C_2 \Rightarrow 3$$

$$\phi = L \sqrt{\frac{k}{D}}$$

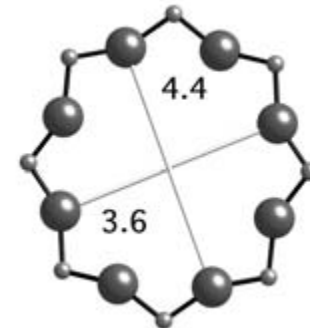
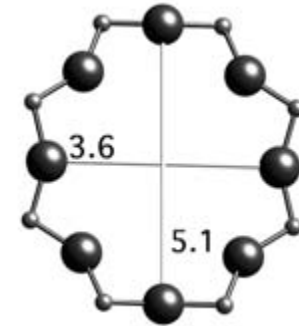
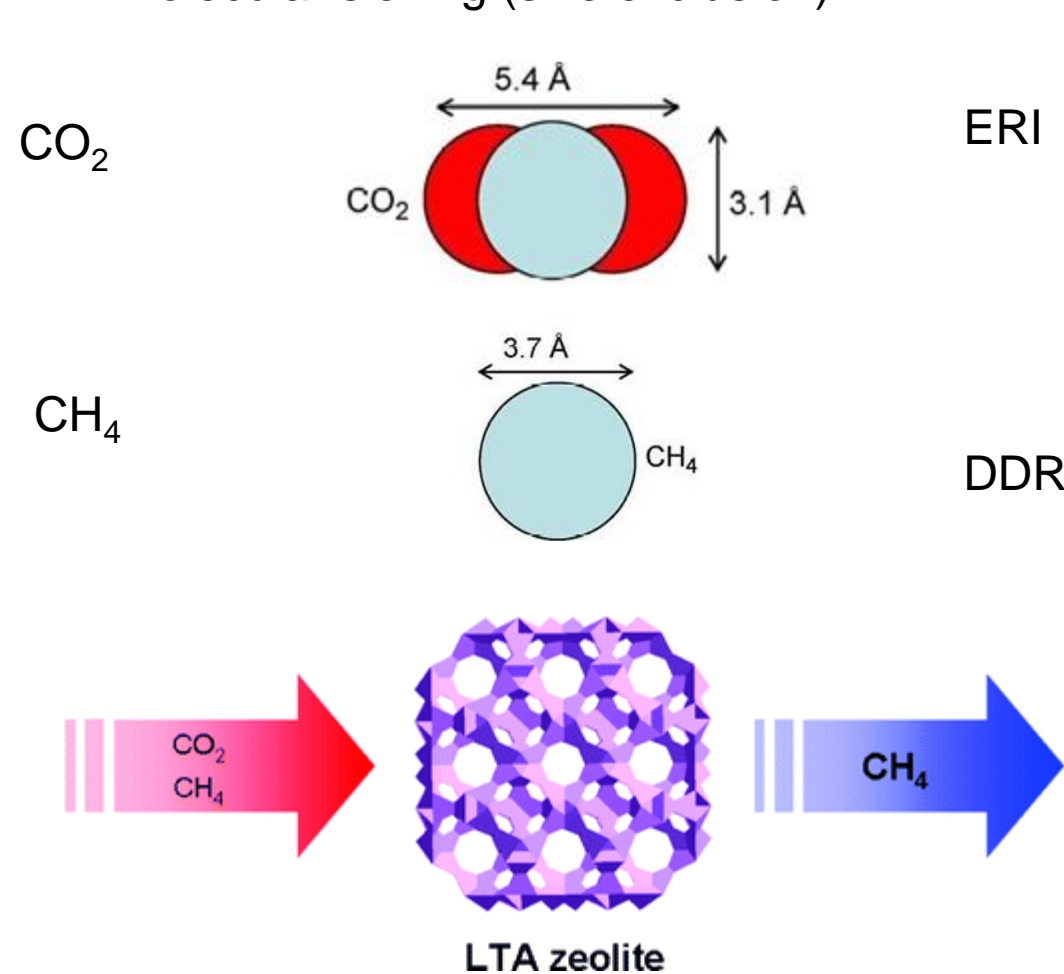
**Very High Selectivity to Propylene
in Catalytic Cracking of n-hexane**

