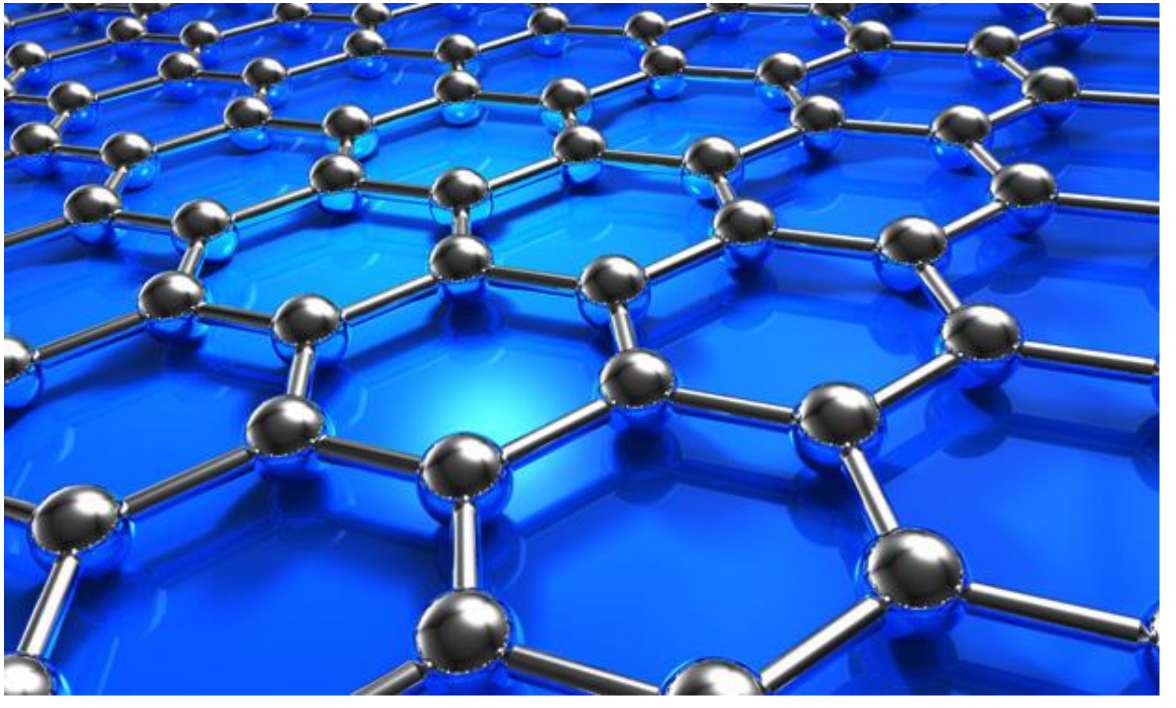
Introduction to Nanotechnology Innovation Design



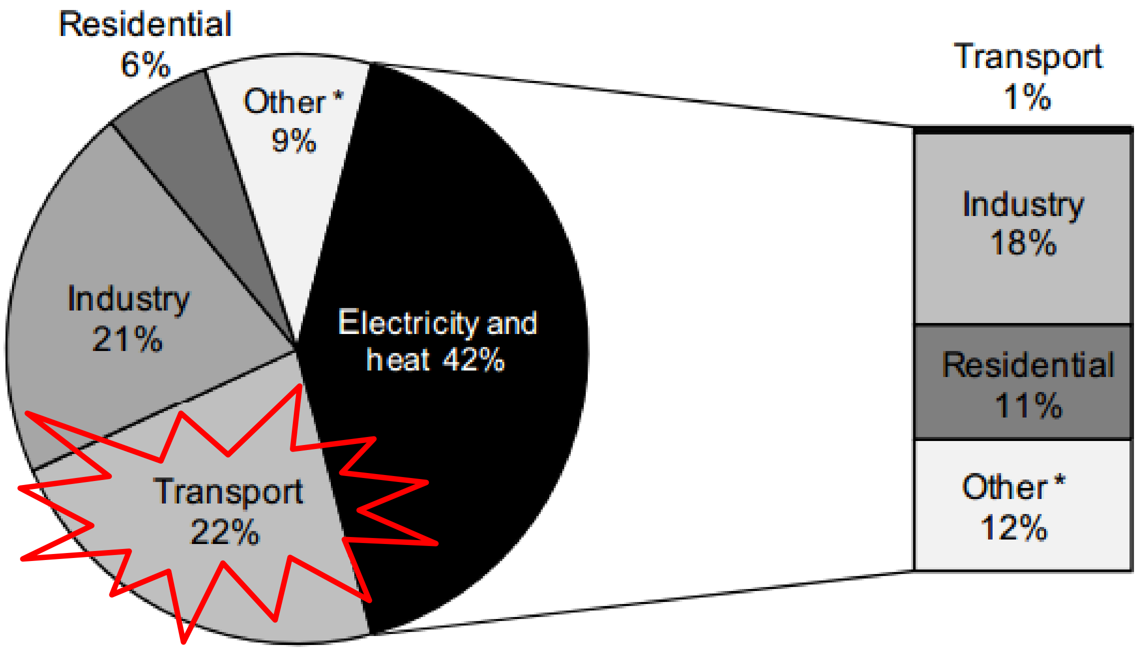
Aileen Sun
B10004048

- Cut emissions
- Mobilize money and markets
- Price carbon
- Strengthen resilience
- Mobilize new coalitions

CLIMATE
SUMMIT 2014

CATALYZING ACTION

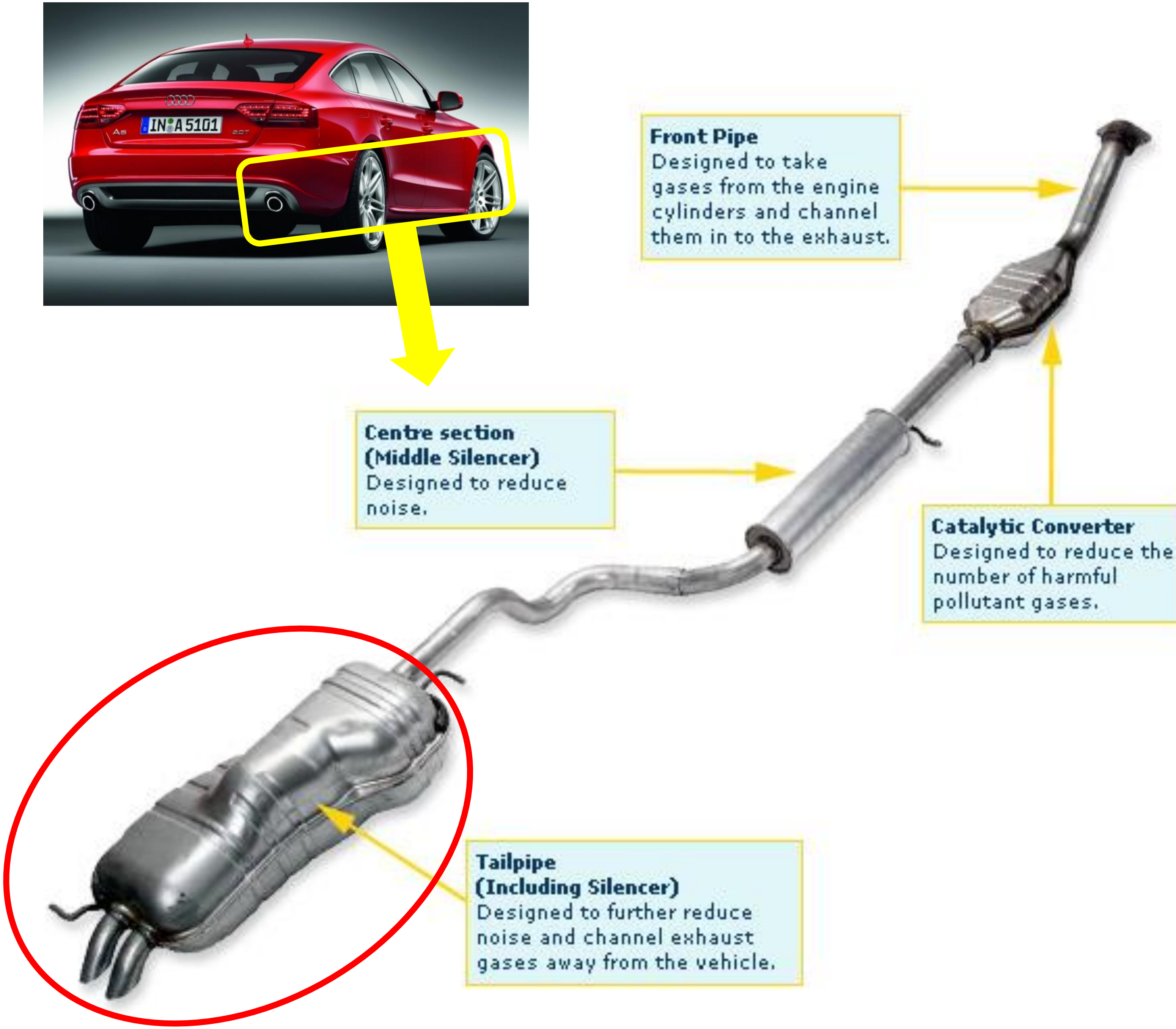
World CO_2 Emissions by Sector in 2011



Note: Also shows allocation of electricity and heat to end-use sectors.

* Other includes commercial/public services, agriculture/forestry, fishing, energy industries other than electricity and heat generation, and other emissions not specified elsewhere.

Key point: Two sectors combined, generation of electricity and heat and transport, represented nearly two-thirds of global emissions in 2011.


IN A 5101
Front Pipe
Designed to take gases from the engine cylinders and channel them in to the exhaust.
Centre section
(Middle Silencer)
Designed to reduce noise.
Catalytic Converter
Designed to reduce the number of harmful pollutant gases.
Tailpipe
(Including Silencer)
Designed to further reduce noise and channel exhaust gases away from the vehicle.

Octane Combustion

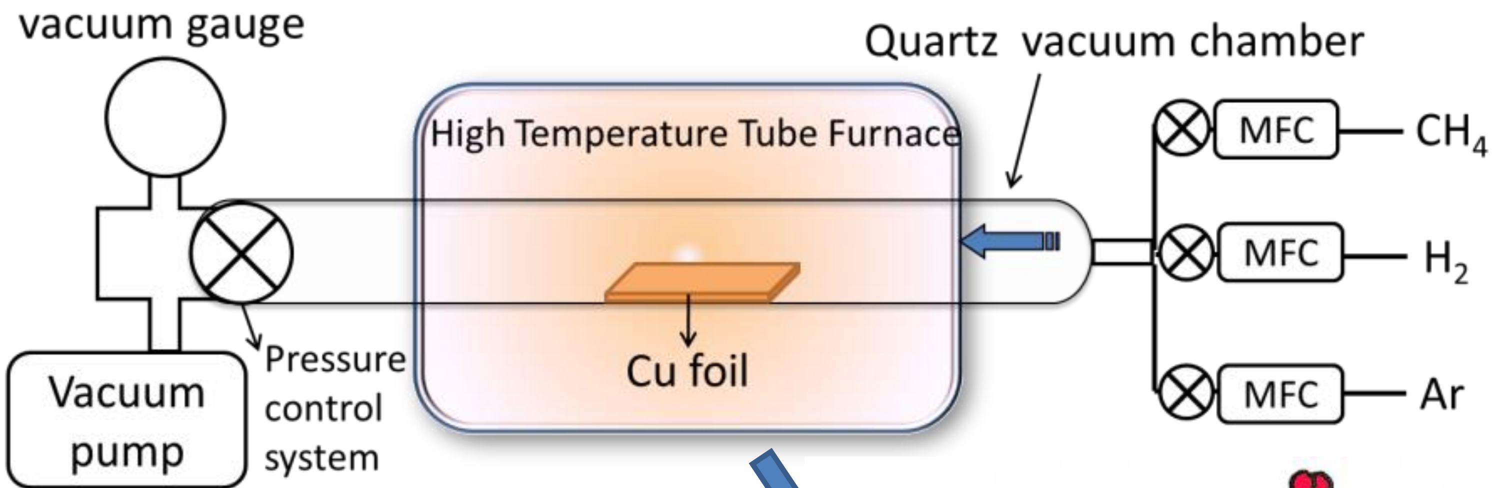
$$2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O + \text{energy}$$

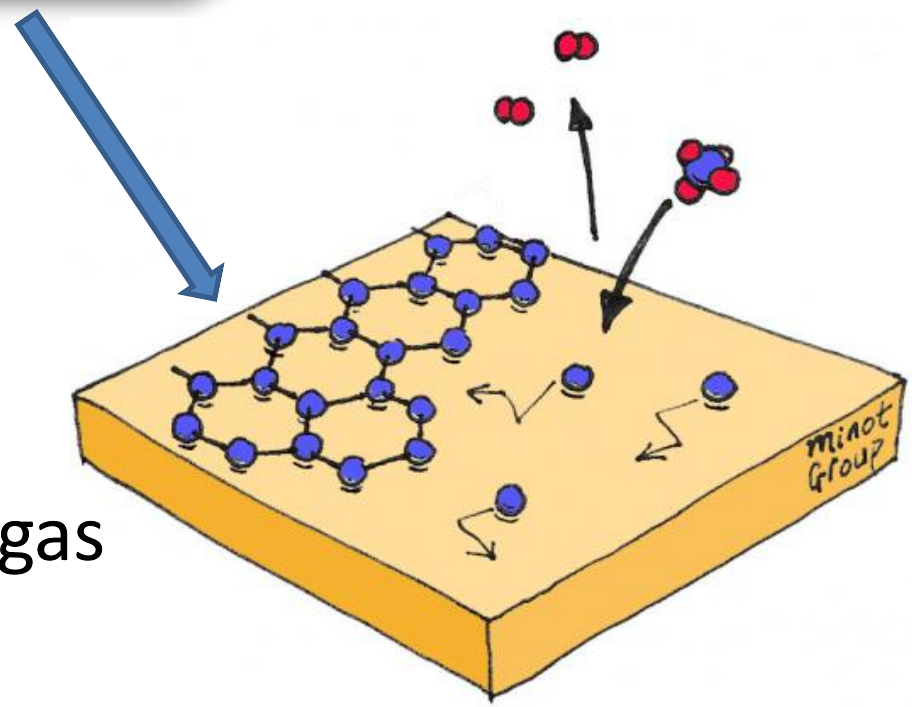
Convert carbon dioxide back to **octane**

