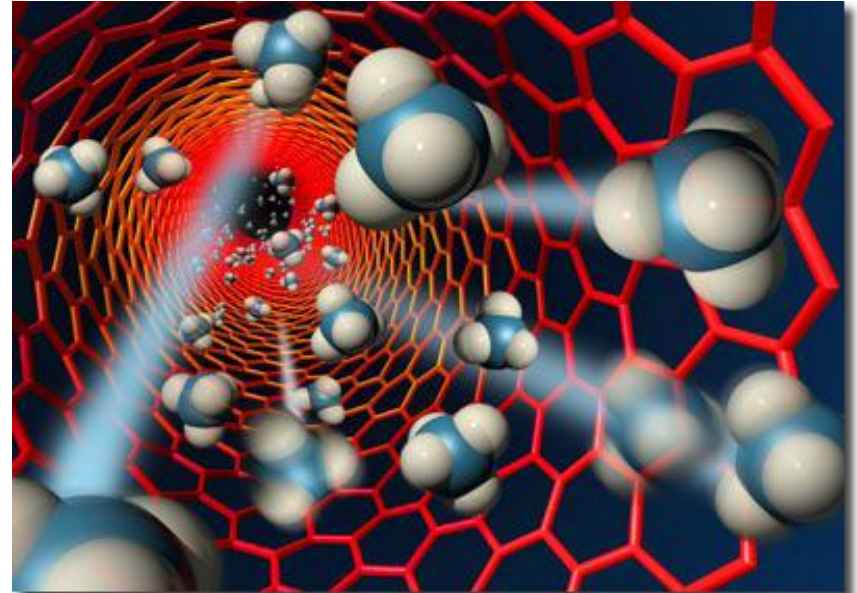
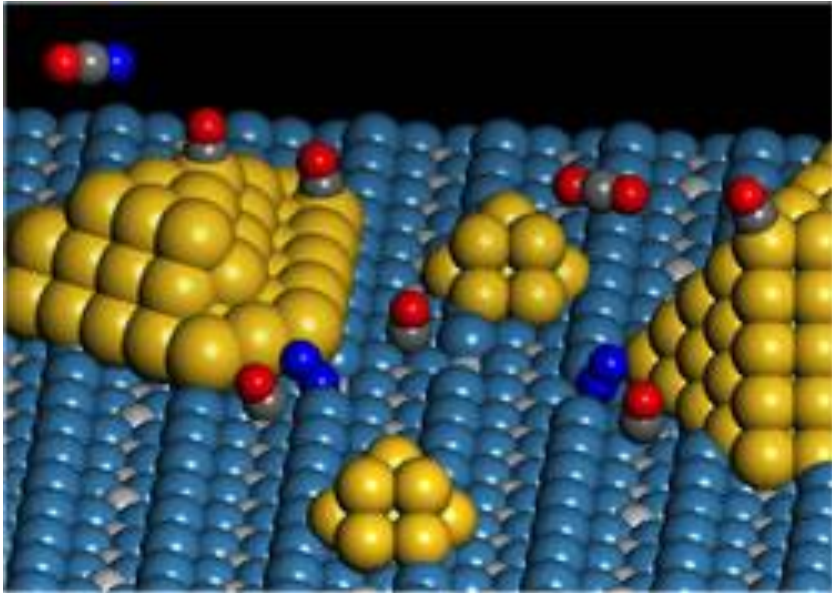


Nanotechnology and Sustainable Development in The Arab world



Dr. Khaled Saoud

Associate Professor of Physics

Liberal Art and Sciences Program

Virginia Commonwealth University-Qatar

Beirut , Lebanon 23-24th May 2017

Outline

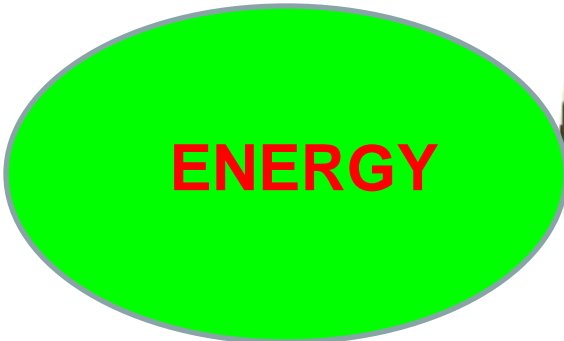
- Introduction to Nanotechnology
- Nanotechnology and Sustainable Development in The Arab World
- Potential Applications of Nanotechnology
 - Photo catalyst for Water Treatment
 - Nanotechnology for Thermal insulation- Aerogel
 - Nanotechnology for cultural Heritage
- Conclusions

Top Problems for The Next 50 Years



2003 6.3 Billion People

2050 10 Billion People

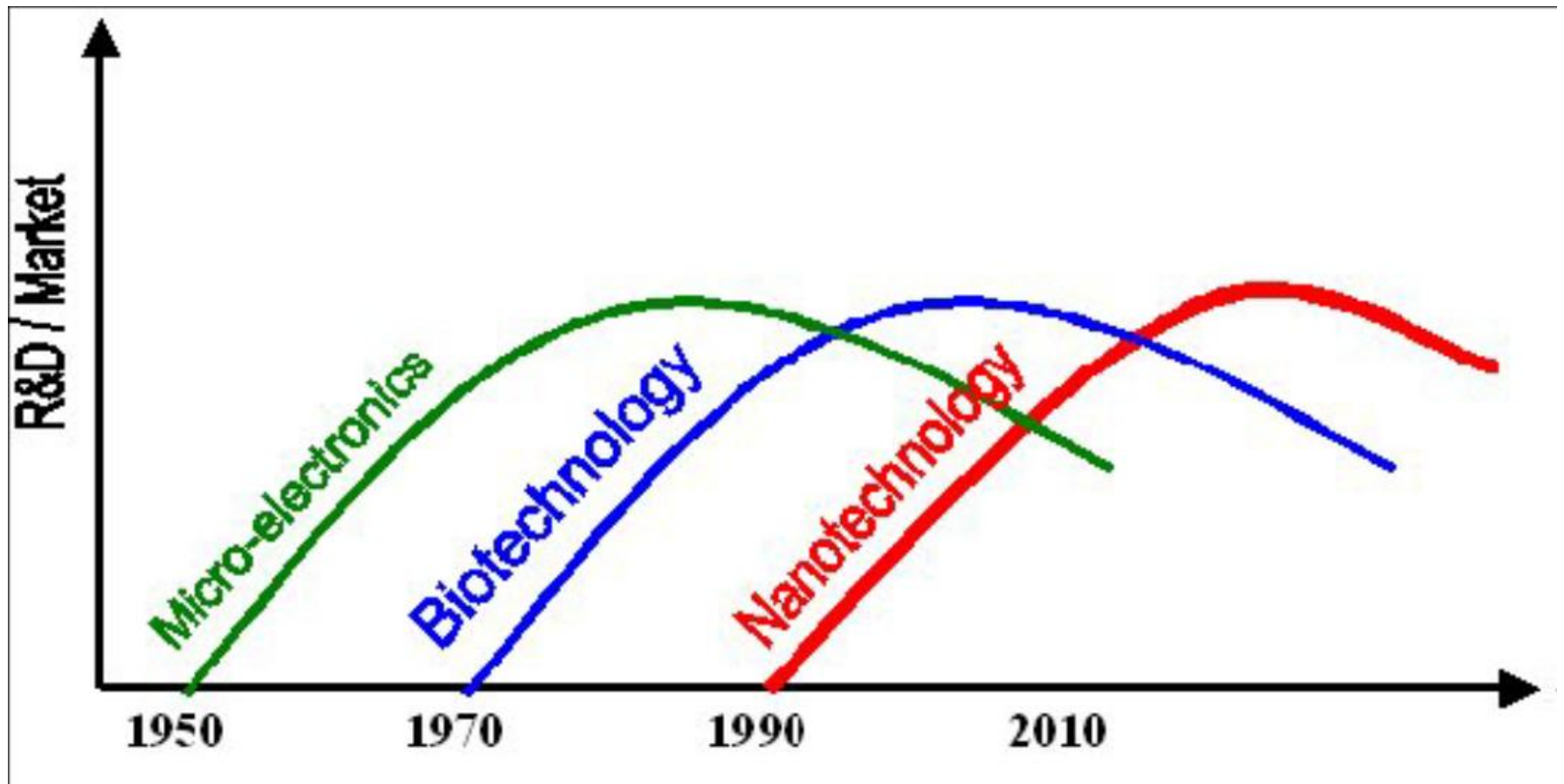


Arab world is no exception

What is Sustainability??

- Sustainable development is generally defined as “development, which meets the needs of the present without compromising the ability of future generations to meet their own needs”
- “enable all people to meet their basic needs and improve their quality of life, while ensuring that the natural systems, resources and diversity upon which they depend are maintained and enhanced both for their benefit and for that of future”

Major Industrial Revolutions



Nanotechnology Everywhere

Google™

Any given search engine will produce 1.6 million hits

THE NATION'S NEWSPAPER HS2005-01

Collegiate Case Study

USA TODAY
NO. 1 IN THE USA
www.usatodaycollege.com

Creating a monster?
By Dan Vergano 5-6

Add science, business, mathematics and stir
By Del Jones 6-9

For future nano info, nano-philes are keeping their eye on Nanosys
By Kevin Maney 9-10

Nanotechnology: The tiny technology that can!