**Muraza et al., ZSM-23,
Chemical Engineering J. 226 (2013)
Fuel (Submitted)
J. Colloidal & Interface Sci (Submitted)
Catalysis Today (Submitted)**

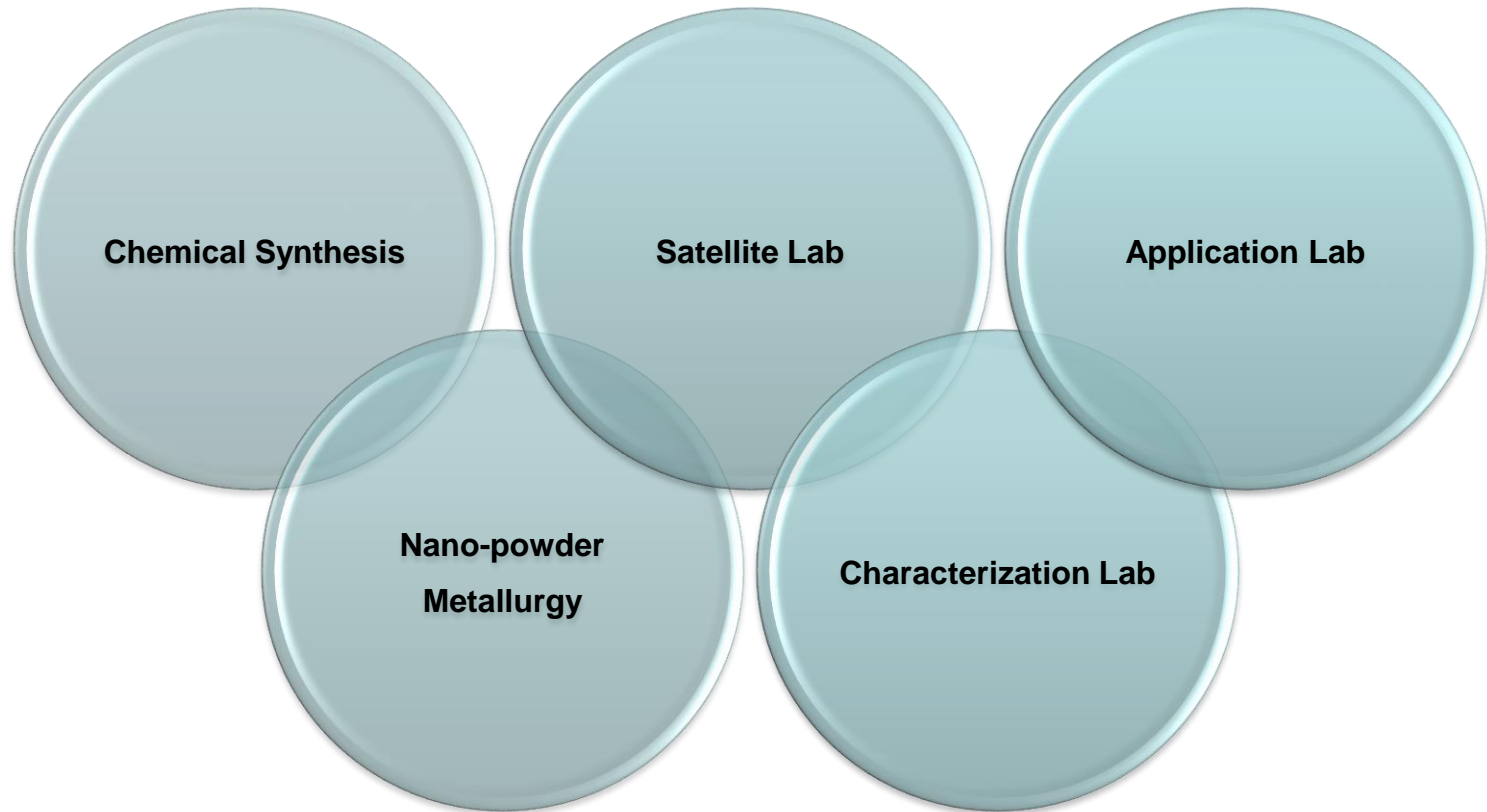
NT in Petroleum-clean gas

Crystalline aluminosilicates
Si-O-Al structures

molecular sieving (size exclusion)