Dissipated heat

Recycled back to engine

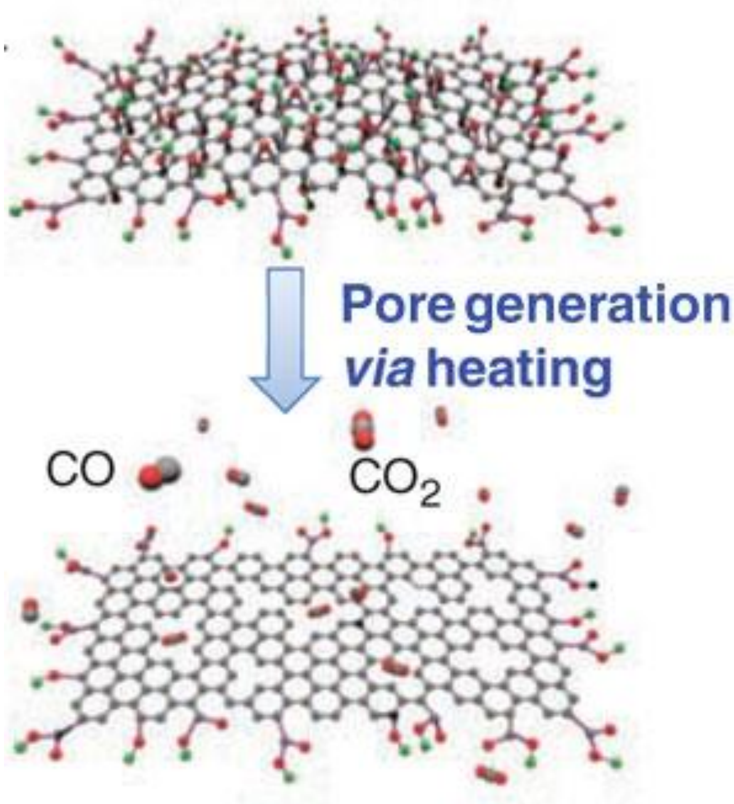
Chemical Vapor Deposition

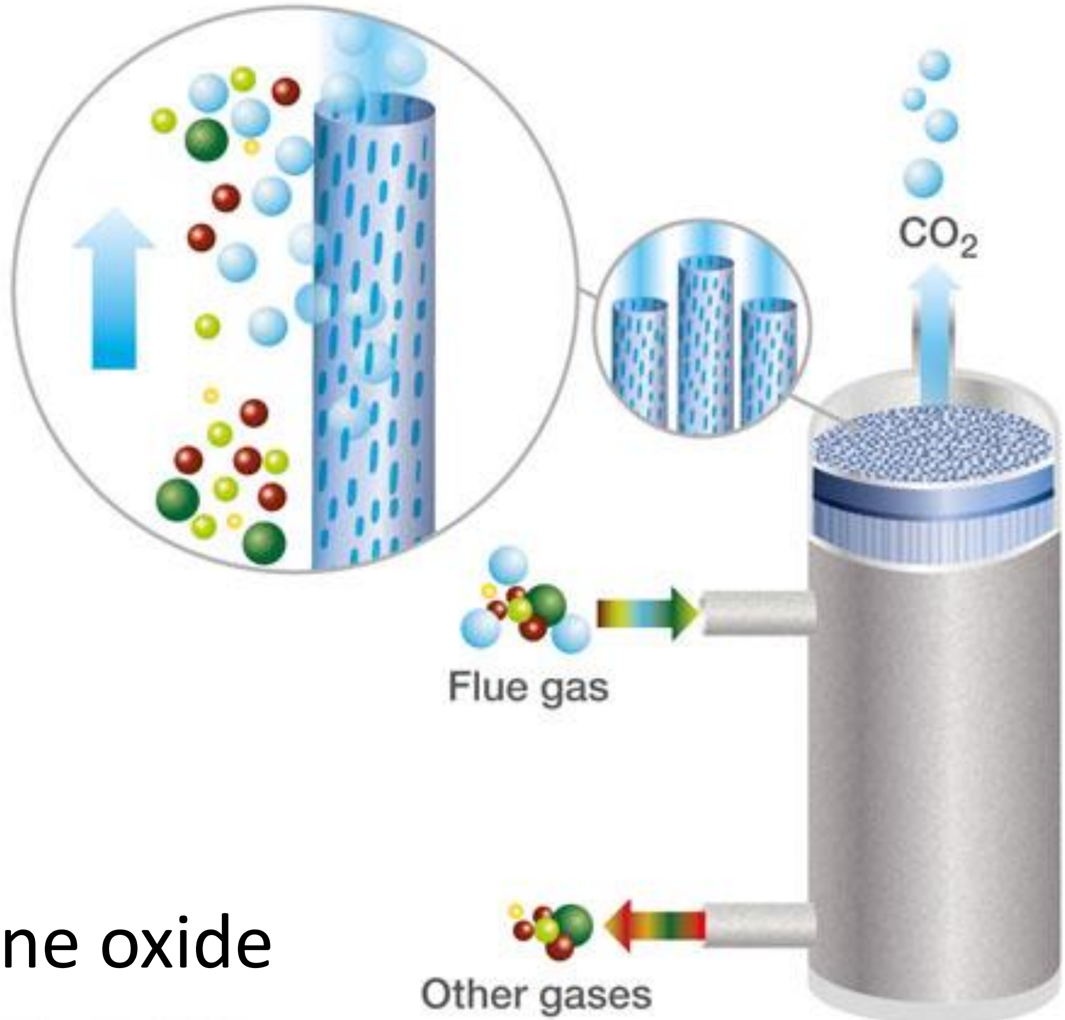




- Bottom-up approach
- 1000 °C
- Methane and hydrogen gas

CO_2 Capture





- Graphene → graphene oxide
- Molecular separation

References

- http://nanotechwizard.com/wp-content/uploads/2013/05/Nanotechnology_Graphene.jpg
- http://www.un.org/climatechange/summit/wp-content/uploads/sites/2/2013/09/climate_summit_2014.jpg
- http://www.un.org/climatechange/summit/2014/09/2014-climate-change-summary-chairs-summary/
- http://www.iea.org/publications/freepublications/publication/co2emissionsfromfuelcombustionhighlights2013.pdf
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- http://image.automobilemag.com/f/85267102+q100+re0/2015-hyundai-sonata-turbo-jp-edition-tailpipe.jpg

NATIONAL TAIWAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

GRADUATE INSTITUTE OF APPLIED SCIENCE AND TECHNOLOGY

INTRODUCTION TO NANOTECHNOLOGY

Application of Nanotechnology in Fuel Cells

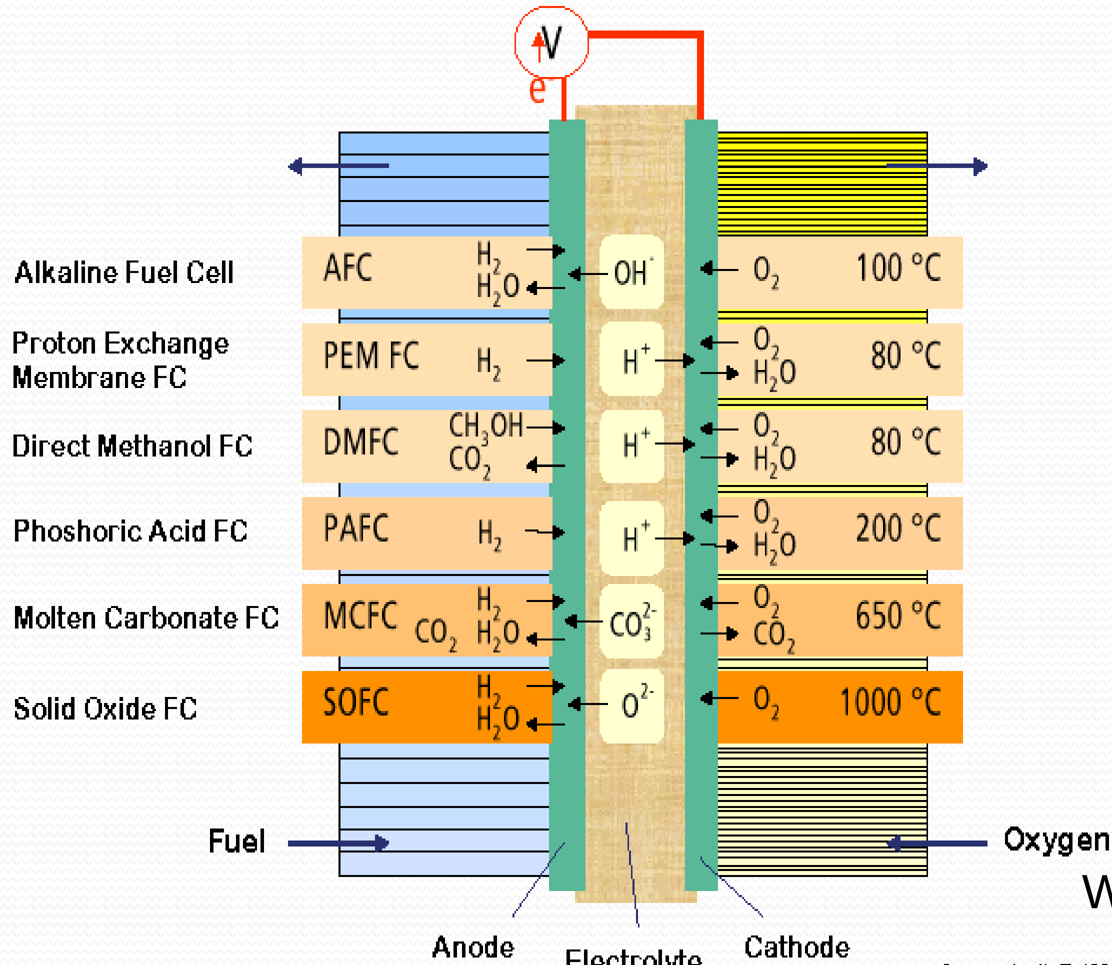
BY ALEMAYEHU DUBALE DUMA

ID: D10322802

Application of Nanotechnology in Fuel Cells

- Introduction
- Fuel Cells
- Types
- Polymer Electrolyte Fuel Cells (PEMFCs)
- Advantages and Application of Nanotechnology in Fuel cells
- Conclusion
- References

Introduction



Source: Ledjeff, 1993

A fuel cell is an electromechanical energy conversion device which produces electricity with an oxidant and a fuel source.

William Robert Grove (1842)

...cont'd

Different Types of Fuel Cells

Fuel Cells

	Low Temperature Fuel Cells		Medium Temperature Fuel Cells		High Temperature Fuel Cells	
Characteristic	PEMFC (Proton Exchange Membrane Fuel Cells)	DMFC (Direct Methanol Fuel Cells)	AFC (Alkaline Fuel Cells)	PAFC (Phosphoric Acid Fuel Cells)	SOFC (Solid Oxide Fuel Cells)	MCFC Molten Carbonate Fuel Cells)
Operating temp (°C)	60 – 80	60 – 80	100 –150	180 – 220	750 - 1050	650
Fuel	H_2 (pure or reformed)	CH_3OH	H_2	H_2 (reformed)	H_2 and CO reformed & CH_4	H_2 and CO reformed & CH_4
Charge carrier in the electrolyte	H^+	H^+	OH^-	H^+	CO_3^{2-}	O^{2-}
Poison	CO>10 ppm	Adsorbed intermediates (CO)	CO, CO_2	CO>1% H_2S>50 ppm	H_2S>1ppm	H_2S>0.5 ppm
Applications	Transportation, Portable		Space, Military		Power generation, Cogeneration	

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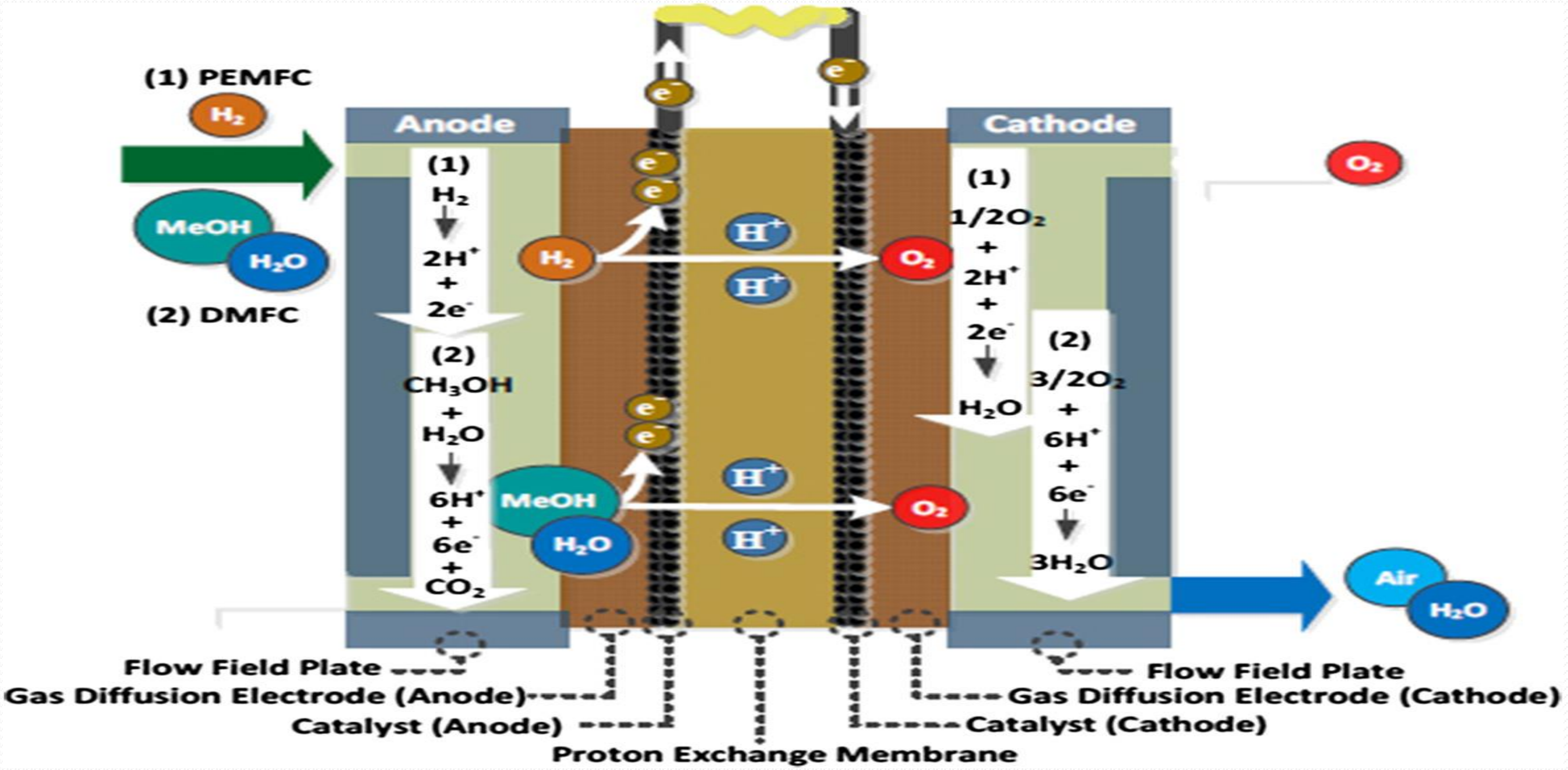
Advantages of Fuel Cells

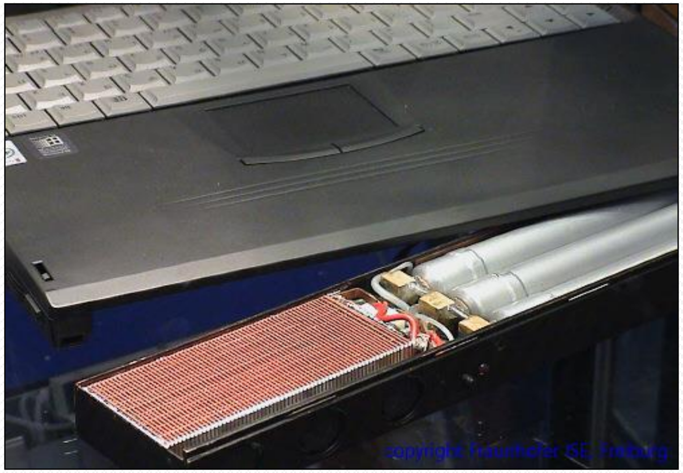
- High efficieny energy conversion
  - Theoretically 83% at 25°C
- High power density
- Reliable
- Compact
- Lightweight

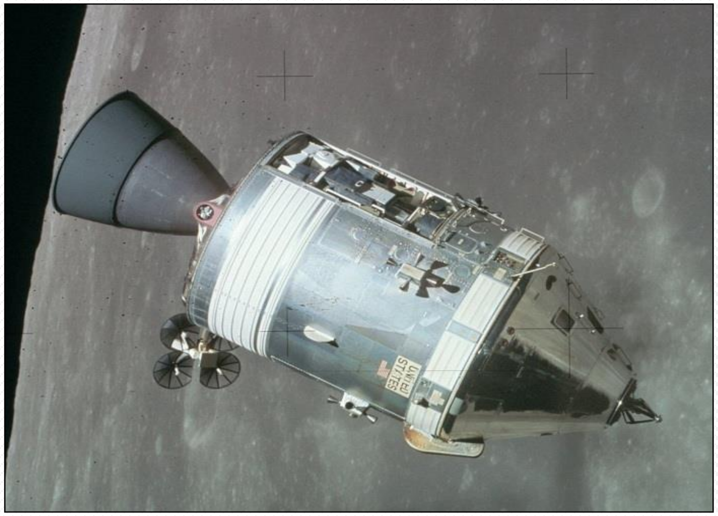
Working principle



Advantages of PEMFCs

- **Have High Energy** Densities
- Quick Start-up Times (Less Than 1 S)
- **Efficiency**
- Reliability
- Cleanliness
- future





Challenges of performance, PEMFCs

- However, **durability** of the electrocatalysts (Pt or Pt alloys),
- The slow rate of the **oxygen reduction reaction** (ORR) on the cathode
- carbon corrosion are all recognized major problems.
- Numerous efforts have been made to improve the activity and durability of Pt used in the ORR.
- Platinum has been alloyed with a variety of transition elements as bimetallic (PtM) and trimetallic alloys PtM_1M_2),
- (M: V, Cr, Ti, Mn, Fe, Co, Ni, W, Mo, Ir, Pd, and Zn) or by dealloying of some alloys of Pt.

…cont'd

- Similarly, bimetallic core–shell nanostructures and Pt ultrathin layered shells on the surface of dimensionally stable M metal core (M core Pt ultrathin-shell) nanoparticles (NPs) have been explored
- However, studies also indicate that under acidic conditions,
- the **Pt–M** alloys may exhibit **instability** and lose oxygen reduction activity, due to leaching of the transition metals from the alloys.
- leaching from the catalyst's surface not only reduces electrocatalytic activity
- increases ohmic resistance and accelerates the degradation of the membrane electrode assembly in fuel cells.
- The use of carbon black (CB) as an electrocatalyst support in low-temperature PEMFCs imposes limits on the durability of the electrocatalysts, thus reducing the actual working life of fuel cell based power devices

…cont'd

- **The carbon corrosion** process is accelerated by the highly corrosive environment within the fuel cells,
- and also by the transient conditions during the start-up and shutdown cycles that result in cathode voltage excursions into high anodic/oxidative overpotentials
- Under such conditions, in the presence of platinum, a powerful carbon oxidation catalyst, carbon corrosion is even more pronounced.