Nanotechnology is making BIG news! Nanotechnology — engineering on a scale of individual atoms — is a way to make new materials, or to improve properties of existing materials. Its uses range from medical devices to car paint. Nanotechnology has been an

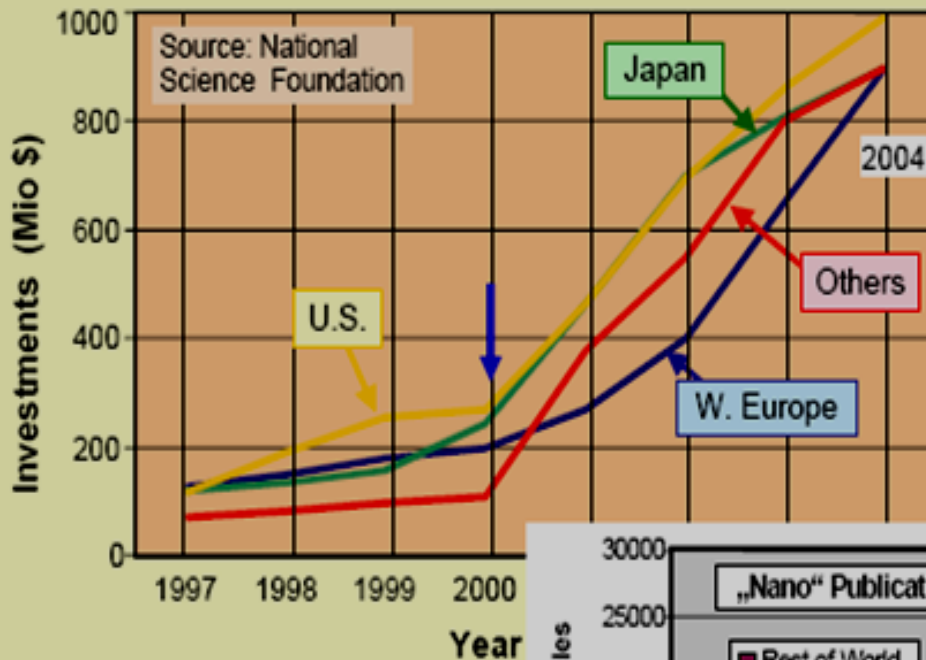


An animated film in China
“*A Fantastic Journey for Nana and Nono*” in Chinese with Chinese and English subtitles.

Nanotechnology Scientist:
Willem Dafoe in Spiderman

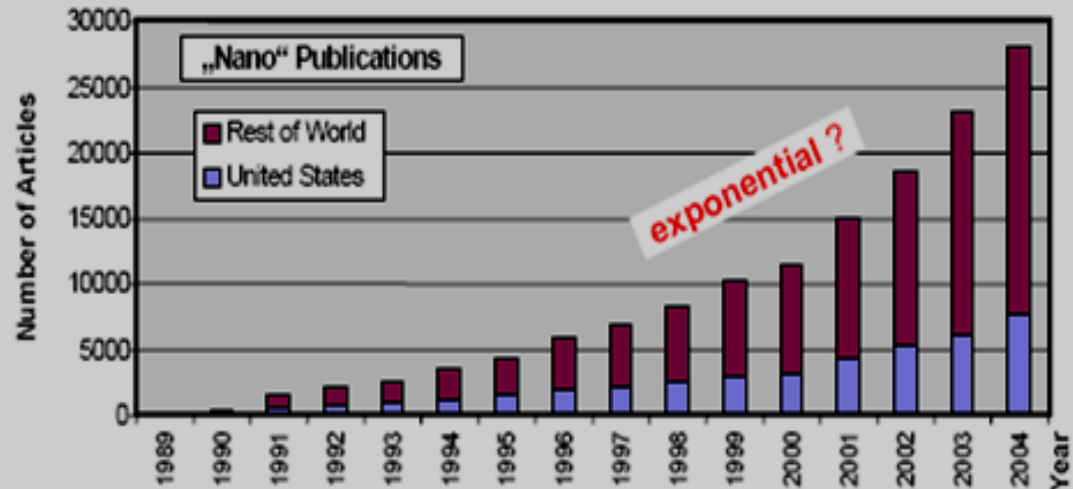
Rapid Growth of Nanotechnology

International Government Funding



- Rapid growth of funding and public awareness since the year 2000.
- >3 billion \$ by 2004.
- excellent opportunities for research & development

Scientific Publications



- Rapid growth; by 2004: already ~5% of articles in high impact factor journals are “nano”

What is So Special About Nanotechnology?

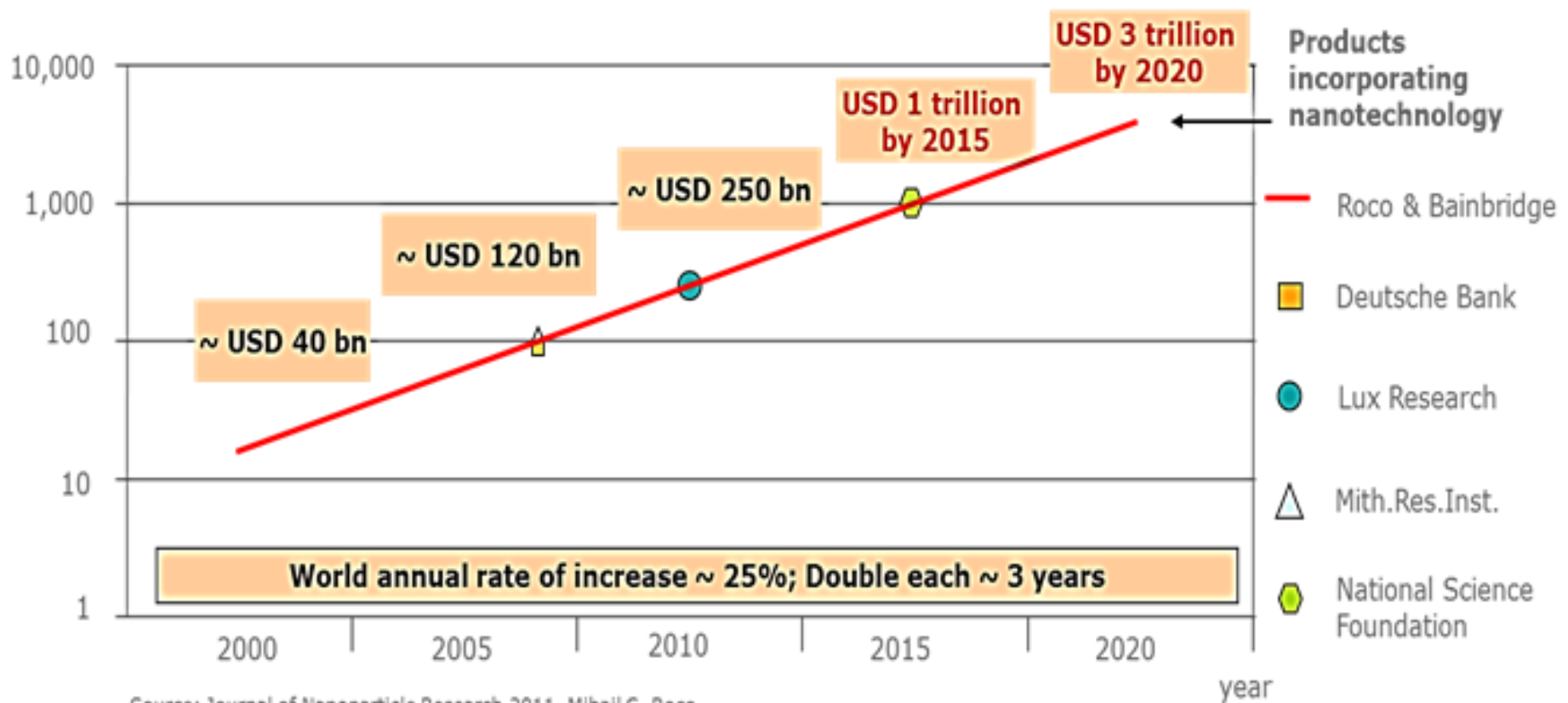
Nanotechnology is on the way to becoming the **FIRST** trillion dollar market



Nanotechnology influences almost every facet of every day life such as energy, clothes, environment, buildings and medicine.

Projected Nanotechnology Market

WORLD MARKET INCORPORATING NANOTECHNOLOGY (billion USD)



Source: Journal of Nanoparticle Research 2011, Mihail C. Roco

Technology Convergence

Revolutionary Technology Vision: The "Zone of Convergence"



Combination of Nanotechnology, Information technology and biotechnology leads to new development in genomics, drug discovery, gene sequencing

...and the Promising Role of Nanotechnology

Edited by Javier Garcia-Martinez

WILEY-VCH

Nanotechnology for the Energy Challenge

With a Foreword by Ernest J. Moniz



Copyrighted Material

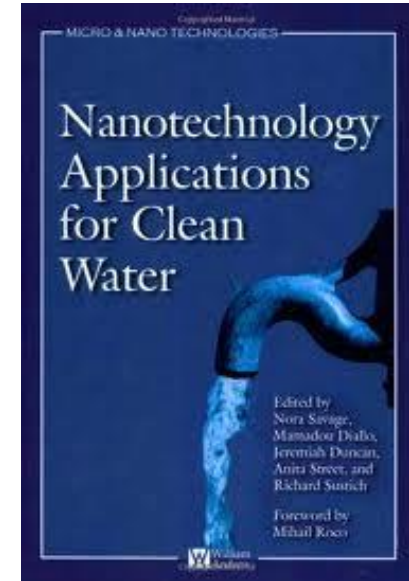
ENVIRONMENTAL NANOTECHNOLOGY

Applications and Impacts of Nanomaterials

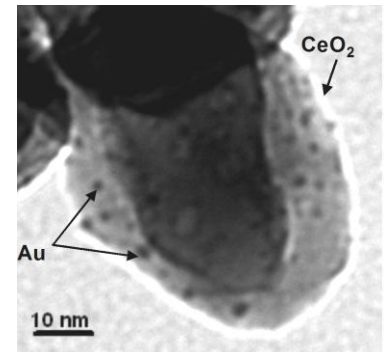
Mark R. Wiesner • Jean-Yves Bottero

Nanotechnology promises:

- Meet Energy demand
- Water treatment,
- Improve food supply
- Improve environmental technologies (treatment, remediation, sensing)
- Improve manufacturing processes (efficiency, waste reduction)
- Reduce gas Emission
- Improve drug development and delivery, medical diagnosis
- Treat Cancer.