CENT LABS

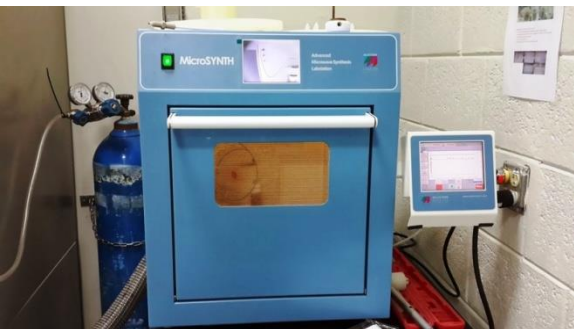


Nanozeolites for Hydrocarbon Conversion

Hydrothermal Reactors

Batch reactors

Microwave



Packed-Bed Reactors with online GC



Catalytic Cracking of n-Alkanes



Methane Reforming

Equipment on Campus



Contact Angle Measuring Device



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Artisan Scientific Corporation

Potentiostat/galvanostat

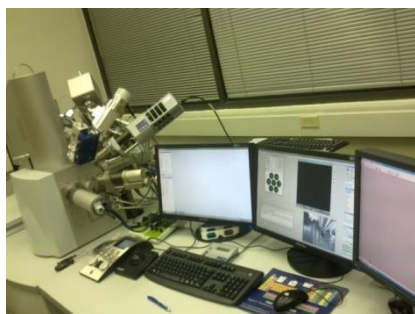


Autoclave

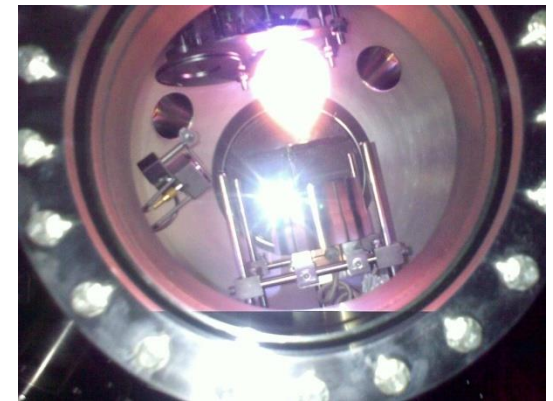
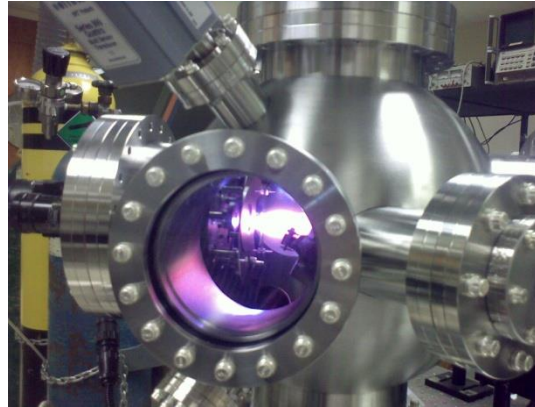