...cont'd

- Several studies explored the use of oxide (MxOy; e.g., M = Nb, Ti, Ta, W, Ce, Ru, Ir, Si, Sn) supported electrocatalysts as an alternative system to achieve improved activity and durability in PEMFCs.
- However, the electronic conductivity of metal oxides is rather
- low for a catalyst support material in PEMFCs.

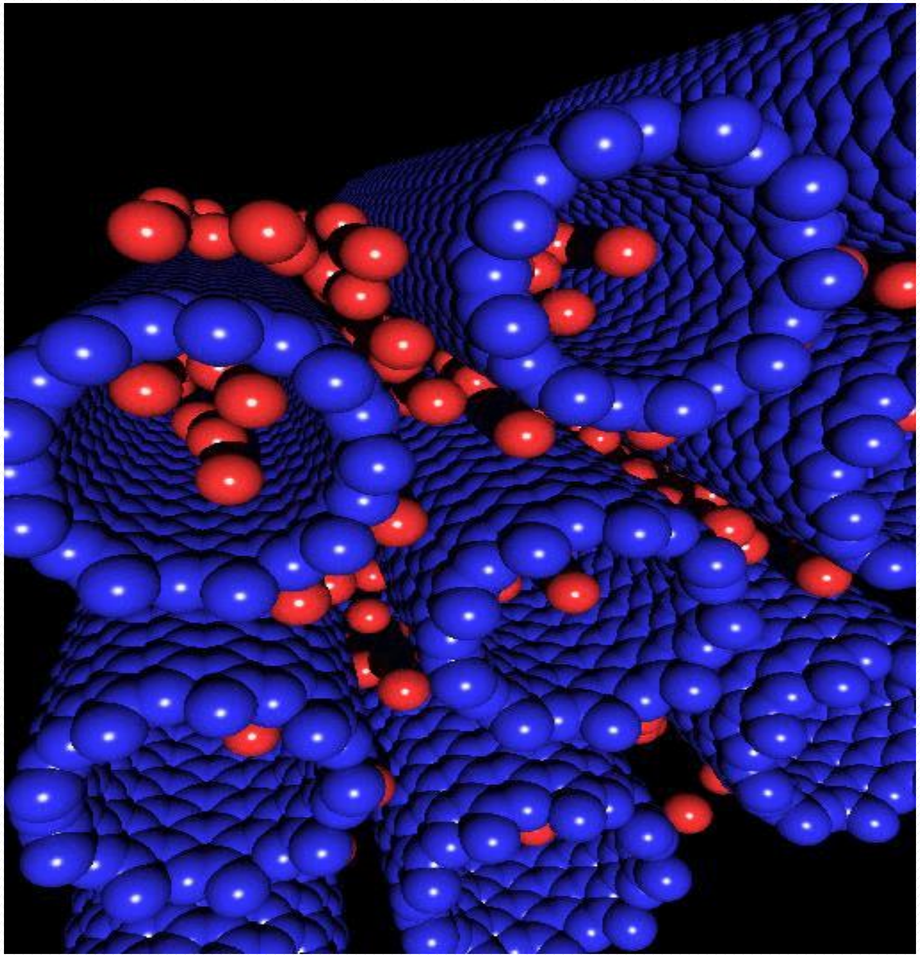
…cont'd

Essential criteria for choosing an electrocatalyst for oxygen reduction

- High oxygen adsorption capacity
- Structural stability during oxygen adsorption and reduction
- Stability in electrolyte medium
- Ability to decompose H_2O_2
- High conductivity
- Tolerance to CH_3OH (in DMFC)
- Low cost

CNTs

- Carbon nanotubes (CNTs) with their high aspect ratios, high
- electron conductivities, favorable morphologies and pore structures,
- have potentially better corrosion resistance and have
- therefore been investigated as an alternative to CB



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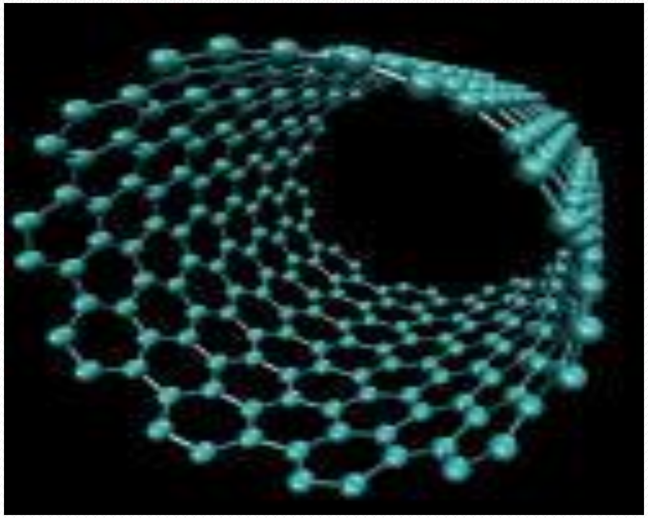
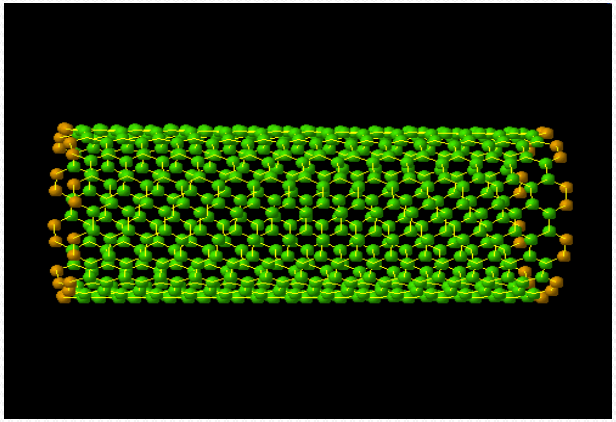
- Single walled nanotubes are only a few nanometers in diameter and up to a millimeter long.
- High conductivity.
- High accessible surface area.
- High dispersion.
- Better stability.





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- To achieve a better dispersion of Pt nanoparticles,
- Recently different polymer modifications of MWCNTs have been carried out.
- Although the approach seems useful in anchoring Pt, the long and flexible polymer chain gives rise to a large contact resistance between Pt NPs and CNTs, which
- decreases the activity of Pt–CNT catalysts.
- To circumvent these issues, **surface properties of the CNTs can be tailored by depositing metal oxide coatings to combine the mechanical and conductive features of the CNTs with desired** surface properties of the selective oxide.

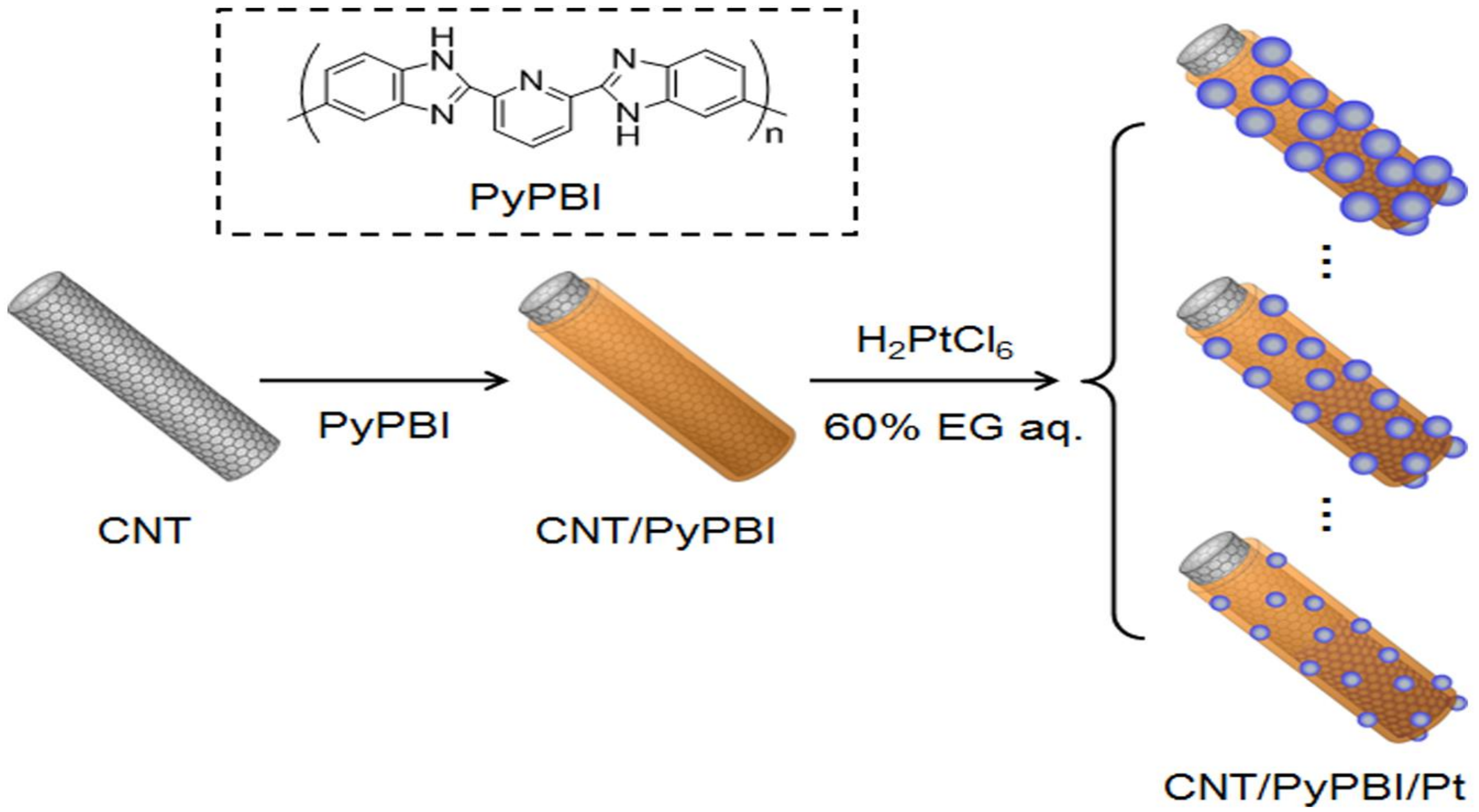

Figure . Schematic drawing describing the preparation of the CNT/ PyPBI/Pt composites. A serious of CNT/PyPBI/Pt composite were prepared by changing the feeding amount of Pt salt. Chemical structure of PyPBI is presented in the dotted frame.

Conclusion

- CNTs is highly useful for the development of a next generation fuel cell electrocatalyst, in which the reduction of the Pt amount is highly demanded.
- Cost reduction and improved durability are the two major targets for accelerating the commercialization of (PEFCs).
- Carbon nanotubes (CNTs) are best alternnatives as an alternative to CB.

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- Particle Size, Facet, and Pt Shell Thickness Effects. J. Am. Chem. Soc. 131,

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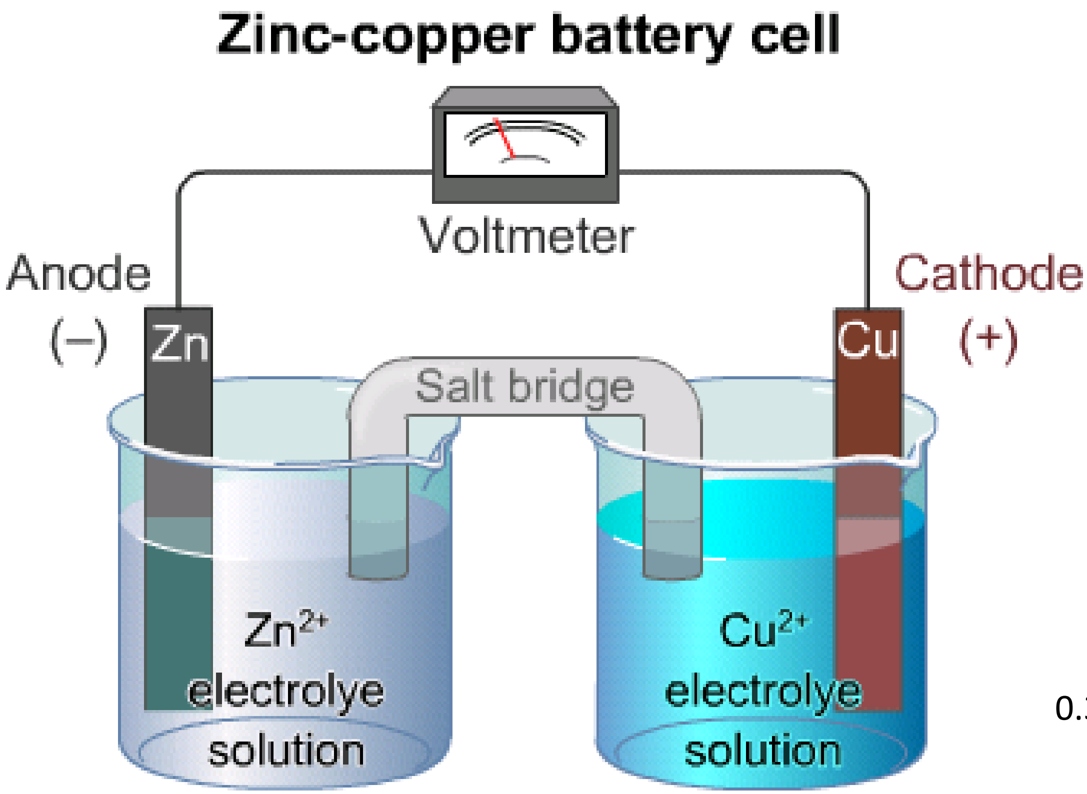
Thank You!

Advances Nano-Technology

Silicon Nanowire Battery Electrodes

Amr Mohamed Sabbah
TIGP – Molecular science and technology program

First battery



-0.76V vs SHE

0.34V vs SHE

Total voltage: 1.1 V

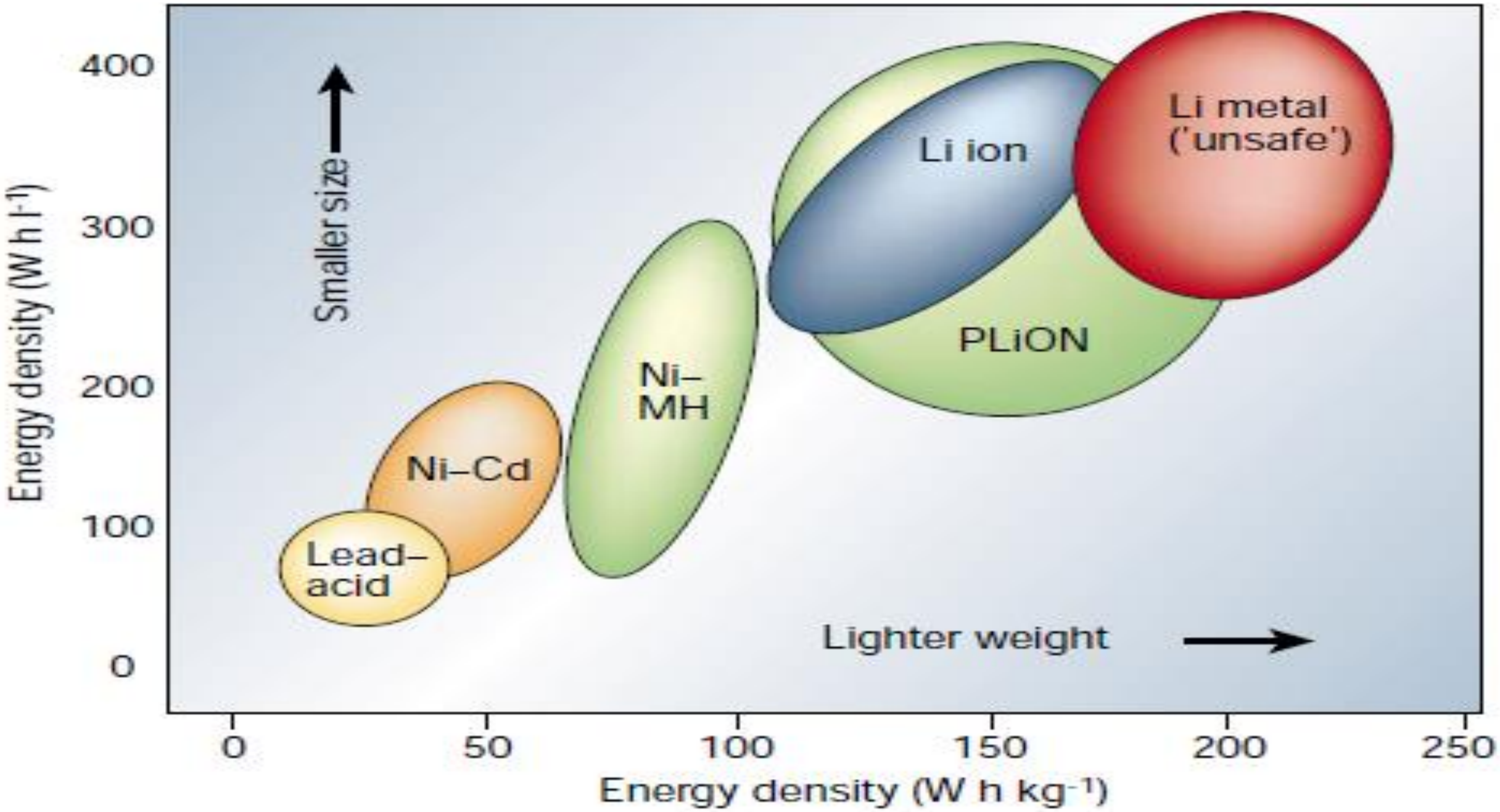
openwetware.org/images/7/72/12_3_MAA.ppt