Treatment/ Remediation



Nanocatalyst

What is Nanotechnology? And How Nanotechnology can help?

- **Nanotechnology**: is the art, design, fabrication, characterization, and utilization of materials, structures, and devices, which are less than **one hundred nanometers**
- **Nanoscience**: The study of the fundamental principles of molecules and structures with at least on dimension roughly **between 1 and 100 nanometers**

“ NSF ”

What is Nano? How small is A Nanometer?



iPod Nano

10⁻⁹ m

Or a Nanometer (nm) is one billionth of a meter

$$1\text{nm} = 1 / 1000,000,000 \text{ m}$$

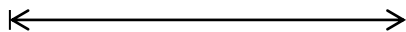
Human hair



80,000 nm



“Nano” – Greek word Means “dwarf”



12,756 Km

1.27 × 10⁷ m

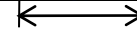
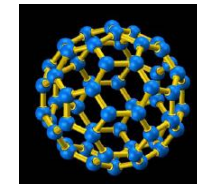
10 millions times smaller



22 cm

0.22 m

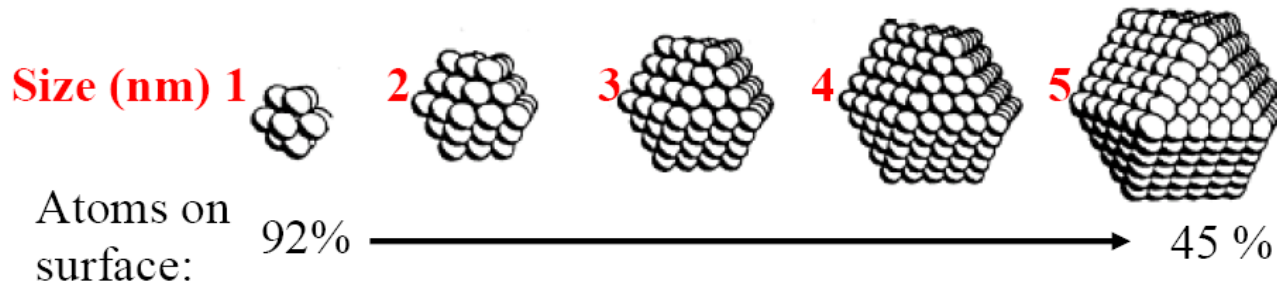
1 billion times smaller



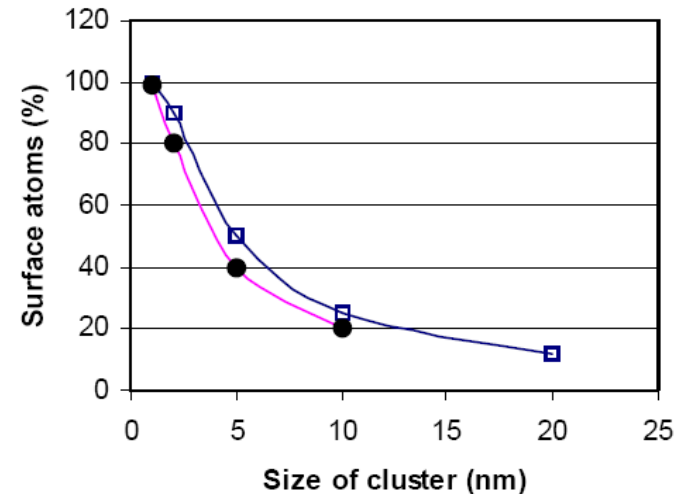
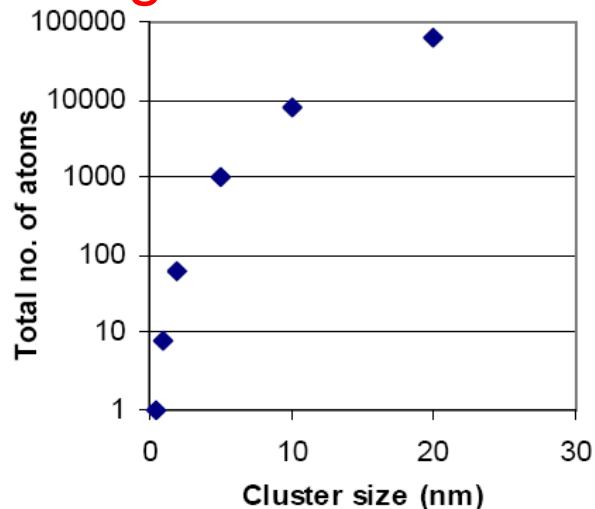
0.7 nm

0.7 × 10⁻⁹ m

What Happened at the Nanoscale?



High Surface area & High Chemical Reactivity



The decrease of the size and the increase in surface area to volume ratio alters the **mechanical, thermal, and catalytic properties** of materials.

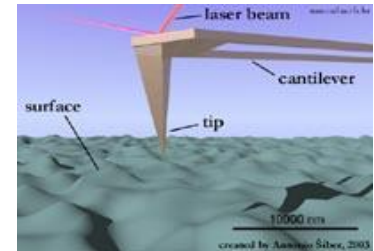
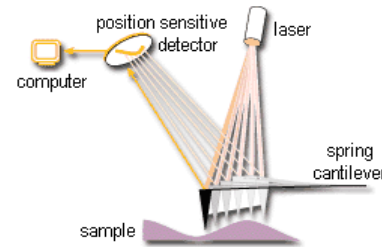
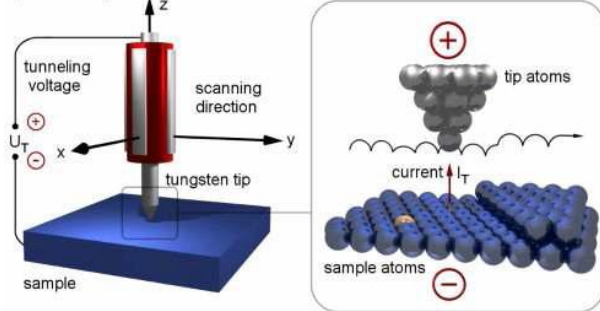
Thanks to Advanced microscopes, Now we Can Now See and Control Things at the Nano-Scale



a) macroscopic scale:



b) atomic scale:



Scanning Probe Microscopy

Atomic Force Microscopy

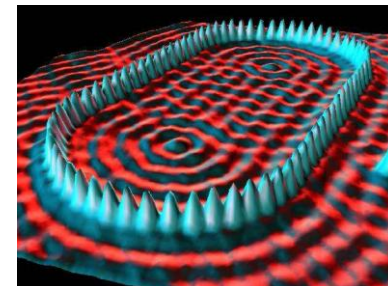
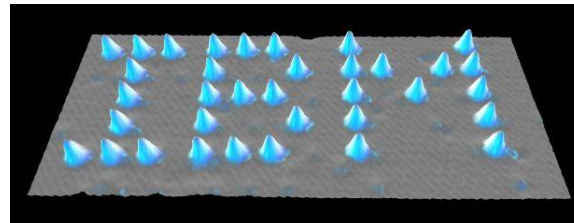
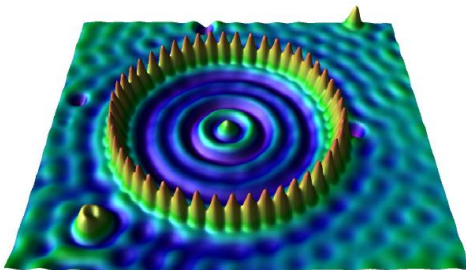


Figure 1.2. STM image of a "quantum corral" (courtesy IBM Research Division).

M.F. Crommie, C.P. Lutz, D.M. Eigler. **Confinement of electrons to quantum corrals on a metal surface.** *Science* 262, 218-220 (1993).

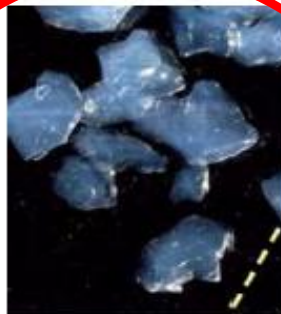
Nanotechnology Leads to Revelation in Materials and Processing



concrete



steel



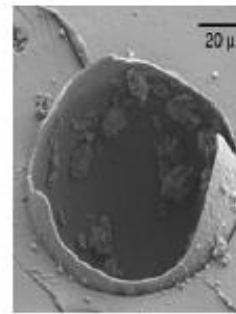
insulation



glass



drywall



plastic



fabrics
& carpet



energy
& hvac



lighting



air & water
filtration



electronics



coatings
& paints

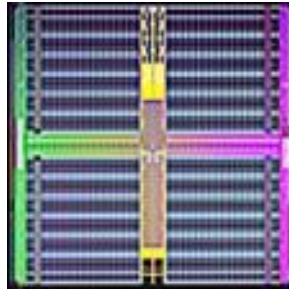
Nanotechnology enable sustainable communities by conserving resources, providing new ways to generate energy & potable water, and recycling waste

Nanotechnology Applications

How might nanoscale science and engineering improve our lives?