Ultra Performance LC

Focused Ion Beam Stations



TGA-DSC-MS



Pulsed Laser Deposition



Semiconductor device analyzer



Spectrofluorometer with combined steady state and lifetime capabilities



Automatic Sputter coater



Microwave reactor



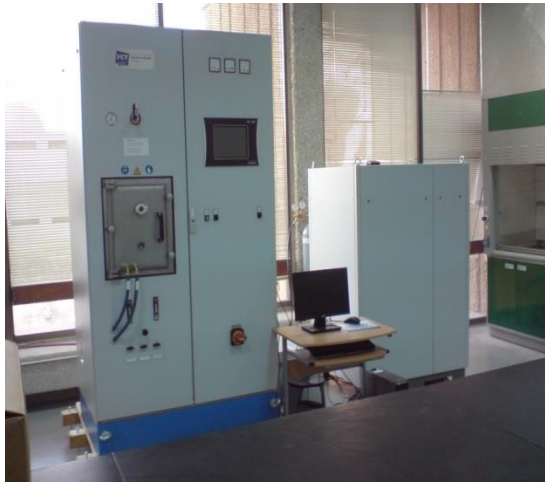
Ultra Sonicator



Surface area analyzer



The quartet in nanopowder metallurgy lab



Spark Plasma Sintering



Hot Isostatic Press



Cold Isostatic press



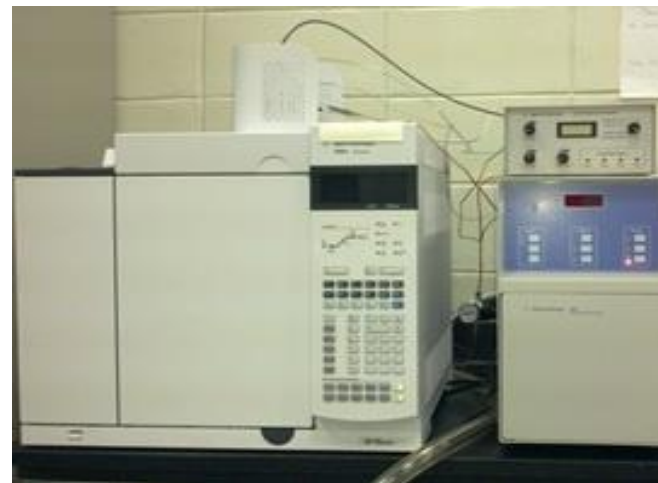
μ-wave sintering



Particle size analyser



Planetary Ball Mill Machine



Gas Chromatograph



Furnace

CNT Application



Hot Press



Blender



1000 kg, 3 meters high
Vertical Reactor in
installation for large scale
production of MWCNT

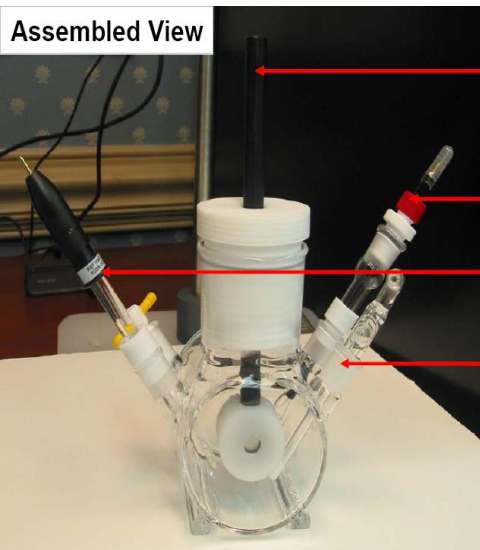
Towards Commercial
Production of CNT



Nanostructured Photocatalysts



Assembled View



AFEX113HOLDER

AFCTR5, Pt coil Counter Electrode

RREF0021 or RREF0024 or
RREF0022 (Reference Electrodes)

RRPG086, Dual Inlet for Purging



Publications



Ultra fast synthesis of zinc oxide nanostructures by microwaves

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² Chemistry Laboratory, University Missouri, 20000, Columbia, Algeria

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Keywords:
ZnO
Nanocrystals
Microwave
SEM

ABSTRACT

We describe a novel route for the synthesis of zinc oxide nanostructures by microwave heating. A very strong energy input as a microwave heater. Two different morphologies of ZnO can be achieved in a matter of minutes. The ZnO nanostructures were characterized by scanning electron microscopy (SEM) and energy-dispersive X-ray (EDX) spectroscopy. The prepared ZnO nanostructures showed a variety of morphologies including nanorods, nanowires, and nanowires.