Brief history of the battery

History of Battery Development		
1600	Gilbert (UK)	Establishment of electrochemistry study
1791	Galvani (Italy)	Discovery of 'animal electricity'
1800	Volta (Italy)	Invention of the voltaic cell
1802	Cruickshank (UK)	First electric battery capable of mass production
1820	Ampère (France)	Electricity through magnetism
1833	Faraday (UK)	Announcement of Faraday's Law
1836	Daniell (UK)	Invention of the Daniell cell
1839	Grove (UK)	Invention of fuel cell (H_2/O_2)
1859	Planté (France)	Invention of the lead acid battery
1868	Leclanché (France)	Invention of the Leclanché cell
1888	Gassner (USA)	Completion of the dry cell
1899	Jungner (Sweden)	Invention of the nickel-cadmium battery
1901	Edison (USA)	Invention of the nickel-iron battery
1932	Shlecht & Ackermann (Germany)	Invention of the sintered pole plate
1947	Neumann (France)	Successfully sealing the nickel-cadmium battery
Mid 1960	Union Carbide (USA)	Development of primary alkaline battery
Mid 1970		Development of valve regulated lead acid battery
1990		Commercialization of nickel-metal hydride battery
1991	Sony (Japan)	Commercialization of lithium-ion battery

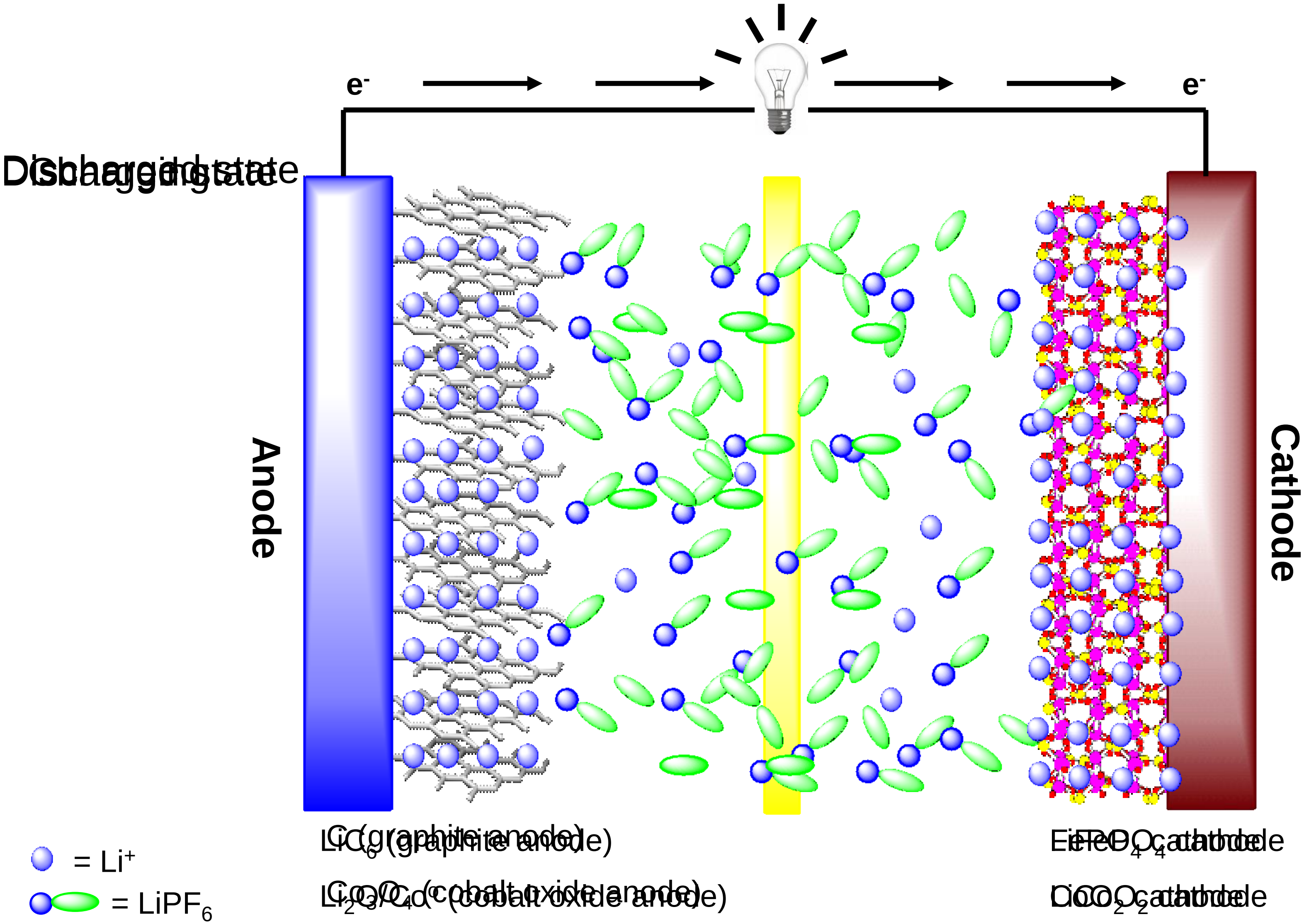
Battery University online

Lithium ion batteries



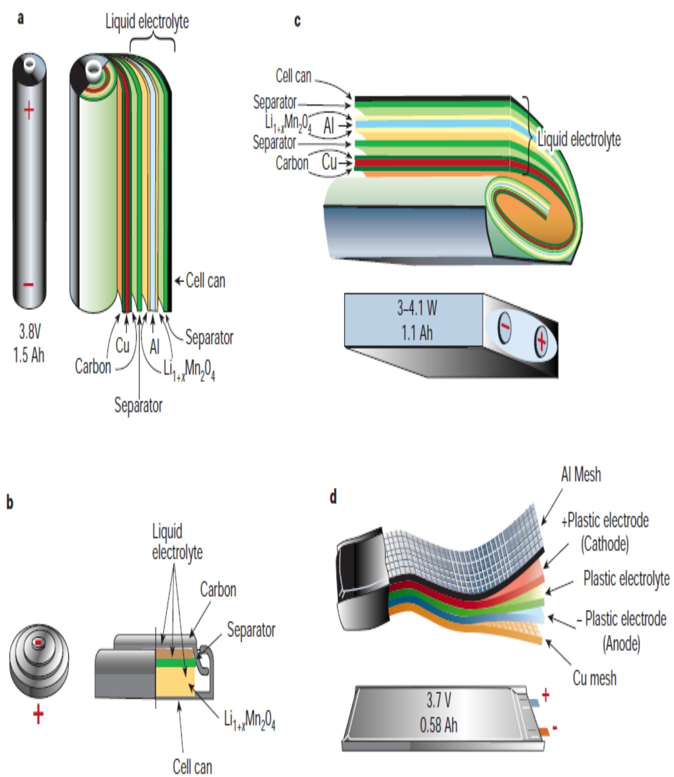
Tarascon JM, Armand M, (2001) Nature, 414:359.

Energy Storage: Lithium ion battery



openwetware.org/images/7/72/12_3_MAA.ppt

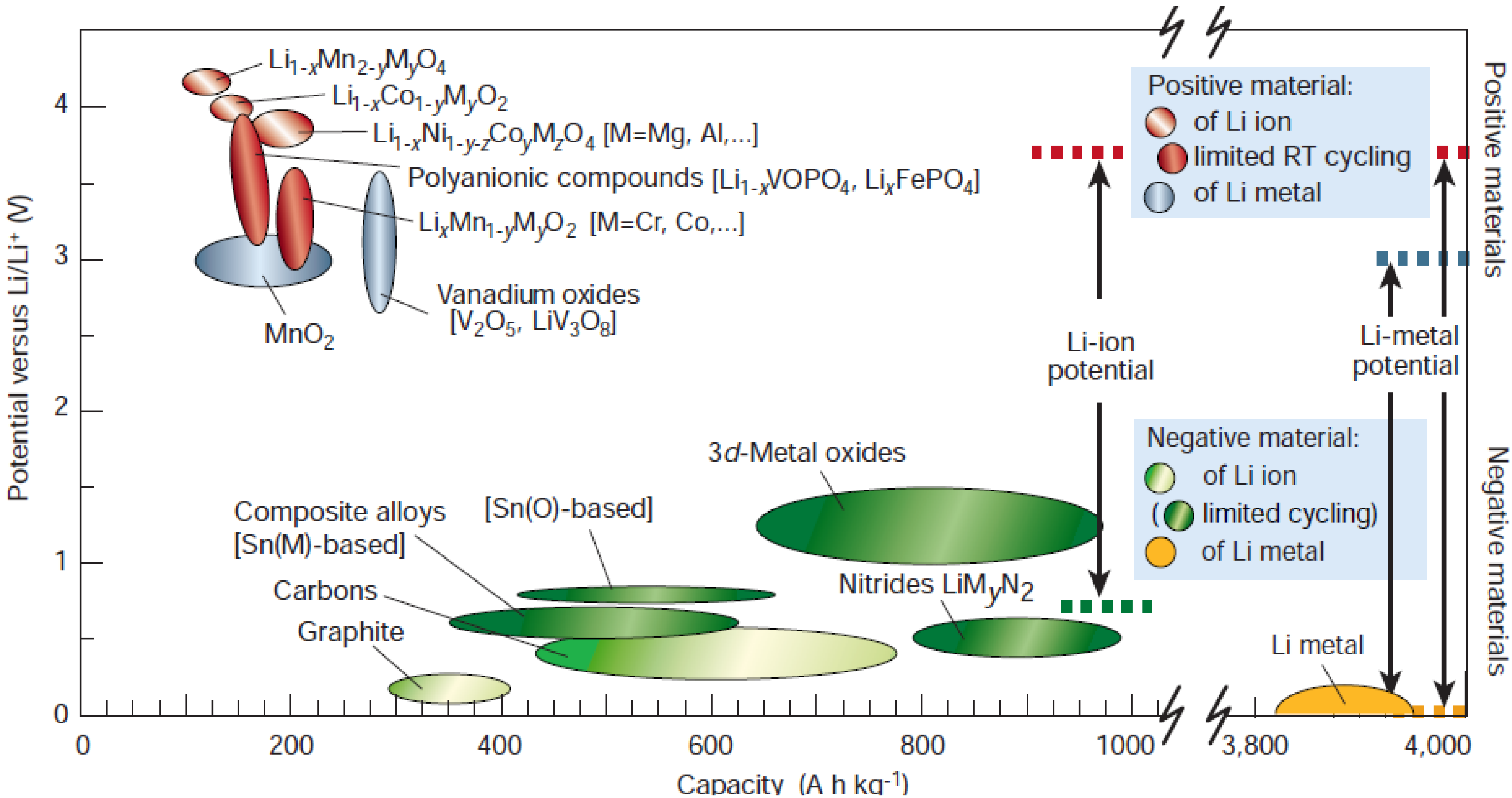
Components and uses of Li-ion battery configurations



Schematic drawing showing the shape and components of various Li-ion battery configurations. a, Cylindrical; b, coin; c, prismatic; and d, thin and flat

Tarascon JM, Armand M, (2001) Nature, 414:359.

LIB electrode materials



Voltage versus capacity for positive- and negative-electrode materials

Tarascon JM, Armand M, (2001) Nature, 414:359.

Materials for negative electrodes (Anode)

Ideal anode materials should have the following conditions:

(a) Good reversibility and charge-discharge cycle life;

(b) High specific capacity;

(c) Good compatibility with electrolyte solution;

(d) Low first irreversible capacity;

(e) Safety, environmentally friendliness;

(f) Abundant raw materials, simple synthesis process, inexpensive.

Silicon (Si)

Silicon has been proposed as the anode instead of carbon.
Higher the Li capacity, larger the accompanying volumetric change

Alloy	Capacity (mAh/g)	Volumetric change (%)
$Li_{22}Si_5$	4200	400
Li_3As	840	201
Li_3Sb	564	147
LiAl	993	94
LiC_6	372	10

A. Patil et al. *Mater. Res. Bull.* **2008,** 43, 1913.

Traditional Si-based anode material

Problems

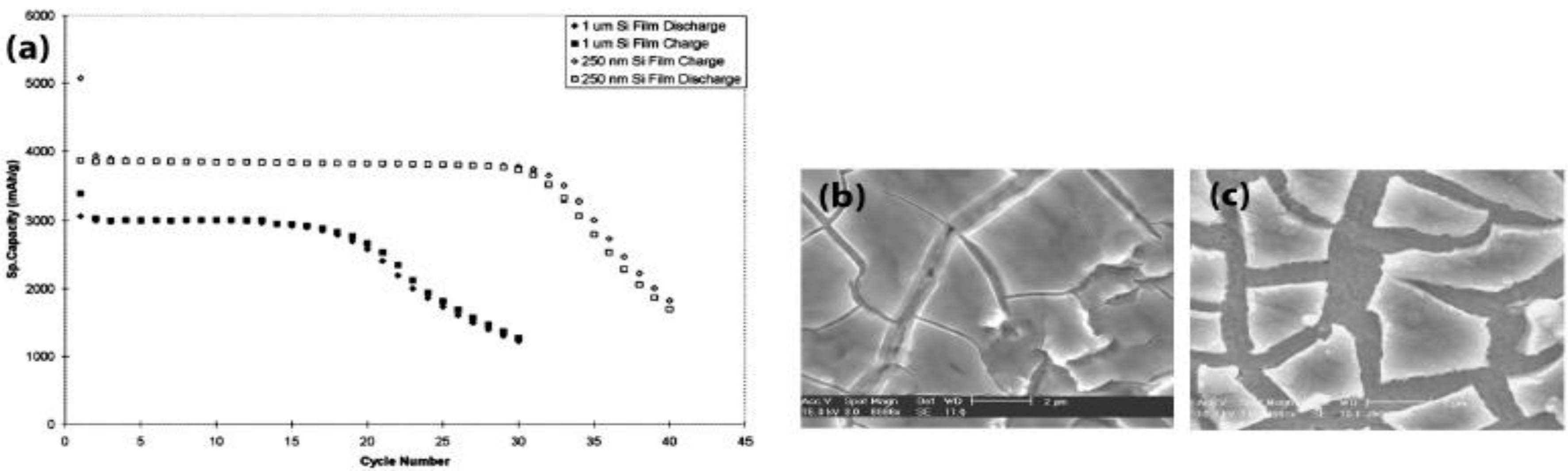
- **Comparison of the theoretical specific capacity, charge density, volume change and onset potential of various anode materials**

Materials	Li	C	$Li_4Ti_5O_{12}$	Si	Sn	Sb	Al	Mg	Bi
Density (g cm^{-3})	0.53	2.25	3.5	2.33	7.29	6.7	2.7	1.3	9.78
Lithiated phase	Li	LiC_6	$Li_7Ti_5O_{12}$	$Li_{4.4}Si$	$Li_{4.4}Sn$	Li_3Sb	LiAl	Li_3Mg	Li_3Bi
Theoretical specific capacity (mAh g^{-1})	3862	372	175	4200	994	660	993	3350	385
Theoretical charge density (mAh cm^{-3})	2047	837	613	9786	7246	4422	2681	4355	3765
Volume change (%)	100	12	1	320	260	200	96	100	215
Potential vs. Li (~V)	0	0.05	1.6	0.4	0.6	0.9	0.3	0.1	0.8

W. J. Zhang, *J. Power Sources*, **2011**, *196*, 13.

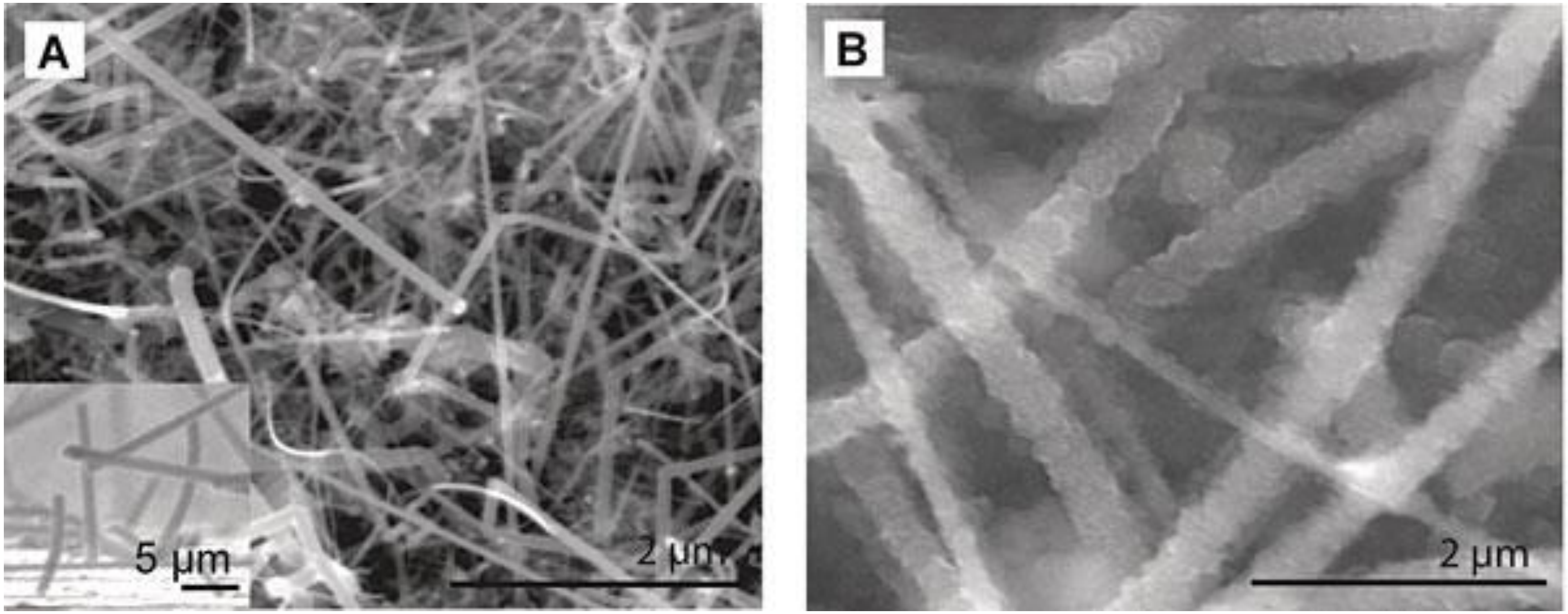
Silicon Films as Anode

Advantage: High theoretical charge capacity of 4200 mAh/g (10 times larger than carbon)
Disadvantage: 400 % volume expansion leading to pulverization and delamination of the electrode films.