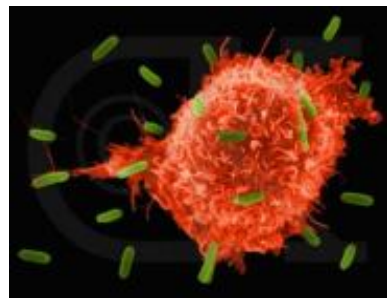
Information Technology

- Smaller, faster, more energy efficient and powerful computing and other IT-based systems



Medicine

- Cancer treatment
- Bone treatment
- Drug delivery
- Appetite control
- Drug development
- Medical tools
- Diagnostic tests
- Imaging



Energy

- More efficient and cost effective technologies for energy production
 - Solar cells
 - Fuel cells
 - Batteries
 - Bio fuels



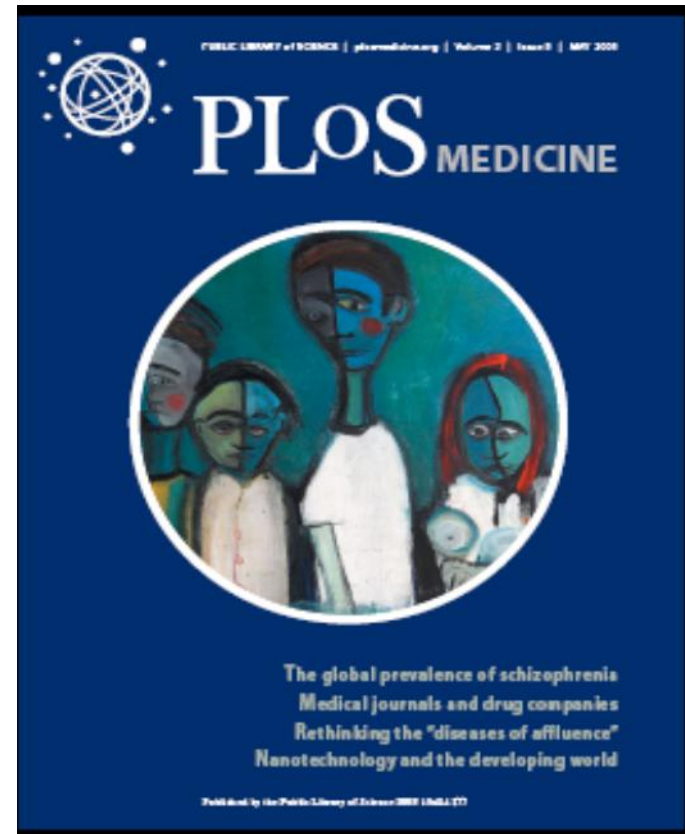
Consumer Goods

- Foods and beverages
 - Advanced packaging materials, sensors, and lab-on-chips for food quality testing
- Appliances and textiles
 - Stain proof, water proof and wrinkle free textiles
- Household and cosmetics
 - Self-cleaning and scratch free products, paints, and better cosmetics



Top 10 Nanotechnologies for the developing world

1. Energy storage, production and conversion
2. Agricultural productivity enhancement
3. Water treatment and remediation
4. Disease diagnosis and screening
5. Drug delivery systems
6. Food processing and storage
7. Air pollution remediation
8. Construction
9. Health monitoring
10. Vector and pest detection and control



PLoS Med 2006; 2(5): e97

Research in the Arab World

- Arab countries spend just **0.3% of their gross domestic product (GDP)** on science and technology, compared to **1-3% in other developing countries.**
- Average publication rate of Arab scientist is less than **1% of the world's peer-reviewed scientific articles**

Country	Publications	Total Citations	Average Publication Impact
USA	8657	20796	2.40
UK	1611	3363	2.09
Germany	2581	5174	2.00
France	1790	3156	1.76
Italy	1053	1654	1.57
Japan	3032	4504	1.49
South Africa	58	76	1.31
People's R China	6124	7954	1.30
South Korea	2140	2741	1.28
India	1130	1302	1.15
Taiwan	1337	1517	1.13
Iran	220	236	1.07
Egypt	82	52	0.63
Saudi Arabia	14	8	0.57
Kuwait	4	1	0.25
United Arab Emirates	8	1	0.13

Major investment in The Arab world in Education and Research

- Mega project such as **Qatar Foundation** (QF) and Science and Technology park(QSTP) in Qatar
- **King Abdullah University of Science and Technology** (KAUST) in Saudi Arabia
- **Masdar** Institute in UAE and other projects in other Arab counties.

Nanotechnology In The Arab World



Arab Industrial Organization
Development and Mining (Arab
initiative to adapt the Science and
Nanotechnology and converging
technologies

Summary of nanotechnology status in the Arab countries

Country	Population in millions [34]	Number of institutions conducting nanotechnology research	Number of nanotechnology-related publications ^a		Total publications	Number of nanotechnology-related publications per million
			2002–2007	2008–2013		
Saudi	26.5	11	44	1398	1442	56
Tunisia	10.7	8	139	418	557	52
Emirates	5.3	5	37	190	227	43
Kuwait	2.6	2	27	58	85	33
Jordan	6.5	2	44	143	187	29
Egypt	83.6	4	385	1634	2019	24
Oman	3	2	13	49	62	21
Qatar	1.9	2	1	20	21	11
Morocco	32.3	1	45	142	187	6

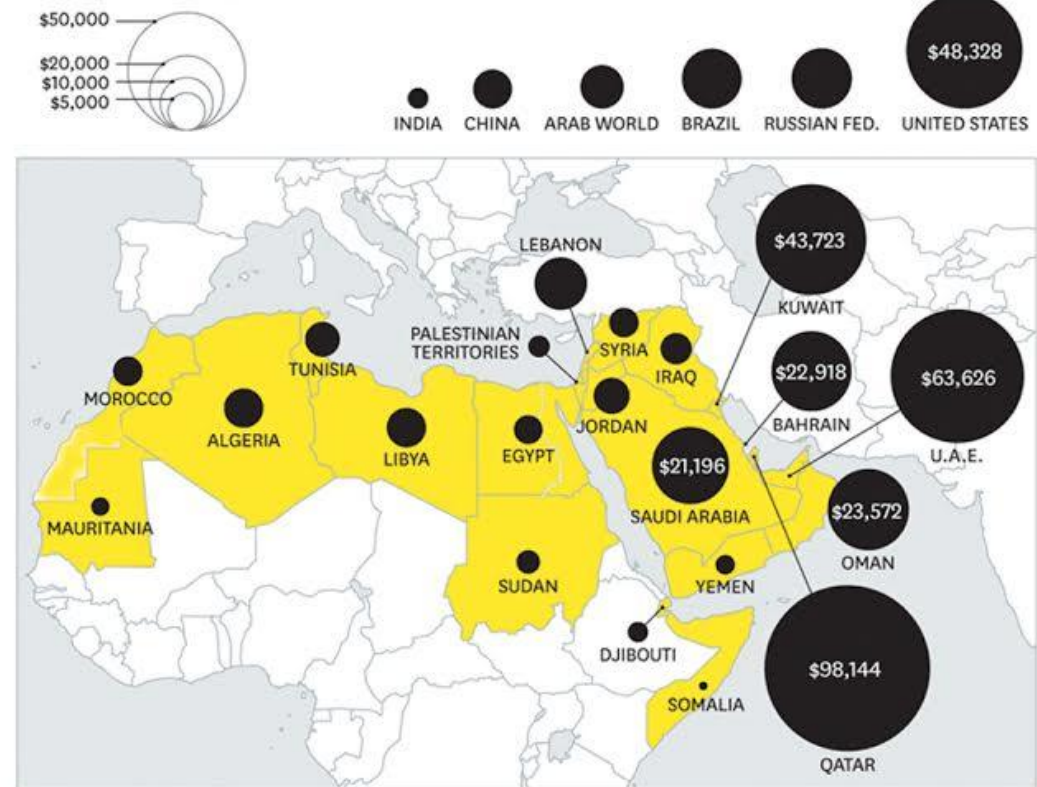
^aThe number of publications in peer-reviewed journals in the topics related to nanoscience and nanotechnology during the period January 2002 to March 2013. The data obtained searching for the phrase 'nano' in the title using the SciFinder database.

➤ New Era in Arab Nanotechnology

Arab World Market

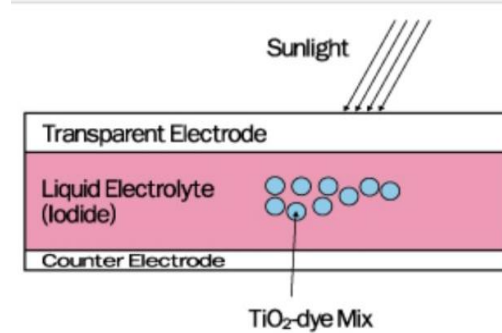
- Fastest developing economies in the world
- Total Arab League GDP is estimated to be more than \$2.3 trillion in 2011. Which make it world's eighth largest economy in the world
- middle class is growing to almost 44% of the region's economy
- more than 150 million people with household consumption. 60% of the Arab countries

PER CAPITA GDP (US\$ IN 2011)



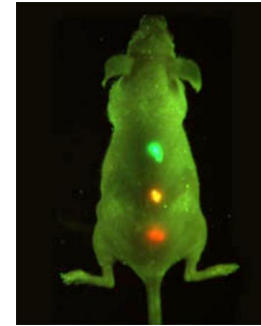
Energy

- Nanotechnology based **solar cells** can provide **better conversion** of sunlight to electricity, **cheaper manufacturing cost**, simple installation, easy manufacturing (paintable manufacturing processes) using **flexible** rolls.
- Nanotechnology can improve the efficiency of fuel production using **nanocatalyst** and **increase fuel consumption efficiency** in vehicles and power by **reducing friction**.
- Enables the production of new batteries such as **lithium-ion battery** which are less flammable, **fast charging**, **high efficiency**, with **lighter weight**, and a **higher power density**.
- **Recycling of waste heat** in many devices and processes such computers, automobiles, and power plants to electrical power.
- Developing **carbon nanotubes** containing wires that **reduces the resistance in the electric grid** and thus **reduce transmission power loss**.