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1. Introduction

The synthesis of nanostructured ZnO of various shapes has been the subject in the last decade. A wide variety of techniques have been used to synthesize ZnO nanostructures including vapor liquid solid (VLS) [1–3] and thermal evaporation [4]. Recently, ZnO nanorods and nanowires have been synthesized by hydrothermal synthesis using microwave thermal evaporation deposition on substrate and this work, we have developed a very simple method to synthesize ZnO nanostructures using a ZnO sintered composite as a heater which can reach temperatures as high as 1000 °C exposure to microwaves.

* Corresponding author. Physics Department, Center of Excellence in Nanotechnology (CENT), King Fahd University of Petroleum & Minerals, Saudi Arabia. Tel.: +966 38853535. E-mail address: ntabet@kfupm.edu.sa (N. Tabet).

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doi:10.1016/j.spmi.2009.03.003



Moving Enzyme-Linked Immunosorbent Assay to the Point-of-Care Dry-Reagent Strip Bio

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¹ Department of Chemistry and Molecular Biology, North Dakota State University, Grand Forks, ND 58220, USA
² Center of Excellence in Nanotechnology, and Department of Chemistry, King Fahd University of Petroleum & Minerals, Saudi Arabia

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Point-of-care
Dry-reagent strip

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and

American Journal of
Biomedical Sciences
ISSN: 1537-9800
www.sciencedirect.com

Patents



Synthesis of highly active nanocrystalline WO₃ and its application in laser-induced photocatalytic removal of a dye from water

M. Qamar¹, M. A. Qamar², Z. Y. Zhang³

¹ Physics Department, Center of Excellence in Nanotechnology (CENT), King Fahd University of Petroleum & Minerals, Saudi Arabia

² Chemistry Department, Faculty of Science, Assiut University, Assiut, Egypt

³ Chemistry Department, Faculty of Science, Assiut University, Assiut, Egypt

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Photocatalysis
Dye removal

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



United States Patent - Al-Qurashi

Patent No.: US 7,601,334 B1

Date of Patent: Oct. 13, 2009

Method for synthesizing metal oxide

Inventor: Nabil A. Al-Qurashi, Doha (SA)

Assignee: King Fahd University of Petroleum & Minerals, Doha (SA)

Notice: Subject to any disclaimer, the term of this patent is extended to related state 33 (U.S.C. 154(b)) by 6 days.

Appl. No.: 12/314,444

Pub. No.: 2009/018,444

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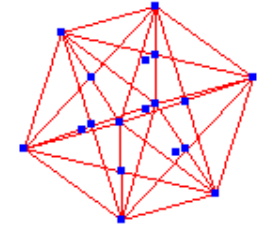
Pub. No.: 2009/018,444

Pub. Date: Aug. 13, 2009

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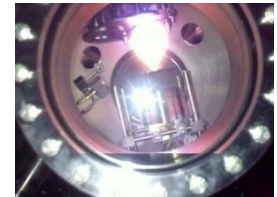
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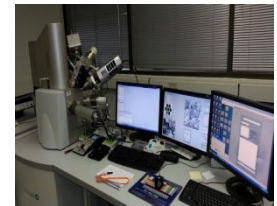


❖ Introduction on Nanotechnology

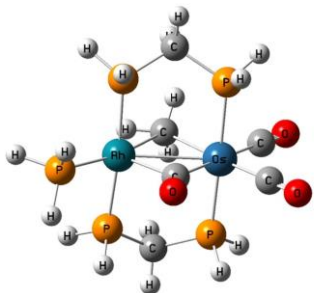
❖ CENT with a bit of history



❖ Research at CENT..



❖ Outlook for students



More at CENT...