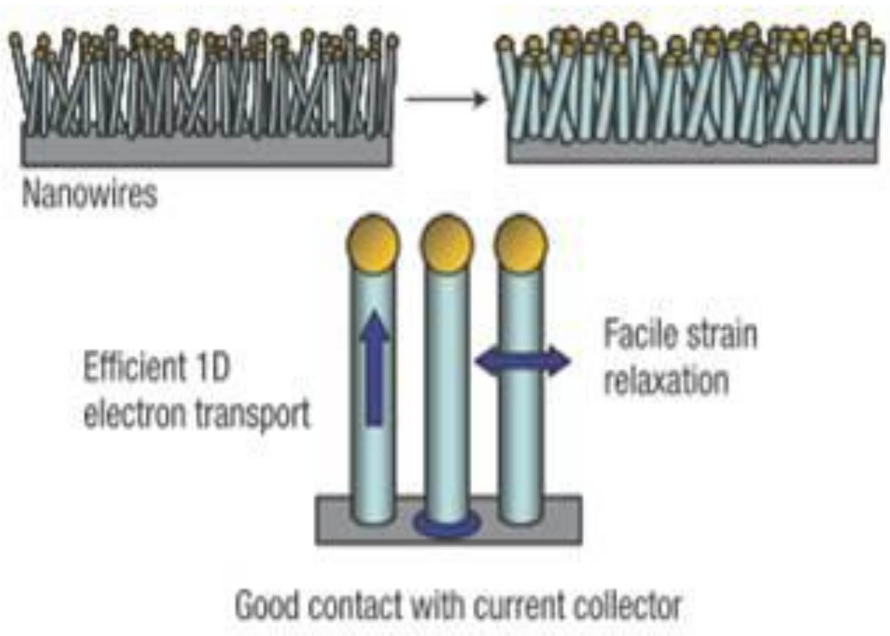
(a) *Specific capacity plotted as a function of cycle number.* ***(b)*** *Stress-induced cracking of the film after a few cycles.*
(c) *Delamination and peeling of the film from the collector electrode after extended cycling [2]*

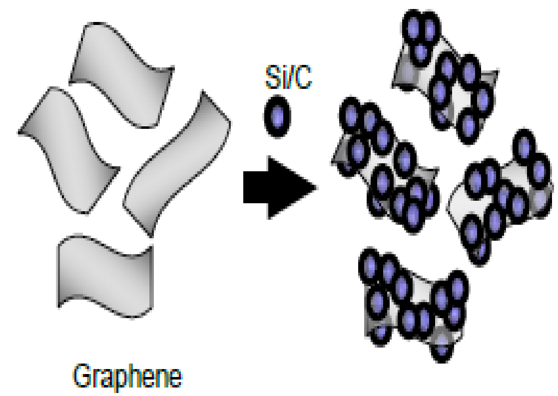
J. P. Maranchi et al. J. Electrochem. Soc. 2006, 153, A1246.

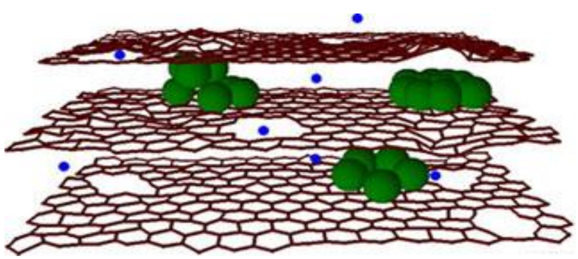


Photos taken by a scanning electron microscope of silicon nanowires before (left) and after (right) absorbing lithium. Both photos were taken at the same magnification. The work is described in “High-performance lithium battery anodes using silicon nanowires,”

Nature nanotechnology, 2008, 3, 31

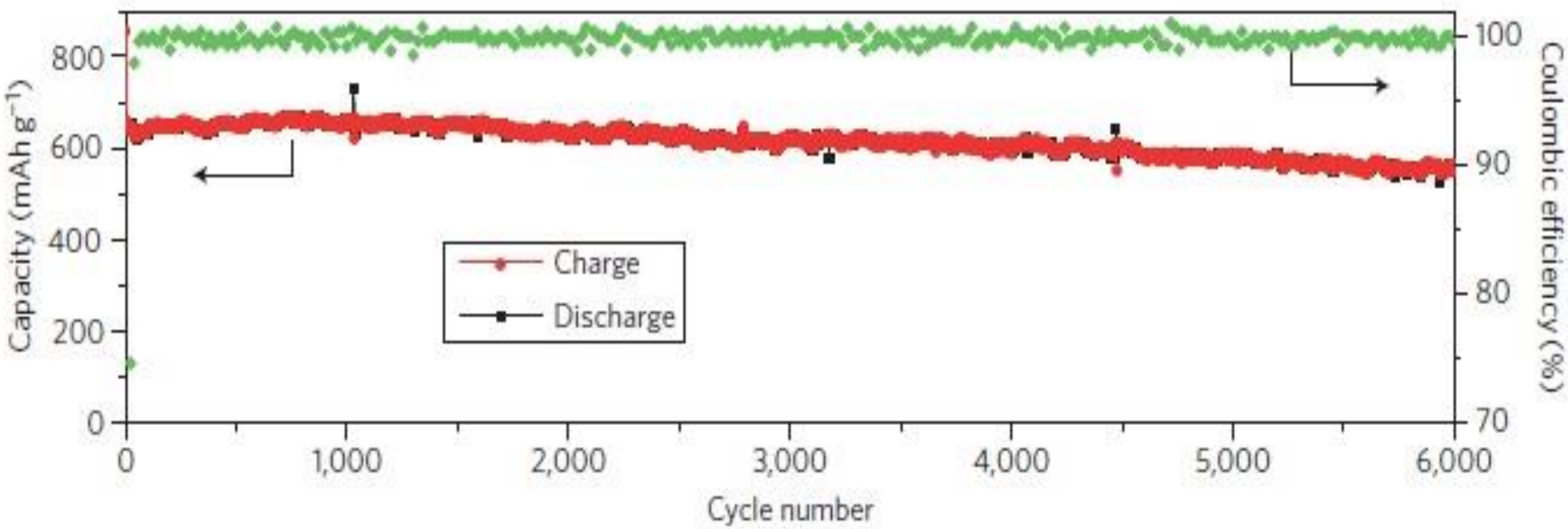






Graphene sheets buffer the volume variation of Si during cycling leading to a high reversible capacity and cycling stability

C. K. Chan et al. Nat. Nanotechnol. 2008, 3, 31.



NATURE NANOTECHNOLOGY , 2012, 7

Thanks for your attention!

National Taiwan University of Science and Technology

Department of Material Science and Engineering

Course:Introduction to Nanotechnology

The Application of Nanotechnology and Nanomaterial

By :Angaw Kelemework

ID: D10304803

Outline

- Introduction
- Classification and Properties of Nanomaterial
- Application of Nanomaterial
- Advantage Vs dissadvantage
- Conclusion

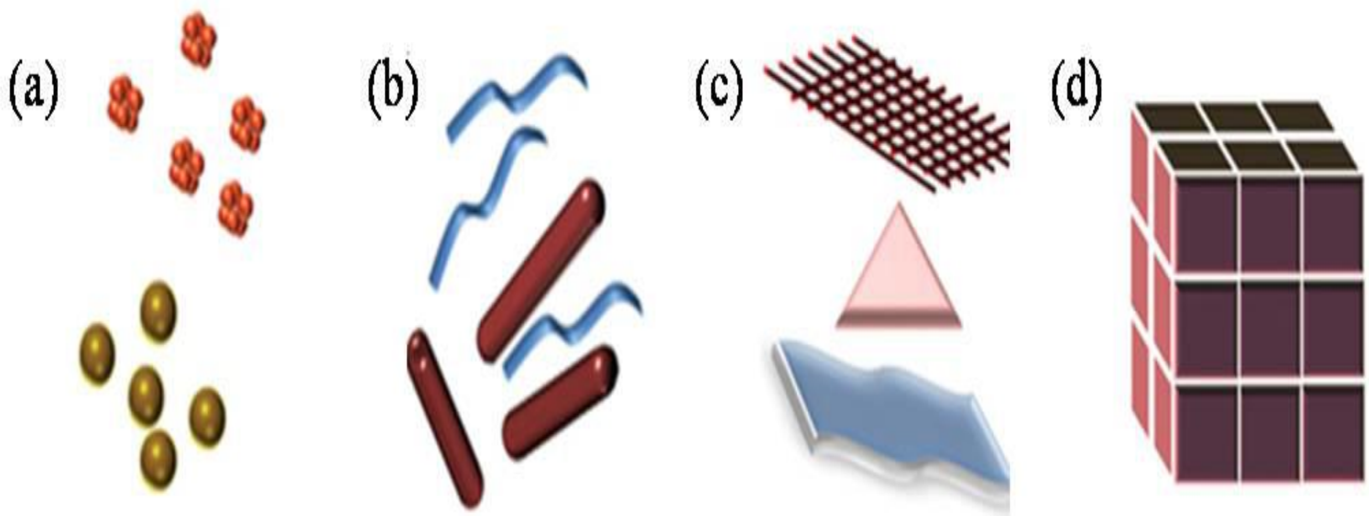
Reference

Introduction

- Nanotechnology, shortened to ''nanotech''
- Nanotechnology, in its traditional sense, means building things from the bottom up, with atomic precision.
- Nanomaterials : **refers to the matter whose length scale, in any dimension, is approximately 1 to 100 nanometers.**

Classification of Nanomaterials

✓ OD , 1D ,2D and 3D



(a) 0D spheres and clusters, (b) 1D nanofibers, wires, and rods, (c) 2D films, plates (d) 3D nanomaterials.

Properties of Nanomaterials

- Nanosized particles of agiven substance exhibit different properties than particles of the same substance.

❖ **Chemical Property:**

✓ Nano particles are very small in size.

✓ Very high surface area to volume ratio.

✓ Reactions are very quick.

❖ *Optical Properties: Colour of Gold*

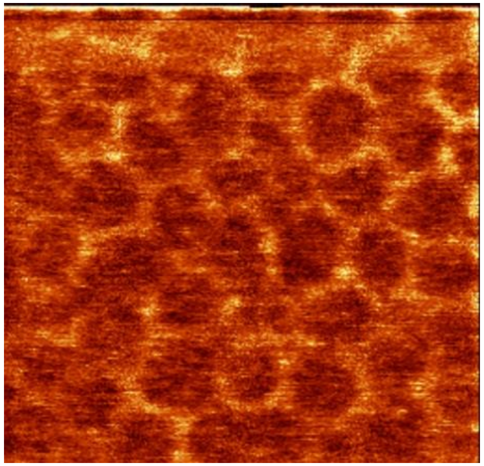
- **Bulk gold**

  appears yellow in colour.

- **Nano sized gold**

  appears red in colour.

The particles are so small that electrons are not free to move about as in bulk gold Because this movement is restricted, the particles react differently with light.



12 nanometer gold clusters of particles look red.

Applications of Nano Materials

Making sun screen (Sun creams):

- Sun creams use nanoparticles of zinc oxide or titanium dioxide to absorb the harmful UV rays(cancer-causing ultraviolet light) from the sun
- Nanoparticles of titanium dioxide and zinc oxide not only retain their highly effective UV light-absorbing capacity, but also absorb and scatter visible light, rendering them transparent on the skin.

Sport equipment:

- Tiny carbon nanotubes use to make lighter and more robust equipment, such as:

✓ Tennis rackets and lightweight bikes.

In battery technology

- Increasing capacity
- Reducing charging time
- Increasing shelf life of battery

By coating the surface using Nanomaterials.

In Food packaging

❖ **packaging examples**

- Food storage bins have silver nanoparticles embedded in the plastic.
- The silver nanoparticles kill bacteria from any food previously stored in the bins, minimising harmful bacteria

- Nano particles in plastic bottles keep beer fresh.

Advantage of nanomaterials

- With NT we can create unique materials and products which are:
  - Stonger
  - Faster
  - Smaller
  - Lighter
  - Cheaper
  - Durable etc…

Dissadvantage of nanomaterials

- Loss of job(in manufacture, farming etc)
- Carbon Nanotube,could cause infection of lungs
- It can lead to an arm race within nations etc.

Conclusion

As a conclusion We could say that the prospect of Nanotechnology are very bright ,It will take some time to really make an impact on the human race .But when it finally comes, Nanotechnology will be undenieble force,which will change the very course of life.

"Nanotechnology is an enabling technology that will change the nature of almost every human made object in the next centuary."

Reference

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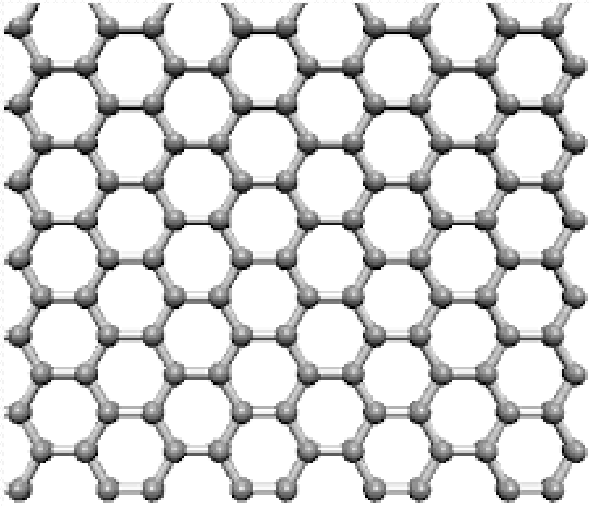
Thank You for Your Attention

A proposal of how to produce Graphene continuously?

Artur Dahlberg **E10312004**

What Is Grapehne?