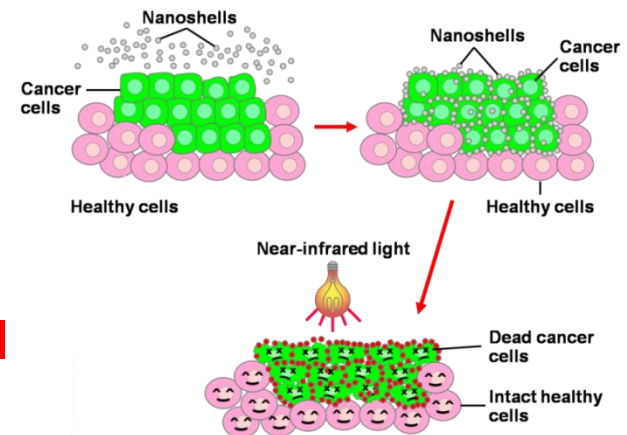


Nanotechnology in Medicine

- Enhancing **medical imaging and diagnostics** using semiconducting Nanocrystals called **Quantum Dots** in imaging techniques such as MRI and the conventional dyes and provide more information.
- **Gold nanoparticles** can be used to detect **early-stage Alzheimer's disease and cancer cells**.
- **Targeting to cancer cells and deliver the treatment** without affecting normal tissues.
- **Spur the growth of nerve cells such as damaged spinal cord or brain cells** by injecting nanostructured gel to fills the space between cells and encourages new cells to grow or **using nanofibers to regenerate damaged spinal nerves**.
- Using microfluidic **lab on a chip** to monitor and **manipulate individual cells and track the movements of cells and individual molecules**.



Detecting Diseases Earlier
Using Quantum which dots glow in UV light “Could locate as few as 10 to 100 cancer cells”
<http://www.whitaker.org/news/nie2.html>

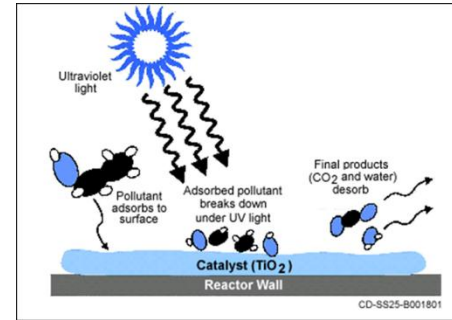


Thermal ablation of cancer cells using Nanoshells have metallic outer layer and silica core

National Cancer Institute

Nanotechnology in Water

- Achieving affordable and clean drinking water by rapid, cheaper **detection of impurities** in and filtration and purification of water. For example, using **magnetic interactions between rust nanoparticles can remove arsenic or carbon tetrachloride from water.**
- Development of **photocatalytic materials for cleaning water** using sun light energy
- Development of **nanostructured filters capable of removing virus from water**
- Development of nanotechnology **sensitive sensors to detect and monitor contaminants in water.**
- Development of Nanofibers **membranes to remove salt from water.**
- Development of highly porous electrodes made from nanomaterial that can be used in **capacitive water desalination.**

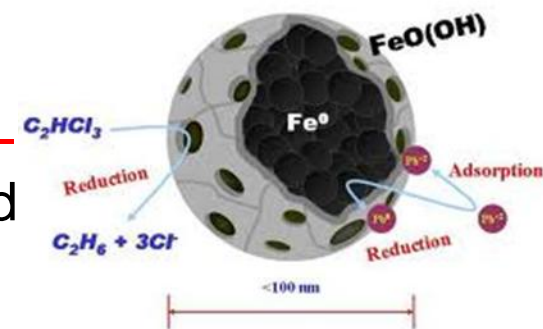
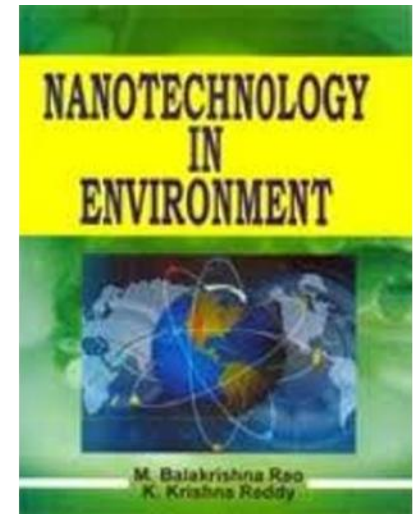


Nanotechnology in Chemical Industry

- Reducing the amount of platinum in the cars catalytic convertor.
- Using Nano photocatalysts such as Titanium and zinc dioxide in water treatment and air purification.
- Using Low temperature Nanocatalysts for petrochemicals to reduce energy consumption.
- Using Nanocatalysts to produce new chemicals and plastics.
- Produce fuel from air
- Using photocatalysts split water to produce hydrogen fuel.
- Using photocatalyst to break CO₂ to carbon and oxygen using the sun light.
- Engineering of biodegradable plastic materials with super thermal, mechanical and electrical characteristics. For example, it can be make easy-to biodegrade plastic bags.

Nanotechnology in Environmental applications

- Using Nanomaterials to **minimize the amount of noble metal but with the same catalytic performance.**
- Using **nanofibers filter media in automobile and airplanes** industry And dust removal in many at **industrial plants and gas turbines.**
- Using Nano membranes for **CO2 capture from power plant flue gases.**
- Using Metal Organic Frameworks (MOFS) for **CO2 absorption** (these materials can absorb 9 times its weight)
- Using nanoscale titanium dioxide in **cement photo-catalytic active concrete surfaces** can be produced for air purification in towns.
- Development of nanofabric "**paper towel,**" woven from potassium manganese oxide wires, that can **absorb 20 times its weight in oil for cleanup applications.**



Nanotechnology in Oil & Gas

- Enhancing the performance and reliability of the drilling equipment by increasing the strength and durability under extreme conditions such as high-temperature and high-pressure.
- Using hydrophobic or hydrophilic Nanomaterials for water flood applications in drilling operation.
- Using Lightweight rugged Nanomaterials that reduce for offshore platforms, and more- energy efficient transportation vessels.
- Using Nano sensors and imaging techniques for extreme environment operations such as deep wells and provide data on reservoir environment and hence improve drilling cost.

Nanotechnology in Agriculture

- Develop Nanomaterials such as hydrogels that can be mixed with the soil and store water and prevent evaporation.
- Developed nanoscale powders of nutrition product that have a high surface area which make it easy to be absorbed.
- Develop new fertilizer particles to minimize the excess use of dangerous fertilizers.
- Developed new materials based on polymer-nanoparticles nanocomposites to be used in the water delivery systems

Nanotechnology in Food

- Development of biosensors for bacteria identification and food quality monitoring.
- Development of Nanomaterials and coating for intelligent, active, and smart food packaging.
- Development of anti-microbial agents such as silver nanoparticles for the surface of the coated film on the packaging.
- Development of Nanomaterials for Nano encapsulation of bioactive food compounds

Nanotechnology in Aerospace and Cars

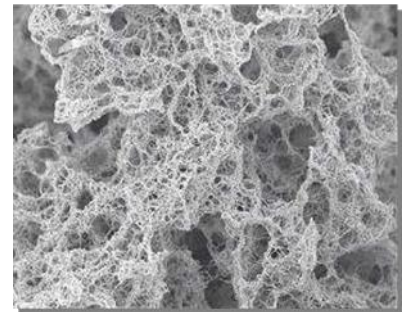
- Develop lighter and stronger materials for aircraft to increase their performance and reduce energy consumption.
- Develop lighter and stronger materials for vehicles to make it faster and safer.
- Develop lubricant for combustion engines to reduce wearing and increase the heat resistant.
- Develop Nano coating for the outer parts of the airplanes and cars to reduce the drag force and hence reduce the fuel consumption.
- Develop Nano scratch resistance coating for cars.

Nanotechnology in Construction and Building

- Develop **Nano sensors** to monitor everything in the building.
- Utilized **waste materials** to create new **sustainable Nanomaterials** to be used in new buildings.
- Develop nanoparticle for **anti-corrosion coating** to prevent structural damage.
- Develop **none flammable and thermal insulation materials** and coating based on Nano clays and silica aerogels to reduce energy consumption and enhance the safety in buildings
- Develop **self-cleaning and photocatalytic coating** to be used on the outer **envelope of the building**.