Date	Title	Speaker
5/2/2013	Science and Technology of Thin Films a joint Seminar by CENT and Chemistry Department	Professor Chopra IIT Delhi, India
10/2/2013	Lecture Series on Science and Technology of Thin Films	Professor Chopra IIT Delhi, India
12/2/2013	Solar Photovoltaics – Status Review a joint Seminar by CENT and Chemistry Department	Professor Chopra IIT Delhi, India
5/3/2013	Hydrogen Production Photo-catalytic over Reducible Metal Oxides to Photo-catalytic Reactions by, a joint Seminar by CENT and CRP	Dr. Hisham Idriss, Chief Scientist, SABIC.
13/3/2013	Nanofabrication by nanoimprint and electron beam lithography and applications a joint Seminar by CENT and COE	Professor Bo Cui,
5/5/2013	Simple Synthesis of Zeolites; New directions without the use of OSDAs, a joint Seminar from CENT and Chemical Engineering Department	Professor Okubo, Japan

Bi-weekly CENT Seminars

Visiting professors

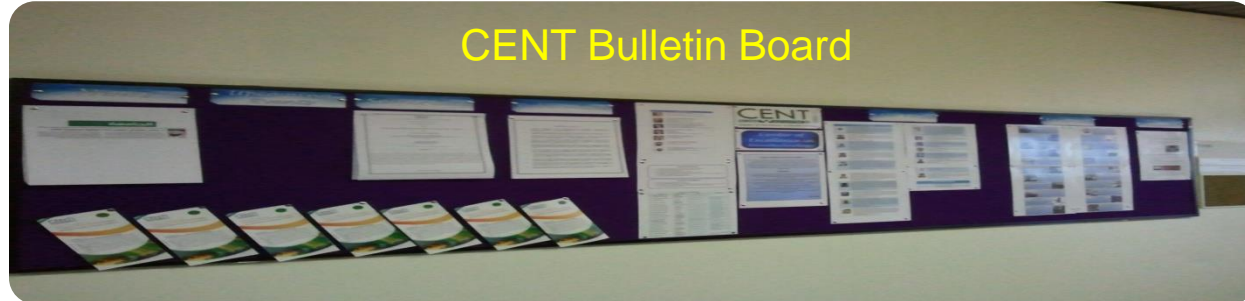
Friends of CENT Mailing list



www.kfupm.edu.sa/cent

web-site & forum

NTGP: graduate program/ courses



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

Desert picnic



CENT Fliers



Banners/Posters

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!! 😊😊**

Is there a place for you at CENT?

- I do not know.. possibly..
- What academic background is ‘most’ relevant..
- What are your aspirations?

A friend (KD) told me that we need more specialized people.. and..
Of course, on the other hand, you need to highlight what is expected from
a researcher (interest, dedication, passionate, step-wise process, etc.)