- Single layer of pure carbon arranged in a Hexagonal network(sp2)
- Many interesting properties
  - One of the lightest materials known
  - High conductivity
  - Very strong
  - Almost transparent
  - High surface area
- Many applications
  - Transistors
  - Solar cells
  - Semiconductors



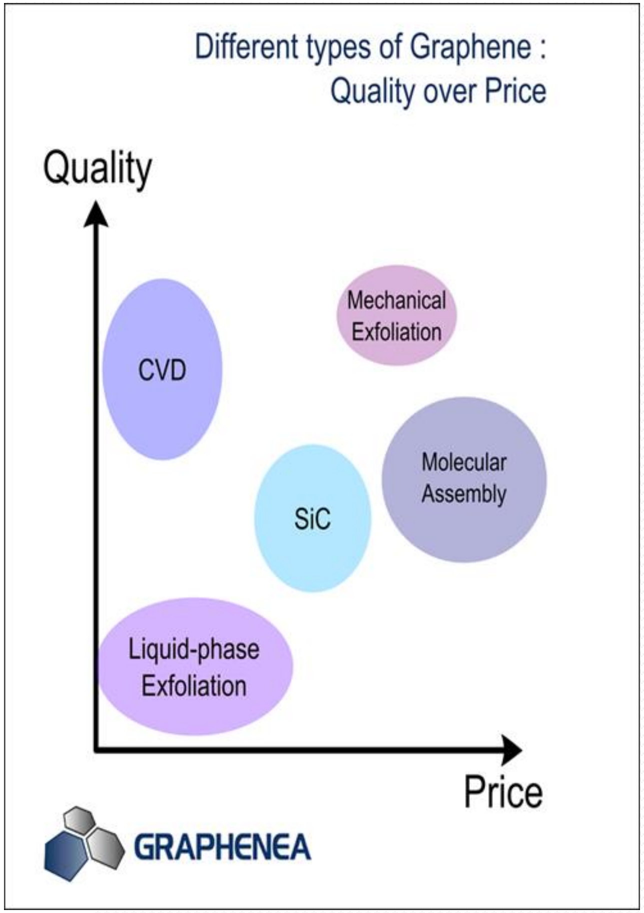
Why CVD as production method?

Reality check no. 1: Graphene and the industry – options for synthesis

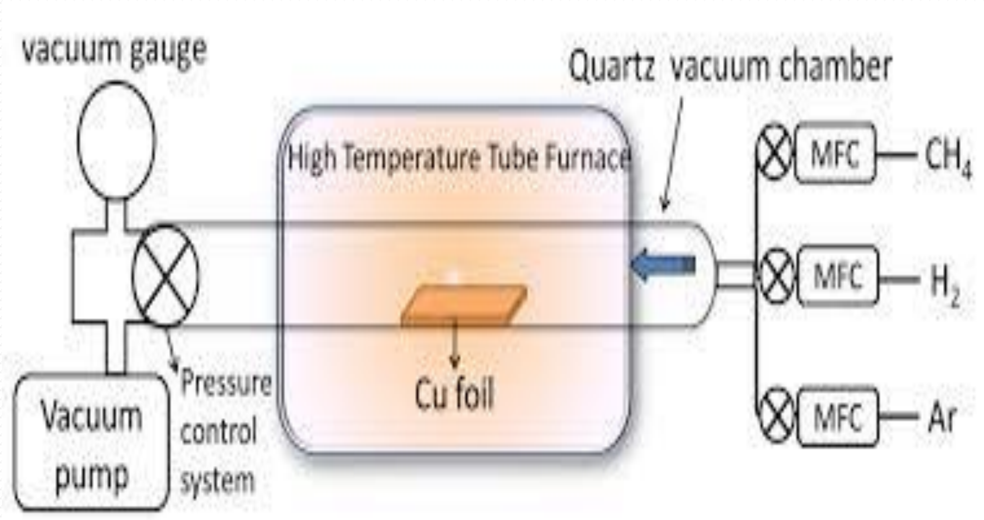
Comparison of synthesis methods:

Method:	Mechanical Exfoliation	Reduction of graphene oxide	Epitaxial growth on SiC	CVD growth on Ni, Cu, Fe, Co
Size	10–100 µm	> 15 cm	> 10 cm	> 15 cm
Mobility	best	bad	high	high
Transfer	yes	yes	no	yes
Scalability	no	yes	not yet	yes
Applications	no	yes	little	most

(Source: Sukang Bae et al., Phys. Scr. **2012**, 014024)



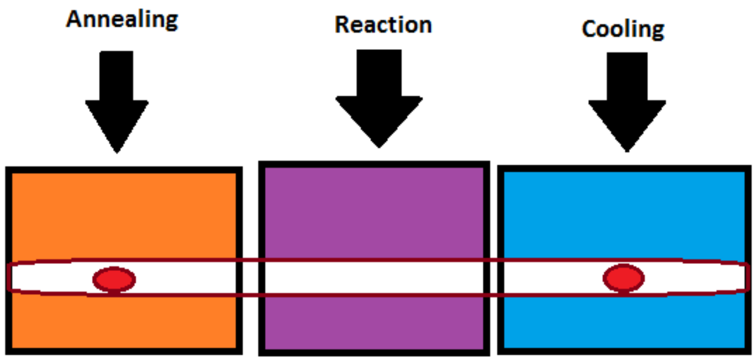
Graphene grown with chemical vapour decomposition(CVD)



- Three steps done in the same reactor
  - Annealing
  - Growth step
  - Cooling step

How to make it continuously

- Separate the three steps into individual parts
- The three different parts could be integrated with an assembly line



What factors are known to have an impact on the growth

- Crystal structure of the metal
- Reaction time
- Temperature and pressure
  - Low pressure and temp. ~1000°C → growth self limiting
- Carbon solubility limit in the metal
  - Low solubility (Cu) → Synthesis of graphene is limited to the surface of the catalyst
  - High solubility (Ni, Co..) → Combination of diffusion from the bulk and metal

- Choosing the right catalyst
  - Copper-> self limiting growth -> high uniformity
- Controlling the ratio of the reaction gases
- Using right conditions during the annealing and cooling steps

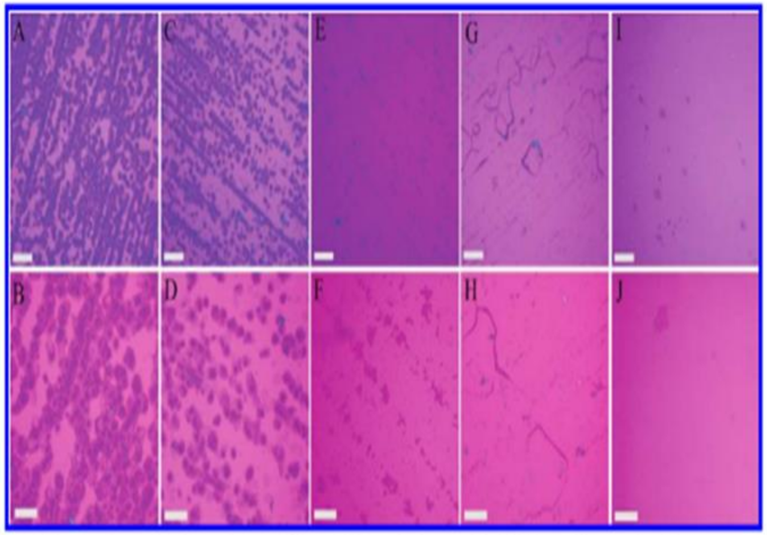
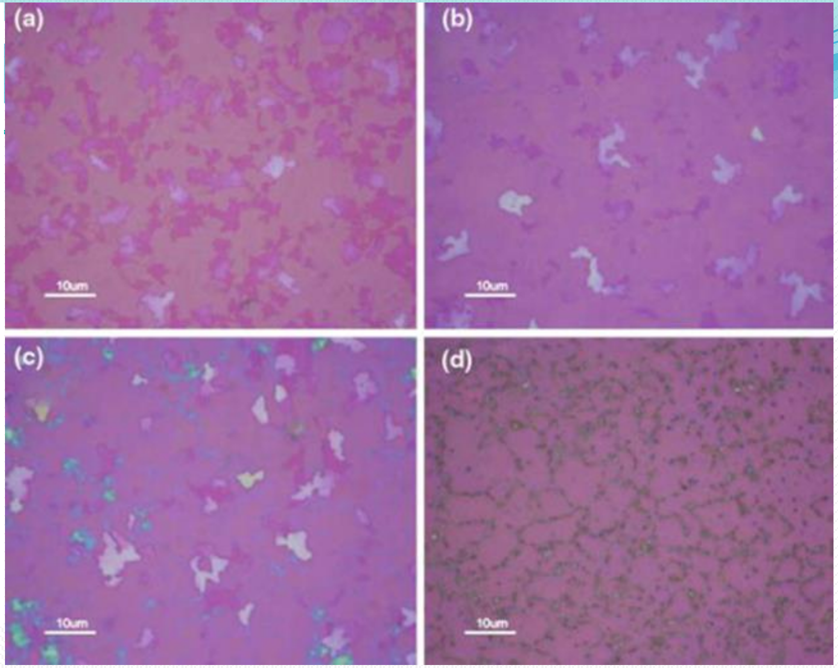
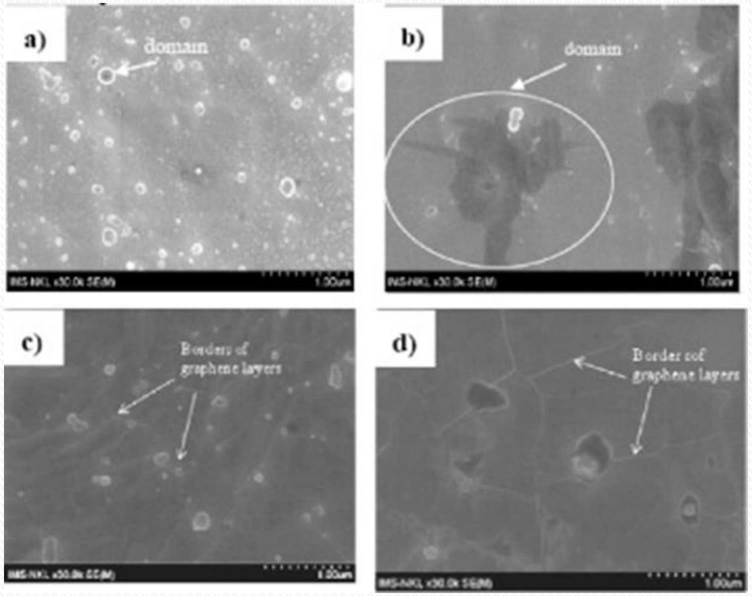


FIGURE 1. Optical images of transferred graphene on 300 nm SiO_2 synthesized under APCVD conditions using Cu as a catalyst at different methane gas compositions: S1 (A, B), S2 (C, D), S3 (E, F), S4 (G, H), and S5 (I, J); scale bars (A, C, E, G, I, 20 μm; B, D, F, H, J, 10 μm).



Lower methane concentration gives higher uniformity

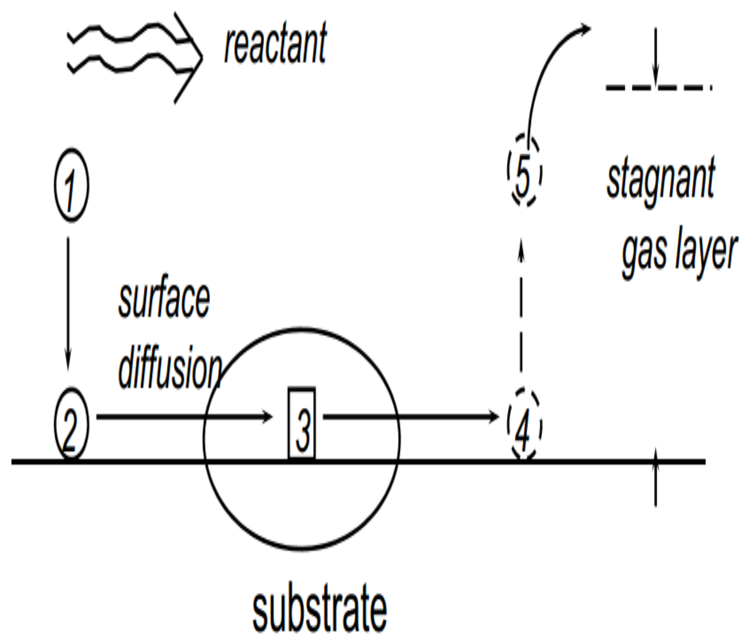
Optical microscope images of synthesized graphenes with different cooling rates: a 8°C/min, b 6°C/min, c 4°C/min, and d 2°C/min



(a) 850 °C, (b) 900 °C, (c) 950 °C, and (d) 1000 °C

CVD growth model for self limiting systems

Mechanism



1. Diffusion from bulk to surface
2. Absorption to the surface
3. Decomposition to form active carbon
4. Diffusion on the surface and formation of lattice
5. Desorption of inactive species
6. Diffusion of inactive species to bulk

Equations

- $F_{mass\ transport} = h_g(C_g - C_s)$, C_g concentration of gas in bulk and C_s concentration of active specie on surface
- $r_{surface} = k_s C_s$ (assuming first order)
- Slower one will be the limiting step
- At Steady state $F_{mass\ transport} = r_{surface}$=r$_{tot}$
- $r_{tot} = \frac{k_s * h_g}{k_s + h_g} C_g$
- if $h_g \gg k_s$ surface reaction controlled, typical for low pressure and high temperature

$$r_{tot} = \frac{k_s * h_g}{\quad} C_g$$

-High CH4 concentration →fast growth but non-uniform multi-layer films with small grain size

-Low CH4 concentration → slow growth but uniform and single layer

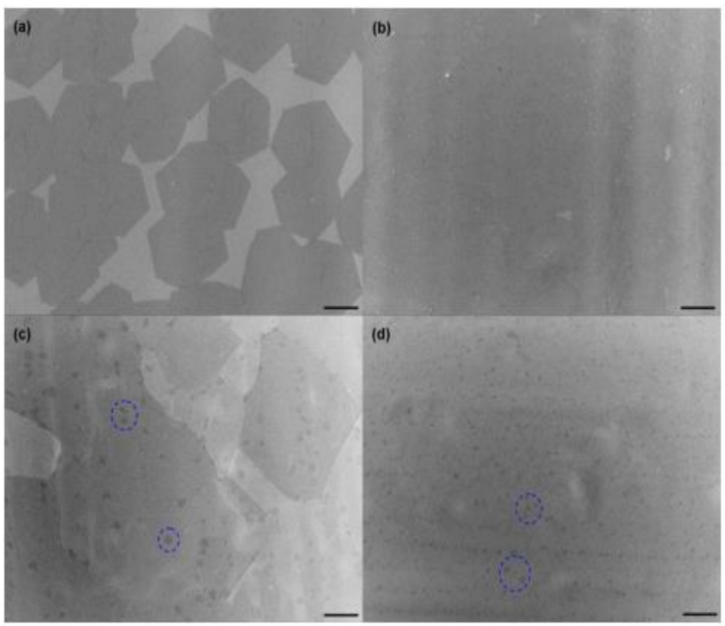
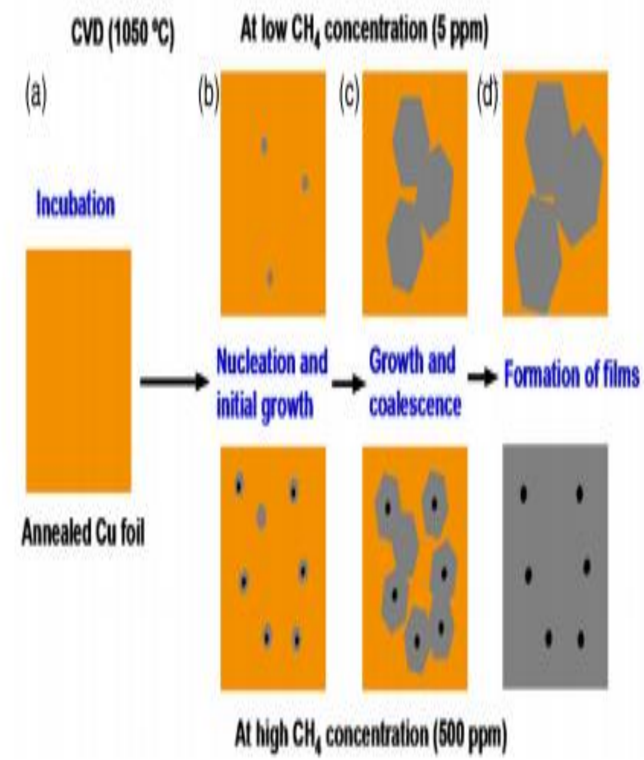


Figure 2. SEM images of CVD graphene on Cu. (a) 5 ppm CH_4 for 60 min. (b) 10 ppm CH_4 for 60 min. (c) 20 ppm CH_4 for 30 min. (d) 30 ppm CH_4 for 20 min. Uncovered Cu surface is brighter (images (a) and (b)). Multi-layer graphene domains are darker (some are highlighted by dashed blue circles in images (c) and (d)). The scale bars are 10 μm.