Concrete

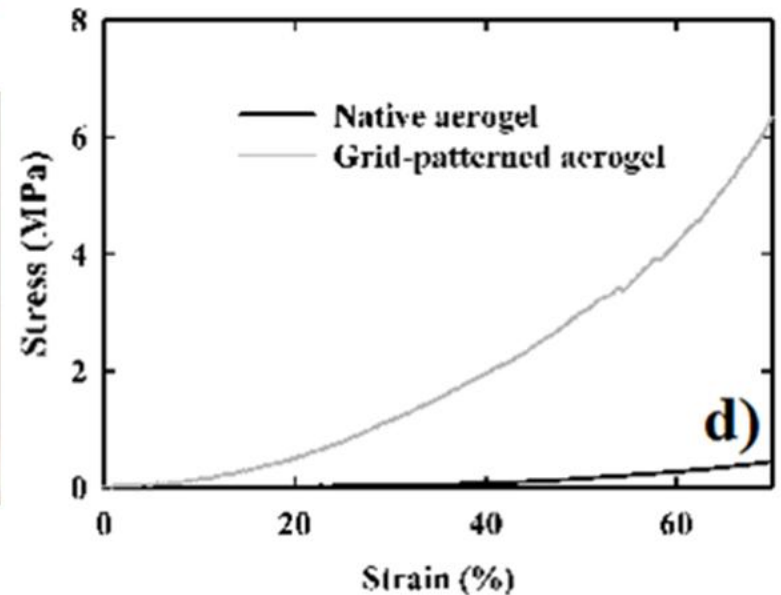
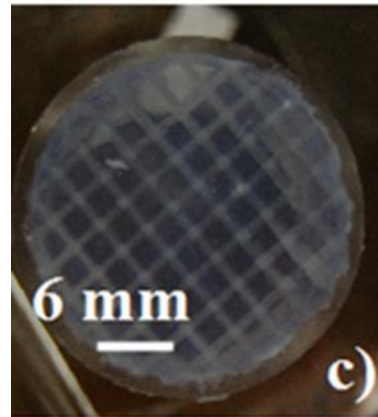
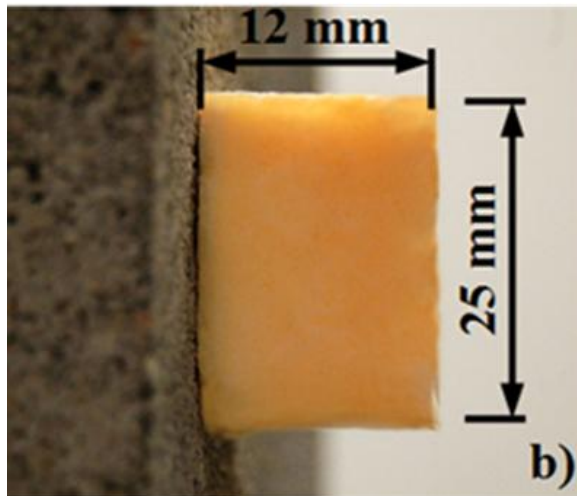
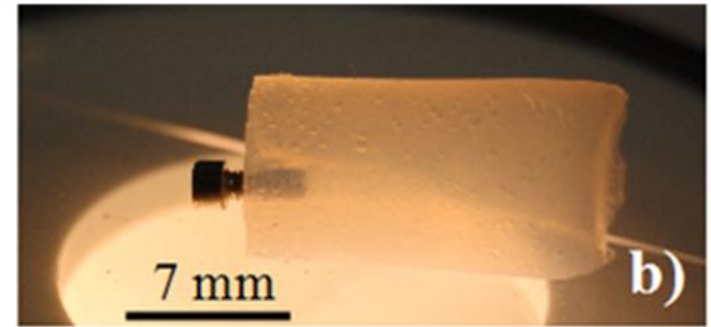
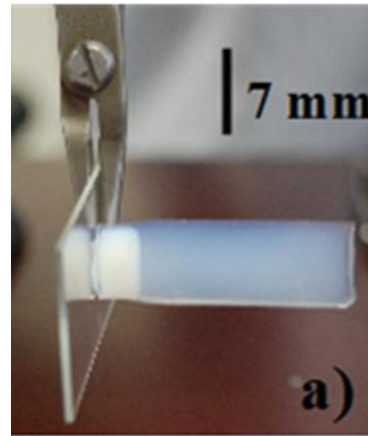
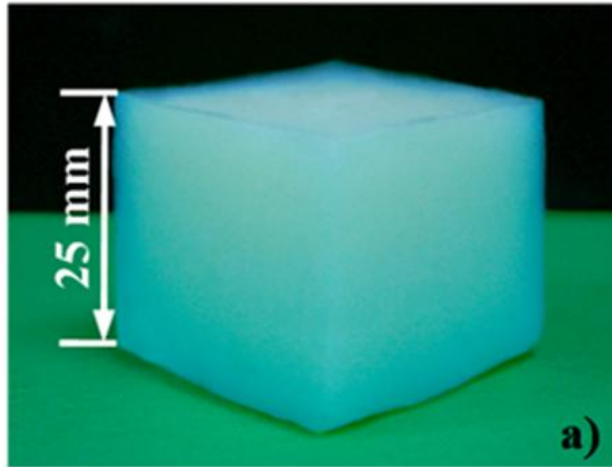


Nano foam

Nanotechnology in Textile

- Develop nanofibers to make functional textile such as **water and stain-repellent or wrinkle-free**.
- Develop **heat resistance coating**.
- Develop **electrostatic resistance** textile by integrate carbon nanoparticle membranes.
- Develop **smart textile for monitoring of human body temperature and heart rate** and solar chargers.
- Develop **wound dressing textile** which has silver nanoparticles as anti-bacteria agent.

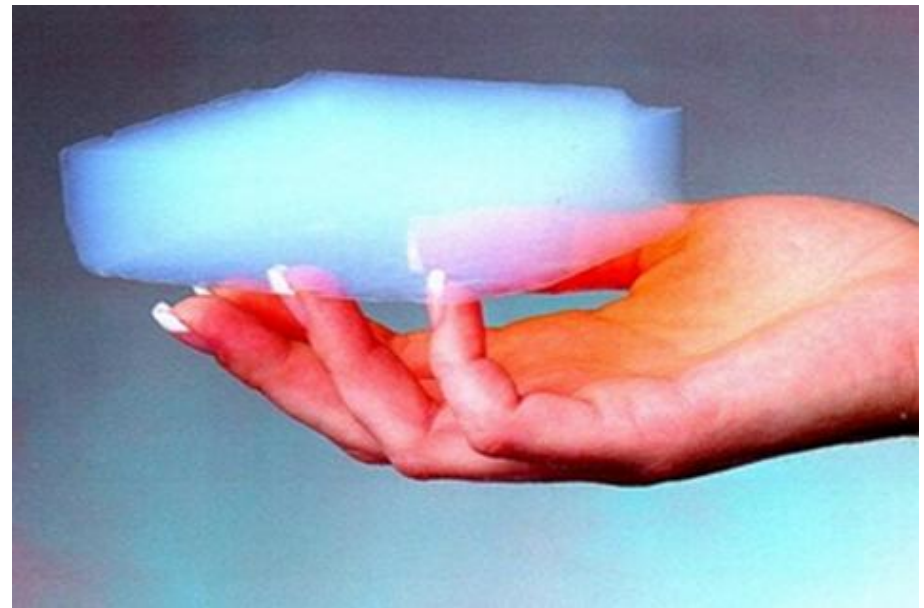
Case study 1: Aerogel material for Thermal Insulation



Nanotechnology for Thermal Insulation and Green Building



Aerogel Translucent Insulation Panels



2022 FIFA World Cup

Anti-flamable Coating for Expanded Polystyrene(EPS)



اللجنة العليا للمشاريع والإرث
2 مايو -

Dr Khaled Saoud – a physics professor from Virginia Commonwealth University in Qatar – remembers Challenge 22 experience.

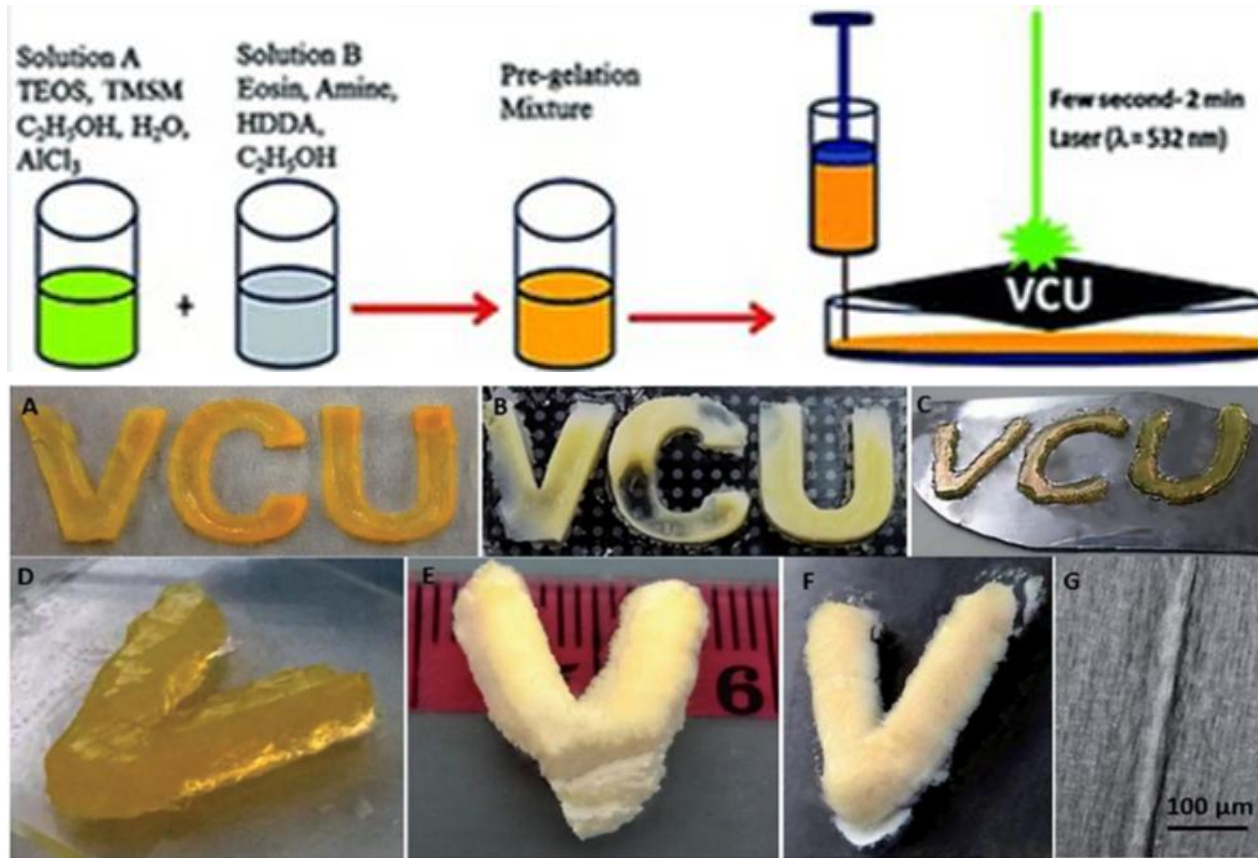


اللجنة العليا للمشاريع والإرث
Supreme)
Committee for
Delivery &
(Legacy
roadto2022@

الصفحة الرئيسية
حول
الصور

Local scientist on how Challenge 22 turned dream to reality : Supreme Committee for Delivery &...
Dr Khaled Saoud, a physics professor from Virginia Commonwealth University in Qatar, on how he won the 2015 edition of SC's innovation programme

3D Printing of Ultra-Light and mechanically Strong Aerogel on Different Substrates using Low Power Visible Lasers with resolution of $10\mu\text{m}$



Physical properties: Shrinkage: 10.4% Density: 0.56 g/cm^3 , Modulus: 81.3 Mpa, BET surface area: $155.3 \text{ m}^2/\text{g}$

Shaukat Saeed, Rola Al Soubaihi, Massimo Bertino, Lauren White and Khaled Saoud,
Journal of Materials Chemistry A, 2015, DOI: 10.1039/c5ta04215a

Officially “hot”! , 2015 RSC Chemistry A Hot Articles

Laser Induced Instantaneous Gelation: Aerogels for 3D Printing

Publishing
Journals, books and databases

Journals ▾ Books ▾ Databases ▾ Alerts ▾ Other ▾ Help ▾ Feedback

Full Text ▾ Enter your search phrase

Home > Journal > 2015 Journal of Material...