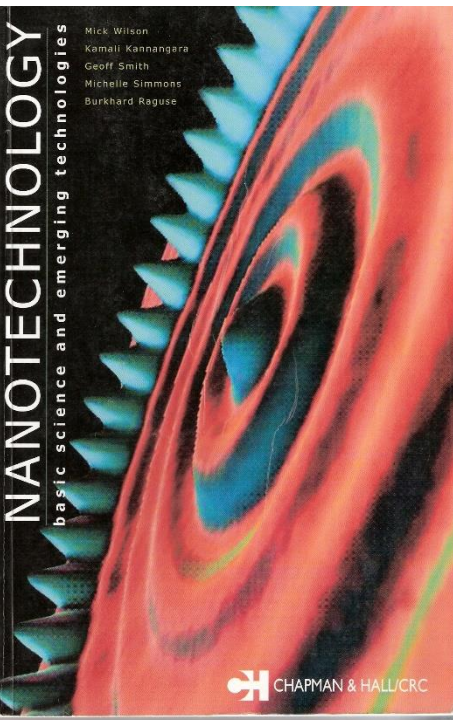
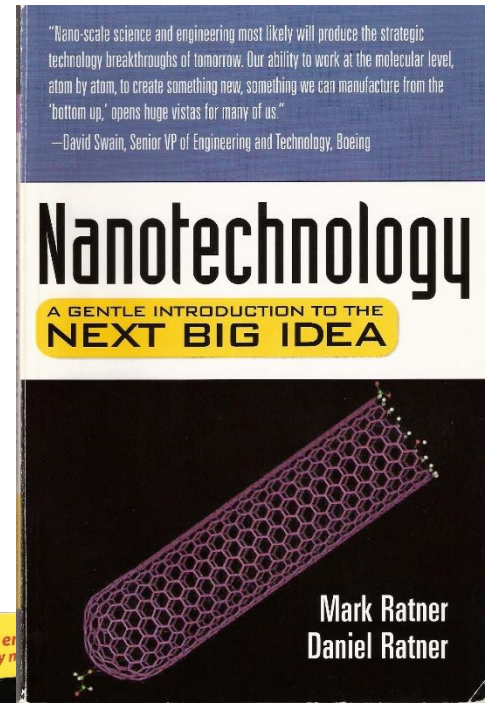
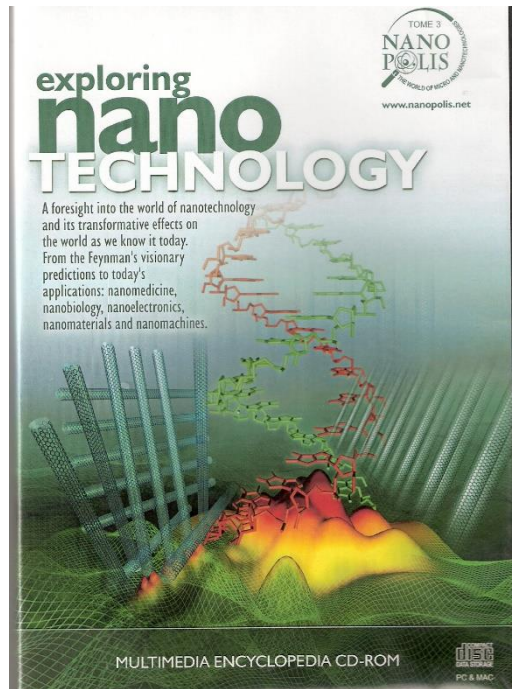
Is there a place for you at CENT?

How to convince students to abandon their comfortable lives and devote themselves to research? Hmmmmmm..

- 1*I believe that doing science is a way of worshipping Allah (Al Omran, verses 190-194) scientists come next to prophets in importance..
- 2*the unbelievable joy of learning, doing and eventually making science
- 3*From personal experience, doing research improves your thinking habits and your memory, and helps you learn how to organize "things"
- 4*You always have an aim to reach.. no time to feel empty or worthless..
- 5*In Saudi: good salary+fame
- 6*It includes travelling and making international friends

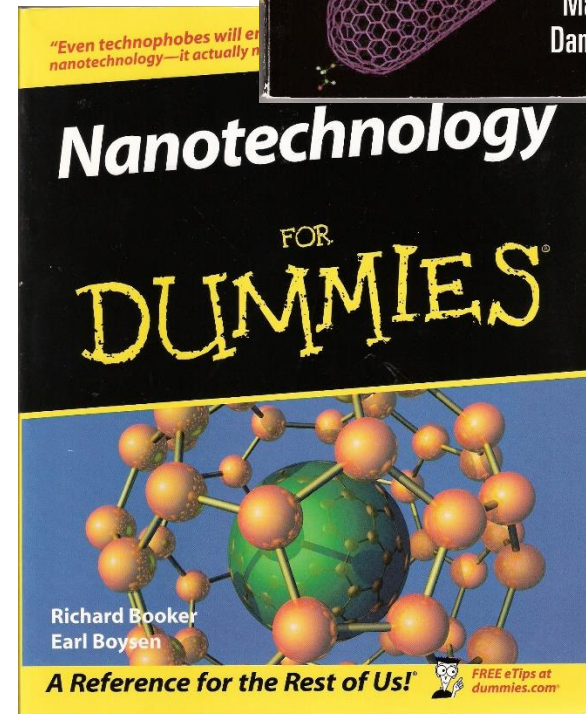
Professor Zbigniew: Projection into the future (life-time) of the earning capacity of someone with PhD compared to someone without it.

Dr. Oki!!



<http://www.jurp.org/>

Enjoy learning!!



In closing..

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

I hope some of you will develop into high profile, world renowned, researchers at CENT (or otherwise).

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