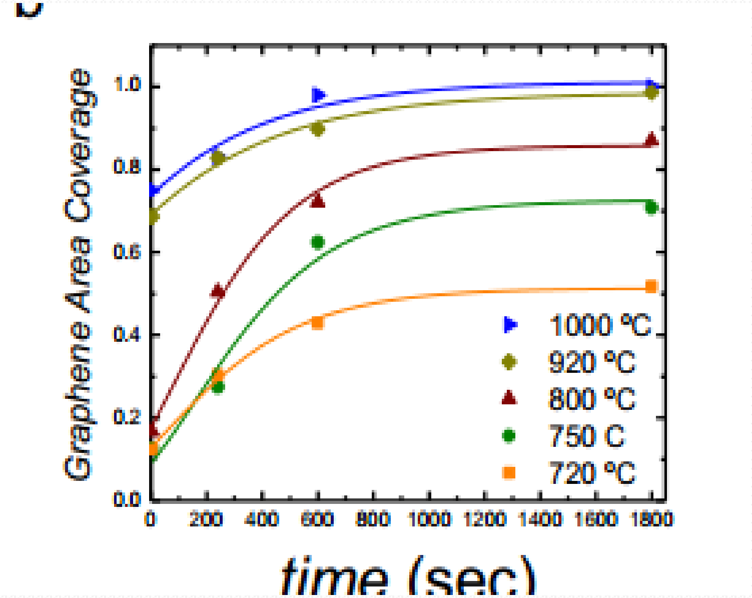
hematic diagram of growth process of CVD graphene on Cu at low (5 ppm) and high (500 ppm) CH_4 concentrations. Four an be distinguished during growth and highlighted in blue: (a) incubation, (b) nucleation and initial growth, (c) growth and and (d) formation of films.

Model for catalyst coverage according to Langmuir's model for self limiting growth

- 1. Dissociative adsorption of methane:
  - $CH_4 + 5Cu = C + 4H$
  - $r_{ad} = \frac{P}{\sqrt{2\pi mkT}} s\, exp\left(\frac{-E_a}{kT}\right) f(\theta)$
- 2. Hydrogen Desorption:
  - $4H = 2H_2 + 4Cu$
  - $r_{des} = v\, \exp(\frac{-E_{des}}{kT})[A]^n$
- 3. Graphene Formation from adsorbed carbon:
  - C = Graphene
  - $\mathrm{r}_{form} = \mathrm{k[C]}$

- If the adsorption and desorption is much faster than the formation reaction of graphene then the graphene area coverage can be given by

$$A_G = \theta_G \left(\frac{e^{F(t-t_0)}+1}{e^{F(t-t_0)}-1}\right)^2$$



Conclusion

- Research has still to be done to fully understand graphene growth
- Compromises has to be done to get the desired outcome

Questions?


thank you
рахмат
danke
謝謝
ngiyabonga
teşekkür ederim
Баярлалаа
mersi
kia ora
barka
welalin
tack
spas
спасибо
faafetai lava
vinaka
спасибі
blagodaram
dank je
misaotra
matondo
paldies
grazzi
mahalo
tapadh leat
gracias
хвала
asante
mana
kiitos
dankie
nanni
nandri
dhanyavad
mauruuru
köszönöm
akun
dankon
aciu
obrigada
bedankt
bayarlalaa
gràcie
hvala
enkosi
djiere dieuf
tau
mochchakkeram
murakoze
дякую
mamnun
chokrane
dziękuję
chnorakaloutioun
gratias ago
gràcies
sulpáy
taiku
go raibh maith agat
sobodi
děkuji
sagolun
sukriya
kop khun krap
obrigado
mèsi
didi madloba
najis tuke
ありがとう
tanemirt
grazie
arigatô
takk
dakujem
trugarez
kam sah hamnida
rahmat
terima kasih
rahmet
diolch
dhanyavadagalu
shukriya
mercé
мерси
তোমাকে ধন্যবাদ
감사합니다
xièxie
ευχαριστώ
merci

Liquid Crystal Nanostructures

Adviser: Prof.Hosseinkhani

Arvin Eskandari
Molecular Science & Technology Program- TIGP
Jan-2015

Outline

- Introduction
- Criteria
- LC Nanostructures Materials
- Applications

Introduction

- Friedrich Reinitzer in 1888 observed a curious behavior with double melting points of cholesterol benzoate, a discovery that today is widely recognized as the birth of liquid crystal (LC) science.

- The (LC) state of matter exists between the crystalline solid and amorphous liquid states. So, LCs are referred to as intermediate phases or *mesophases.*

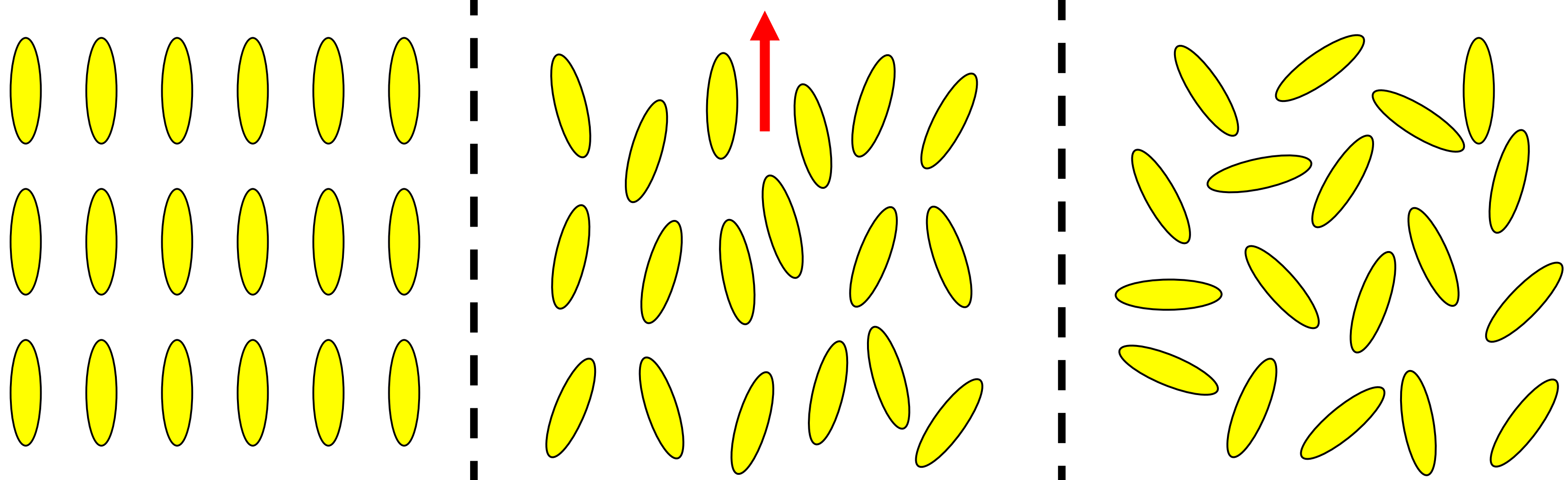
Introduction

- LC flows like a liquid and has long-range order like solids (”soft matter”)
- A LC is formed by the self-assembly of molecules in ordered structures, called **phases**.
- The molecules (**Mesogen**) in a LC are shaped like **rods** or **plates**.
- Liquid crystals are abundant in living systems (lipid bilayer).

LCs as the *fourth state of matter*

➢ Fluid properties of liquids + Optical properties of solids

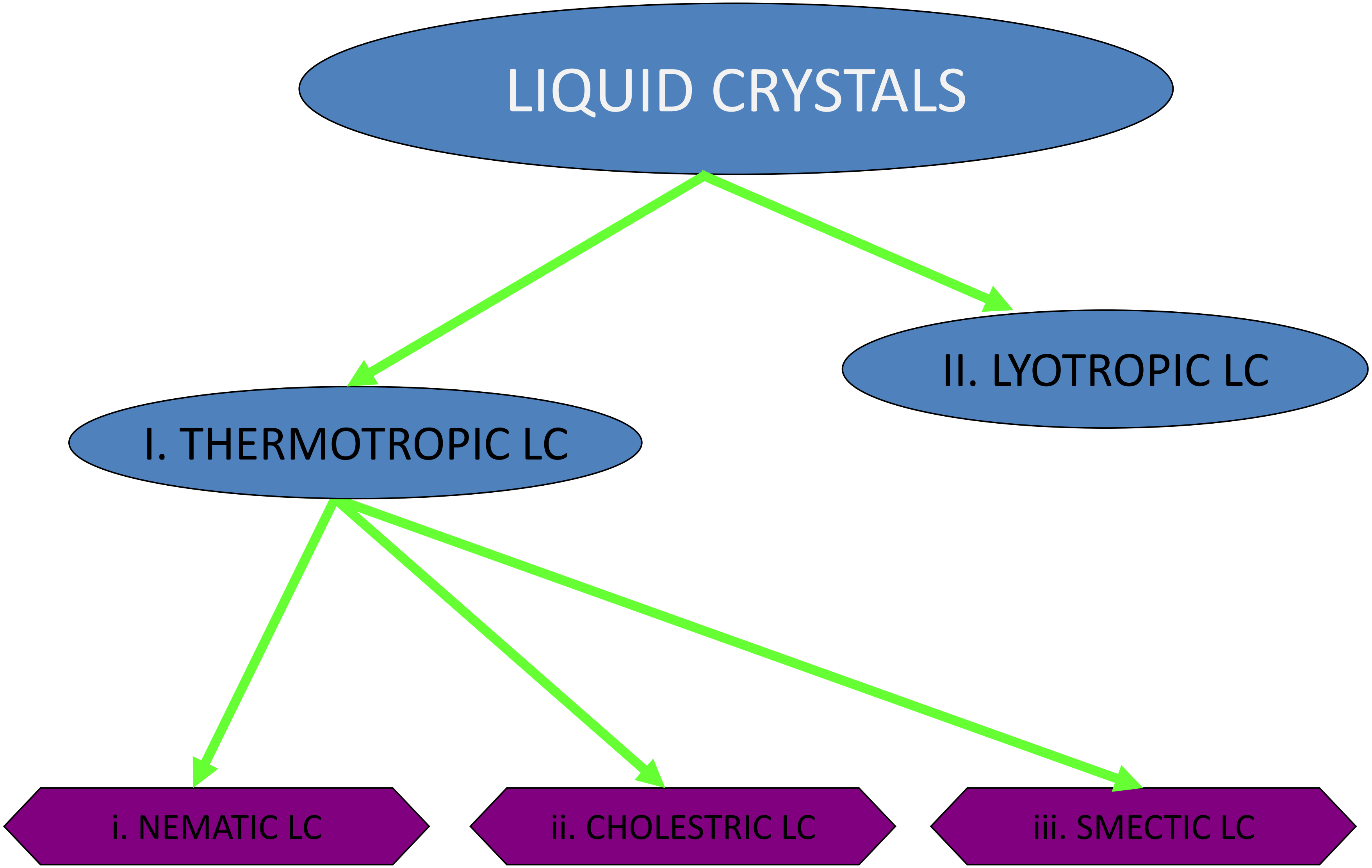
Crystalline Solid | Liquid Crystal | Amorphous Liquid



Crystalline Solid
- Highly ordered
- Cannot flow
- Optically anisotropic

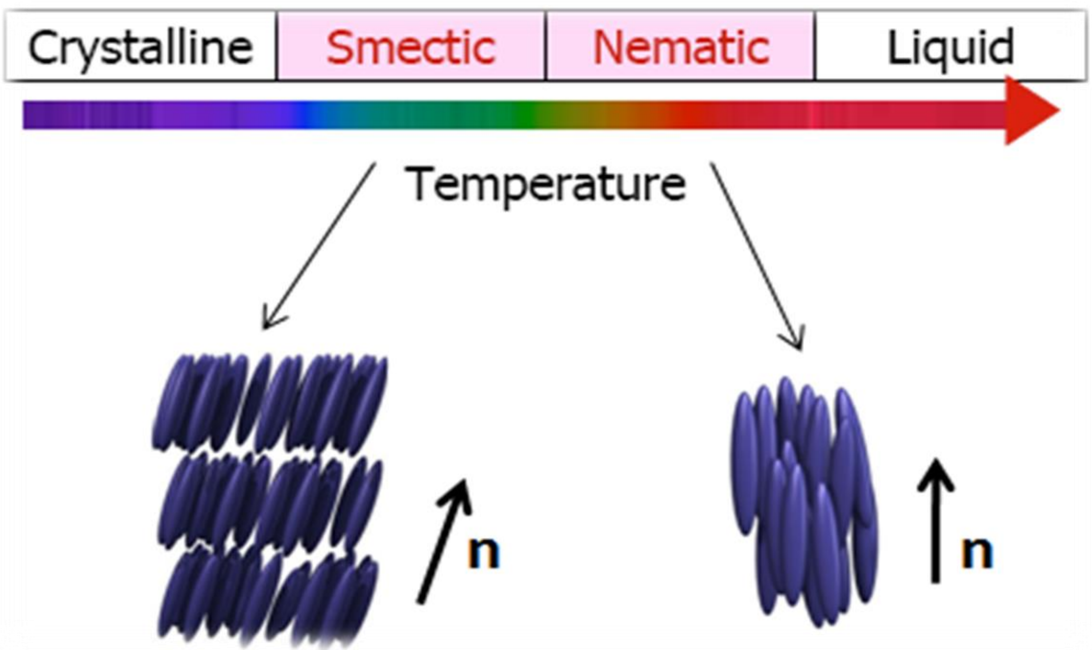
Liquid Crystal
- Some degree of order
- Can flow
- Optically anisotropic

Amorphous Liquid
- Highly disordered
- Can flow easily
- Optically isotropic

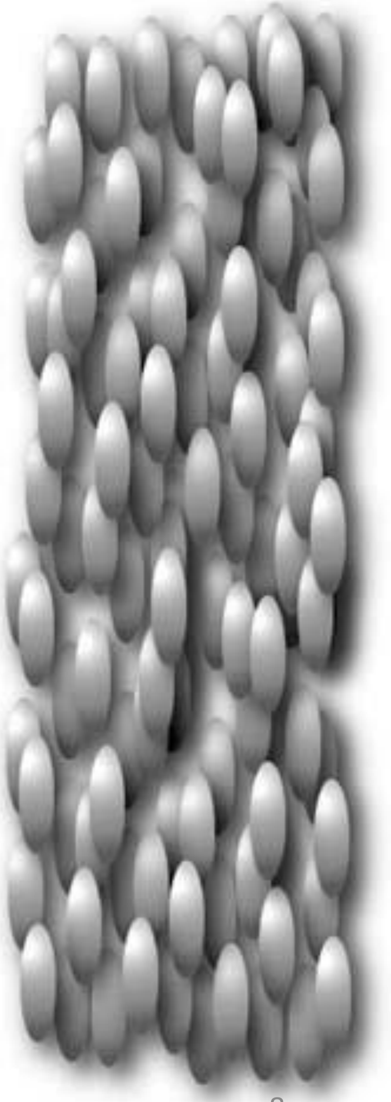

LIQUID CRYSTALS
I. THERMOTROPIC LC
II. LYOTROPIC LC
i. NEMATIC LC
ii. CHOLESTRIC LC
iii. SMECTIC LC

I. THERMOTROPIC LIQUID CRYSTALS

Liquid crystals are said to be thermotropic if there liquid crystalline properties depend on the temperature.



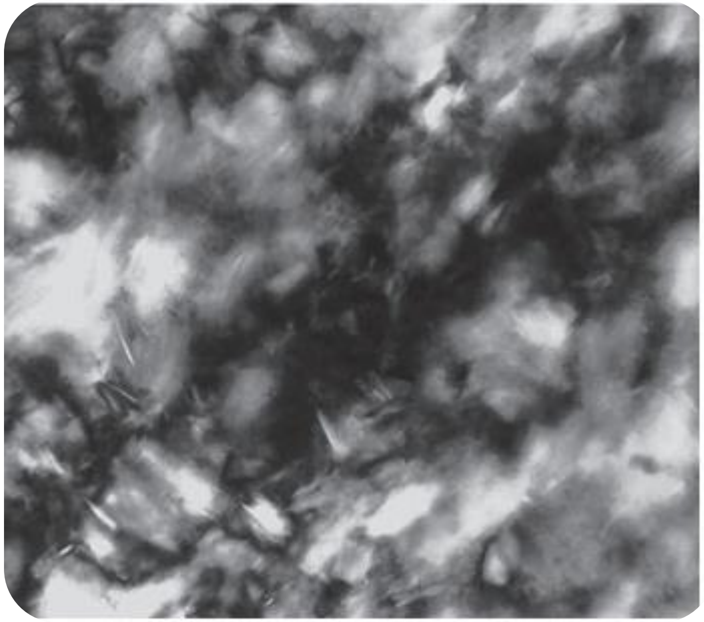
i. NEMATIC LIQUID CRYSTALS

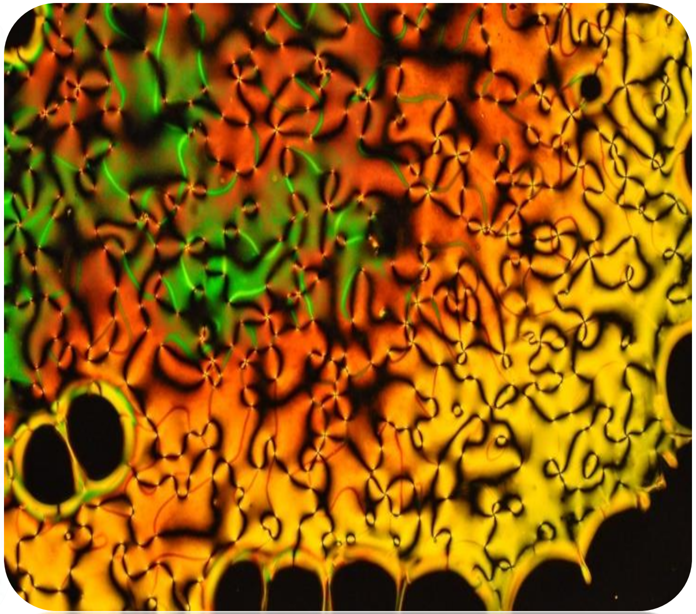


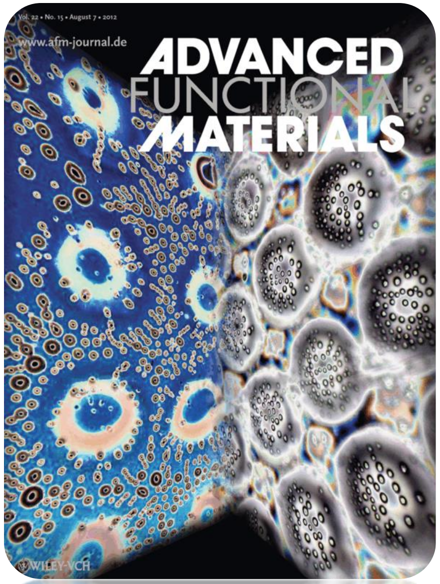
One of the most common LC phases is the nematic, where the molecules (mesogens) have no positional order, but they have long-range orientational order. (Most nematics are uniaxial: they have one axis that is longer and preferred, with the other two being equivalent (can be approximated as cylinders)

In Greek ‘nematic’ means thread. And hence the thread like structure of the nematic crystals.