2015 Journal of Materials Chemistry A Hot Papers

Description


This on-going web collection features all the articles published in *Journal of Materials Chemistry A* in 2015 marked as HOT, as recommended by referees. Congratulations to all the authors whose articles are featured!

Laser induced instantaneous gelation: aerogels for 3D printing

Shaukat Saeed, Rola M. Al-Sobaihi, Massimo F. Bertino, Lauren S. White and Khaled M. Saoud

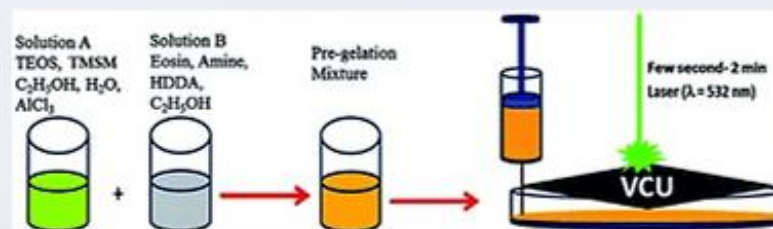
J. Mater. Chem. A, 2015, 3, 17606-17611

DOI: 10.1039/C5TA04215A

 Collapse | PDF | Rich HTML

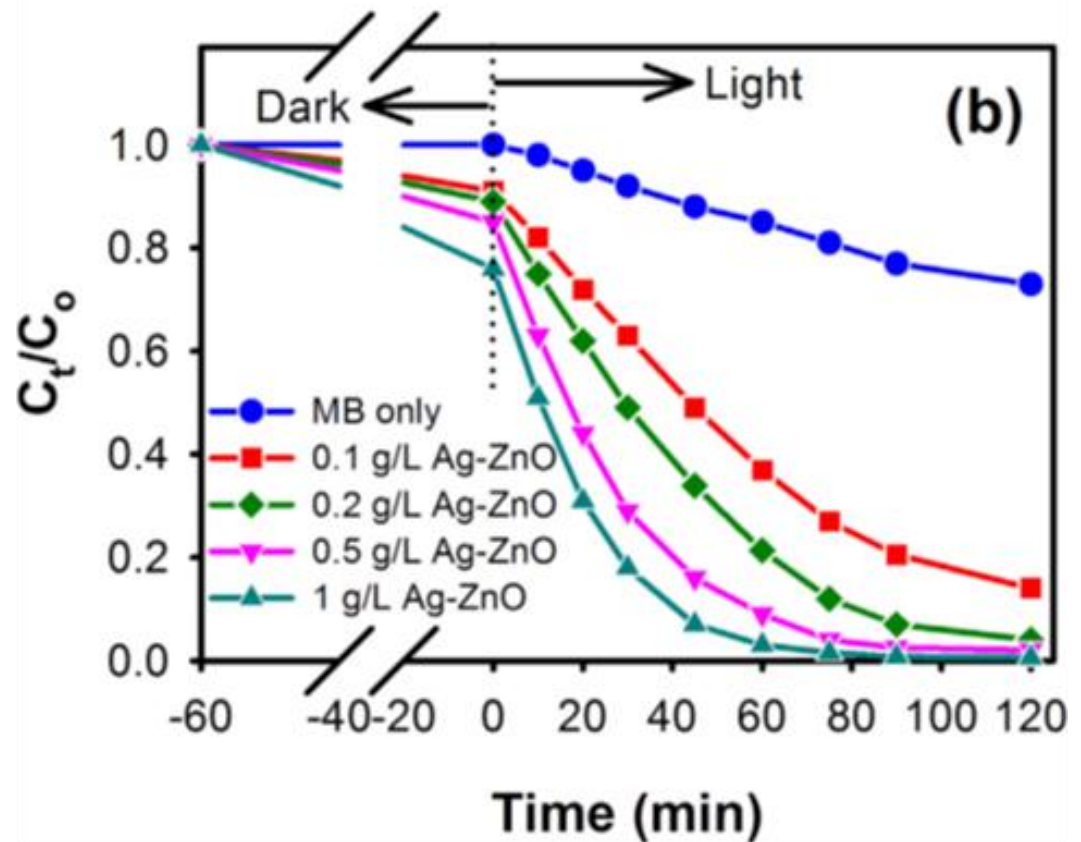
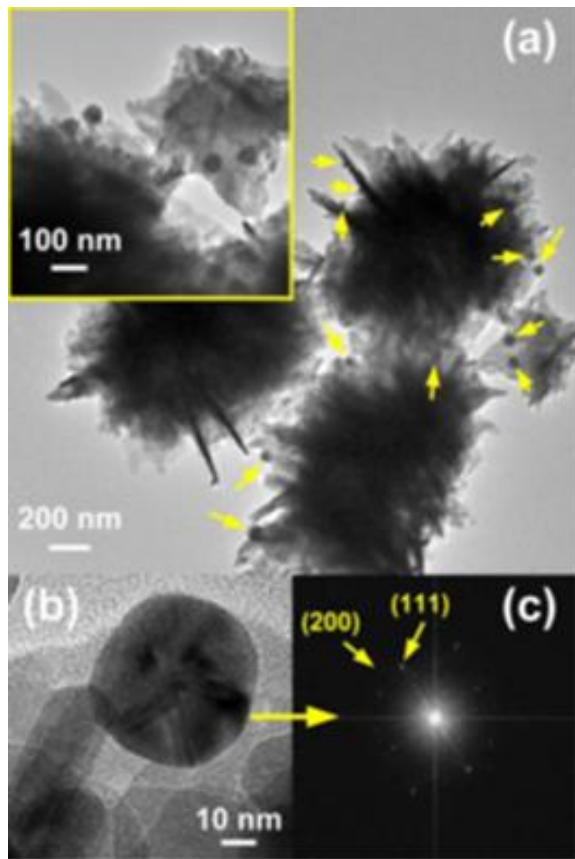
From themed collection 2015 Journal of Materials Chemistry A Hot Papers

We present the synthesis of polymer cross-linked silica aerogels in a matter of seconds by illuminating the solution of TEOS, hexanedioldiacrylate, Eosin Y and amine with a laser beam ($\lambda = 532$ nm).



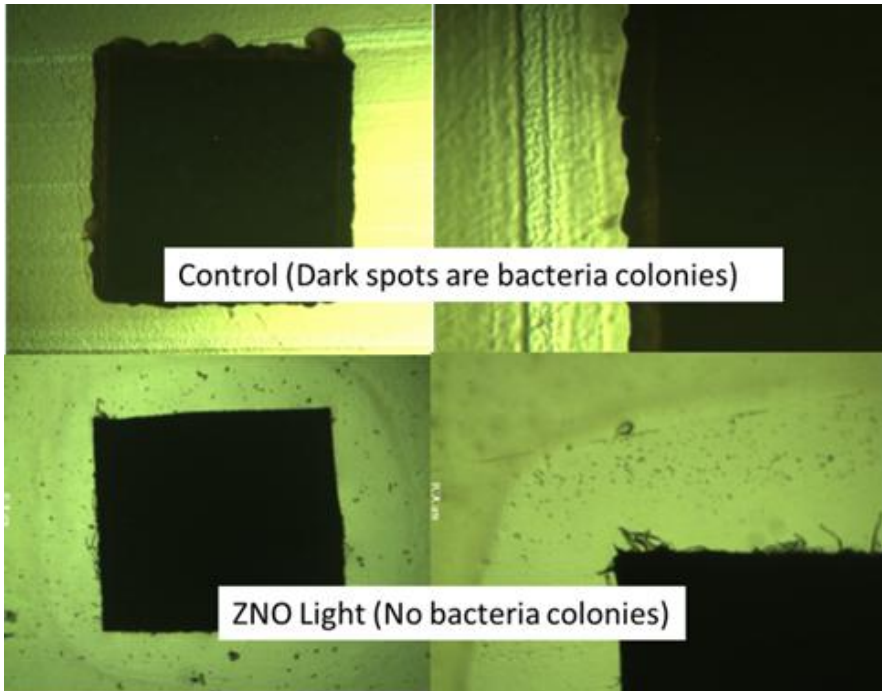
Shaukat Saeed, Rola Al Soubaihi, Massimo Bertino, Lauren White and Khaled Saoud, Journal of Materials Chemistry A, 2015, DOI: 10.1039/c5ta04215a

Case Study 2: Silver/Zinc Oxide Photo catalyst (Ag/ZnO) for Waste Water Treatment

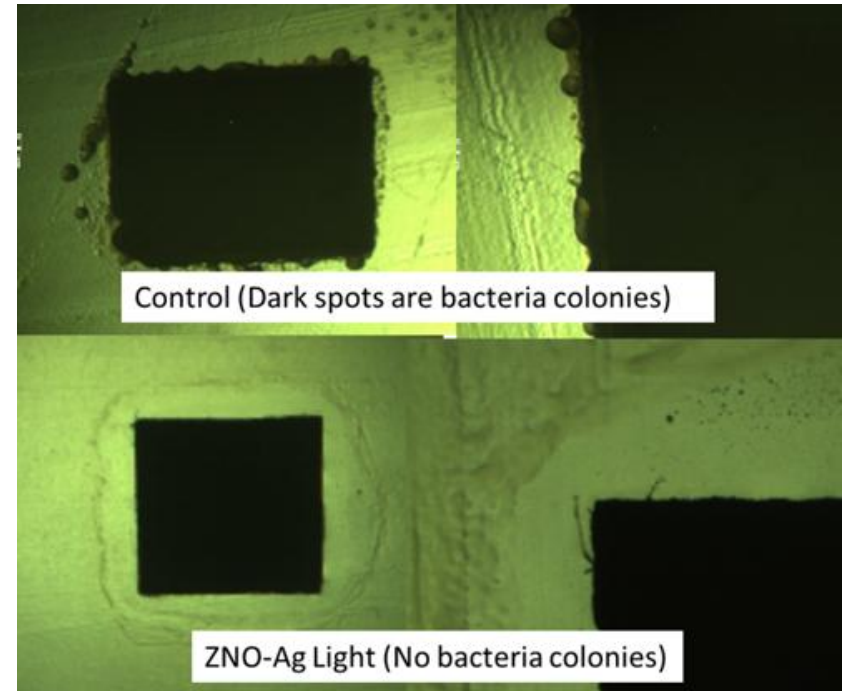


Nanoparticles Under Light

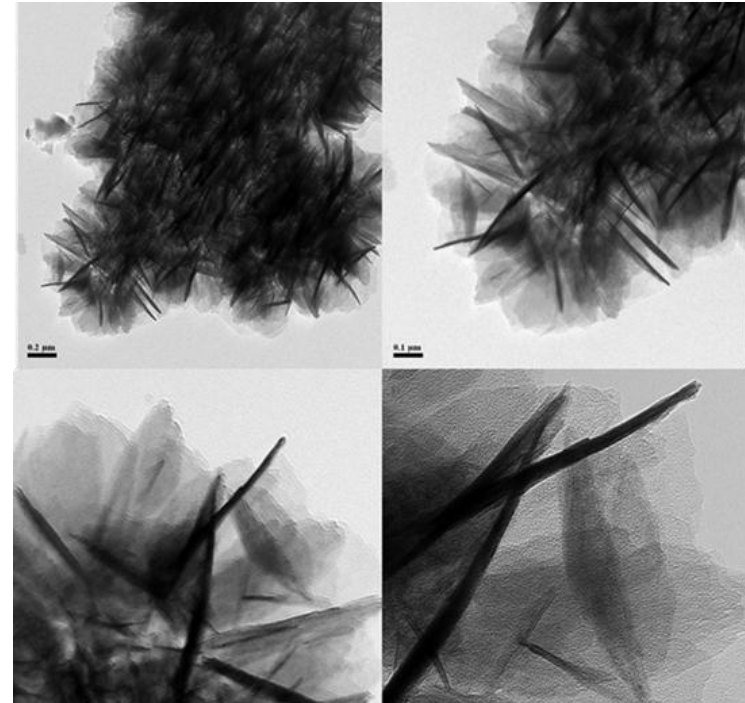
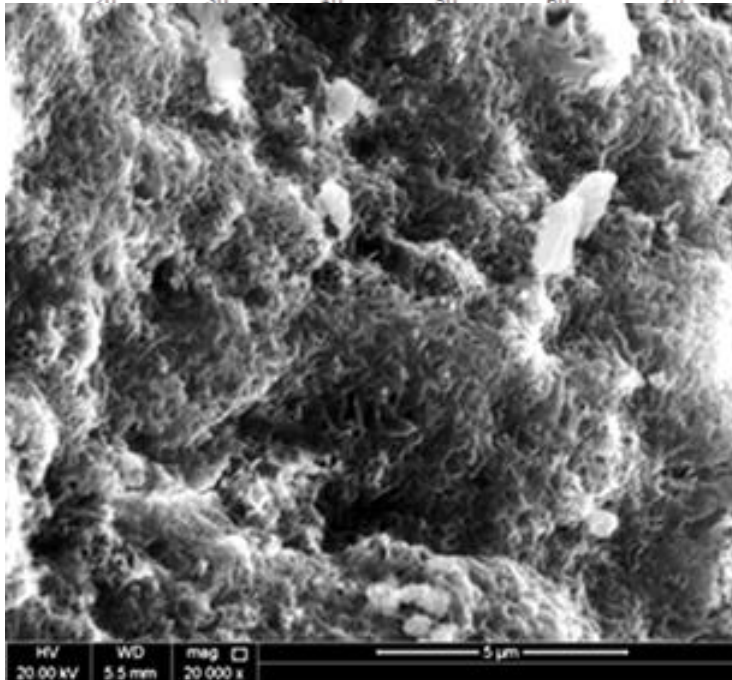
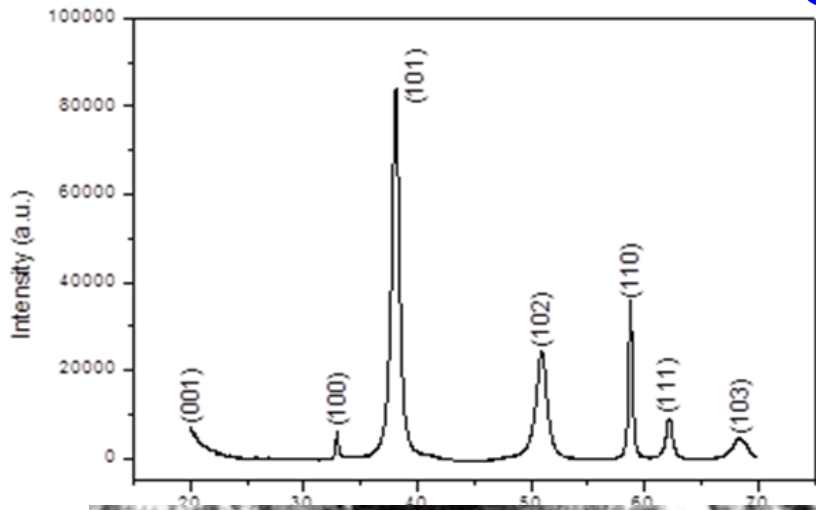
ZnO under light



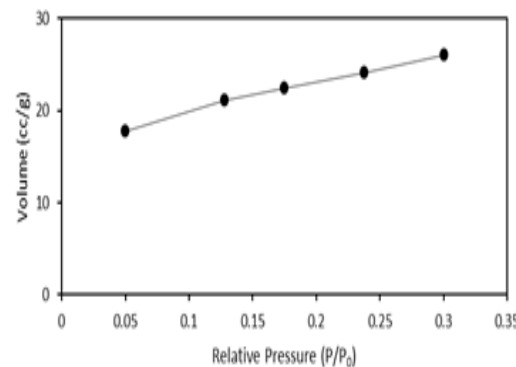
Ag/ZnO under light



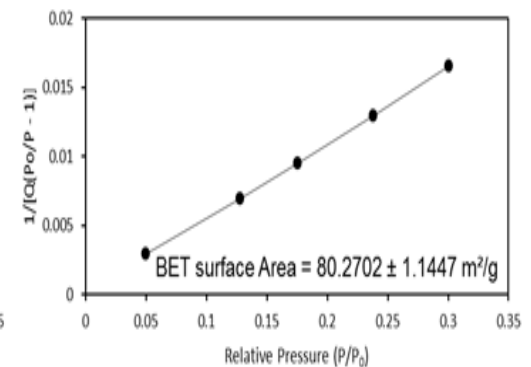
Case Study 3: Mg(OH)₂ Nano Sheets



Isotherm Linear Plot: Mg(OH)₂



BET SA Plot: Mg(OH)₂



Reference paper and old paper treated with $\text{Mg}(\text{OH})_2$ and $\text{Ca}(\text{OH})_2$ Nano-particles

$\text{Ca}(\text{OH})_2$

$\text{Mg}(\text{OH})_2$



The pH value for old paper samples is 2.5 which rises to **8.5** in case of calcium hydroxide and to **10.5**, in case of magnesium hydroxide sample.

Challenges for Technology Transfer

- Expensive analytical/quality control/facilities are required to set up a manufacturing plant for nanotechnology-based products.
- Lack of early involvement of industry partner in the technology development and transfer project and mutual trust.
- Industry lacks technology adoption capabilities and risk taking attitude.
- Lack of finance/ capital and incentives to take up innovative and risky technology projects for commercialization.
- Industry is not aware of technologies available with laboratories and also not having enough funds to promote lab/ industry interactions.
- Nanotechnology is highly interdisciplinary in nature, availability of skilled manpower in this area is also a major challenge to face the severe competition from multinationals.

The Future of The Arab world is in Your Hands

Investing in Nanoscience, and Nanotechnology holds a great potential for major improvement in the Arab world in many sectors such as products, technologies, and services. The Projected Nanotechnology Market will reach \$ 2.6 trillion in 2015 and provides more than 7 million jobs.



Acknowledgment

لجنة الأمم المتحدة الاقتصادية
والاجتماعية لغرب آسيا
مركز الاسكوا للتكنولوجيا



الصندوق القطري لرعاية البحث العلمي

Qatar National Research Fund

Member of Qatar Foundation

Research Group



Dr. Massimo Bertino



Dr. Shaukat Saeed



Rola Al Soubaihi (PhD student)



Lauren White (PhD student)

***Thank you
Questions???***