Nematics have fluidity similar to that of ordinary (isotropic) liquids but they can be easily aligned by an external magnetic or electric field. An aligned nematic has the optical properties of a uniaxial crystal and this makes them extremely useful in liquid crystal displays (LCD).



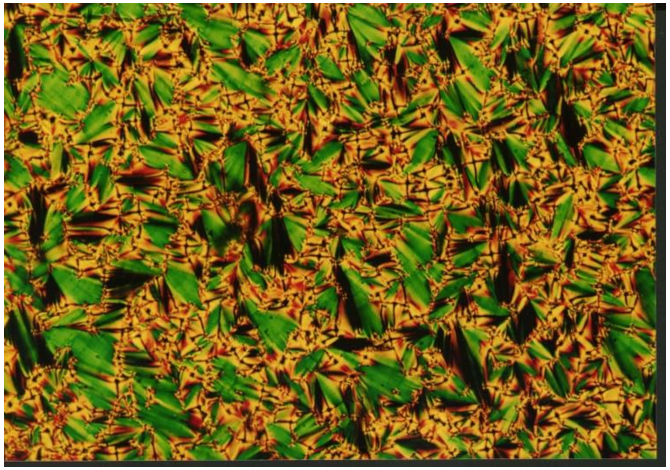




ii. SMECTIC LIQUID CRYSTALS

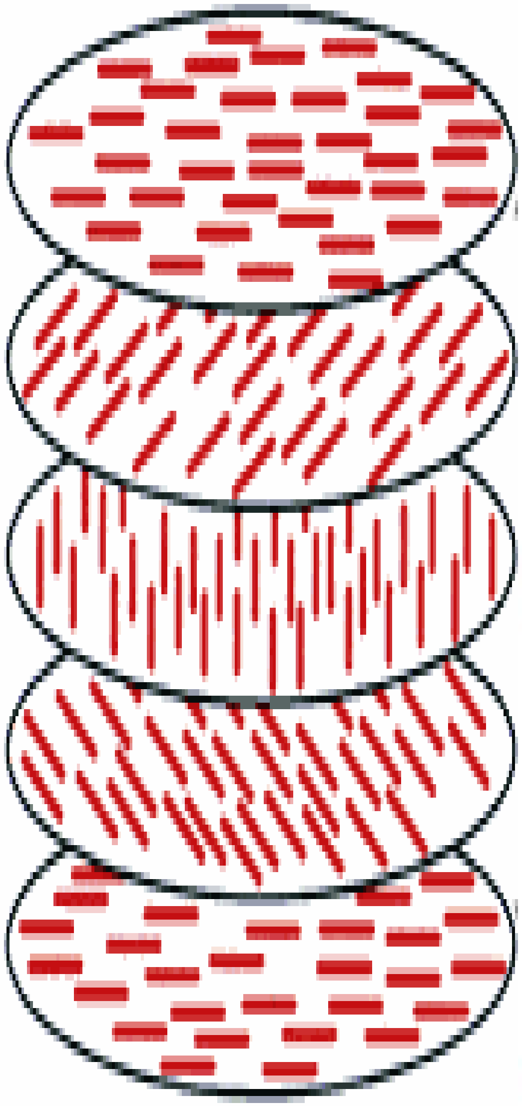
The mesogens have both positional order and orientational order.

The smectic phases, which are found at lower temperatures than the nematic, form well-defined layers that can slide over one another like soap.

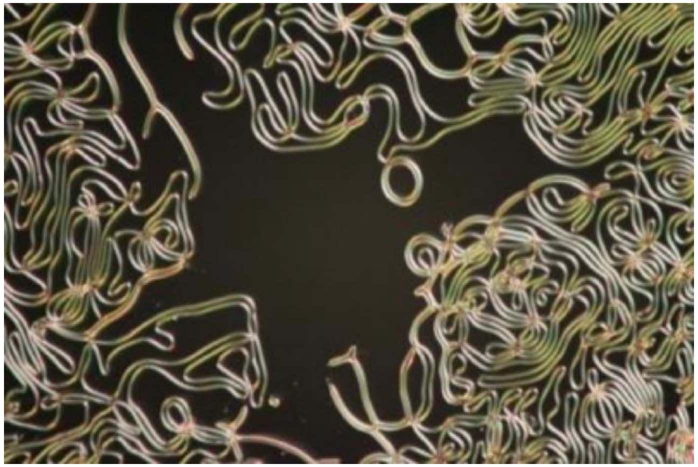


Smectic A

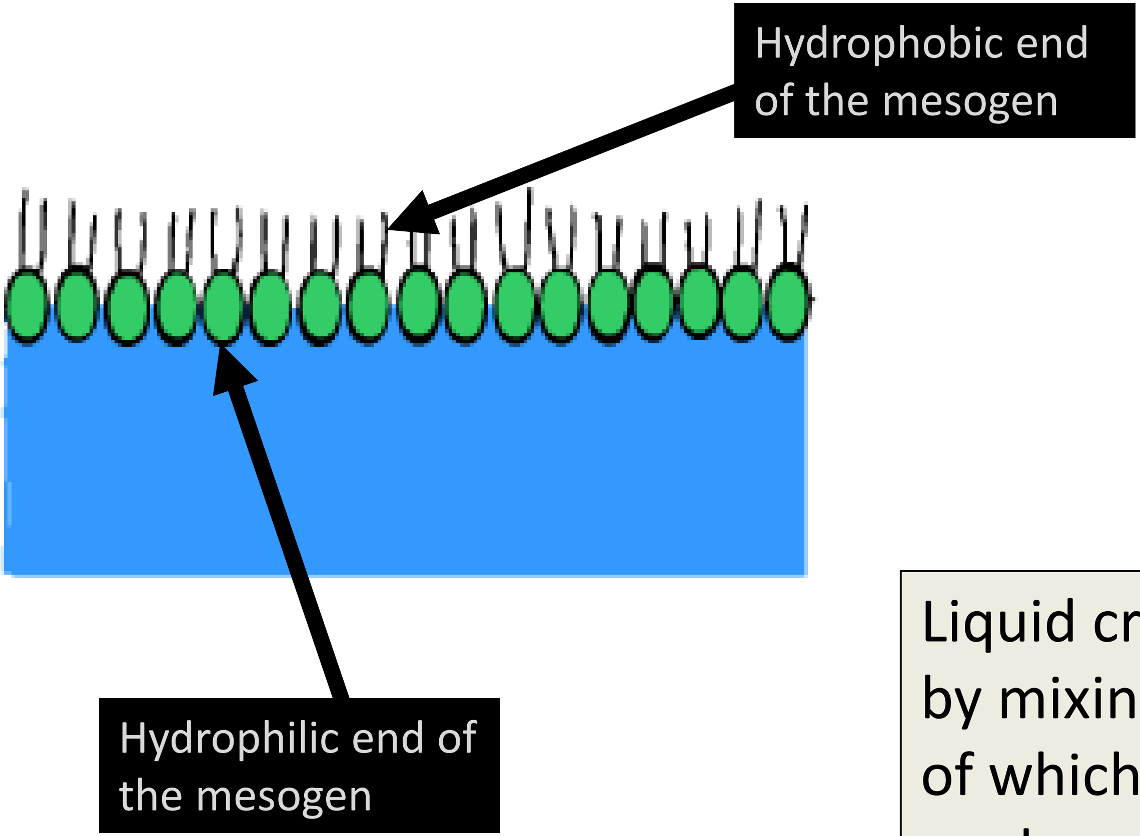
Smectic C



The cholestric phase can be defined as a special type of nematic LC in which the thin layers of the parallel mesogens have their longitudinal axes rotated in adjacent layers at certain angle.



II. Lyotropic LIQUID CRYSTALS



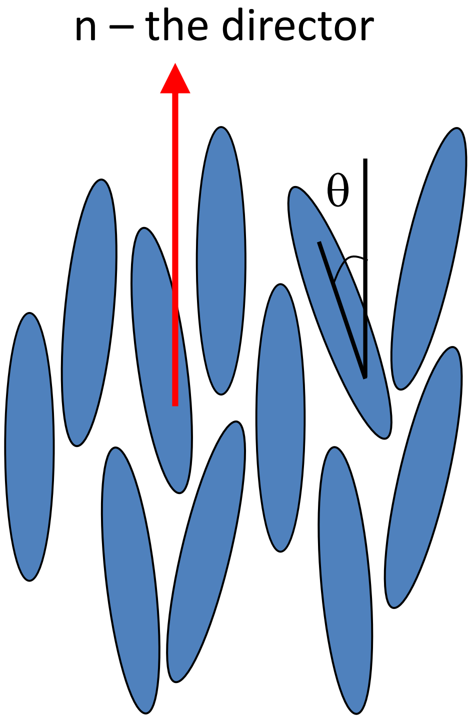
Liquid crystals which are prepared by mixing two or more substances, of which one is a polar molecule, are known as lyotropic liquid crystals.

Eg. Soap in water.

Order parameter

- The order parameter is the degree to which the individual molecules align with the average direction.
- It is defined in terms of the angle that the molecules make with **n**, the vector describing the average direction
- An important property of this vector is that

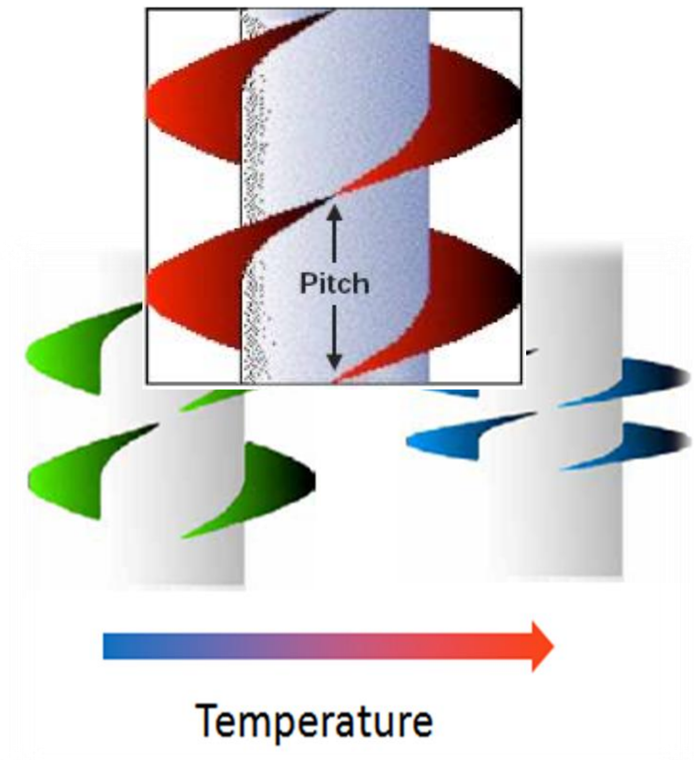
  n = - **n**
- The order parameter (S) is typically S $\approx$ 0.65 for a liquid crystal; for a perfectly ordered crystal S = 1 and for an isotropic liquid S = 0
- If the temperature is increased in a thermotropic liquid crystal, the molecules become more disordered and so the order parameter will reduce.



$$S = \frac{1}{2}\left\langle 3\cos^2\theta - 1 \right\rangle$$

Colour generation in thermotropic LCs

The colour of the reflected light depends on how tightly twisted the helix is. It **depends on the pitch**



- When the helix is **tightly twisted**, the pitch is smaller, so it reflects **smaller wavelengths** (**blue end of the spectrum**); when the liquid crystal is **less twisted**, it has a larger pitch, so it reflects **larger wavelengths** (**red end of the spectrum**).

LC Dealing with Nanotechnology

1- **liquid-crystalline nanomaterials**

• CdSe

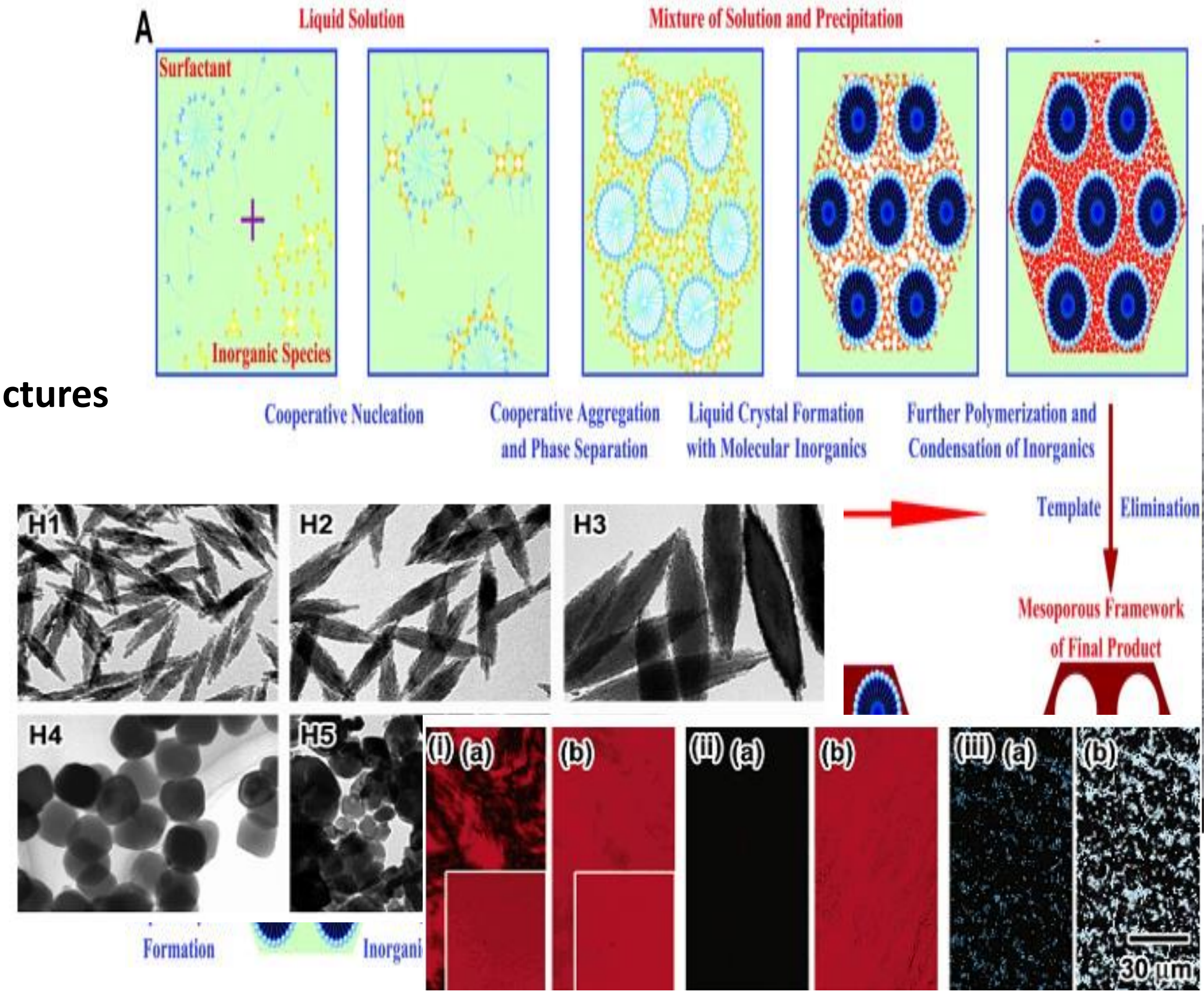
• Graphene Oxide

2- **Synthesing Superstructures via LCs (template)**

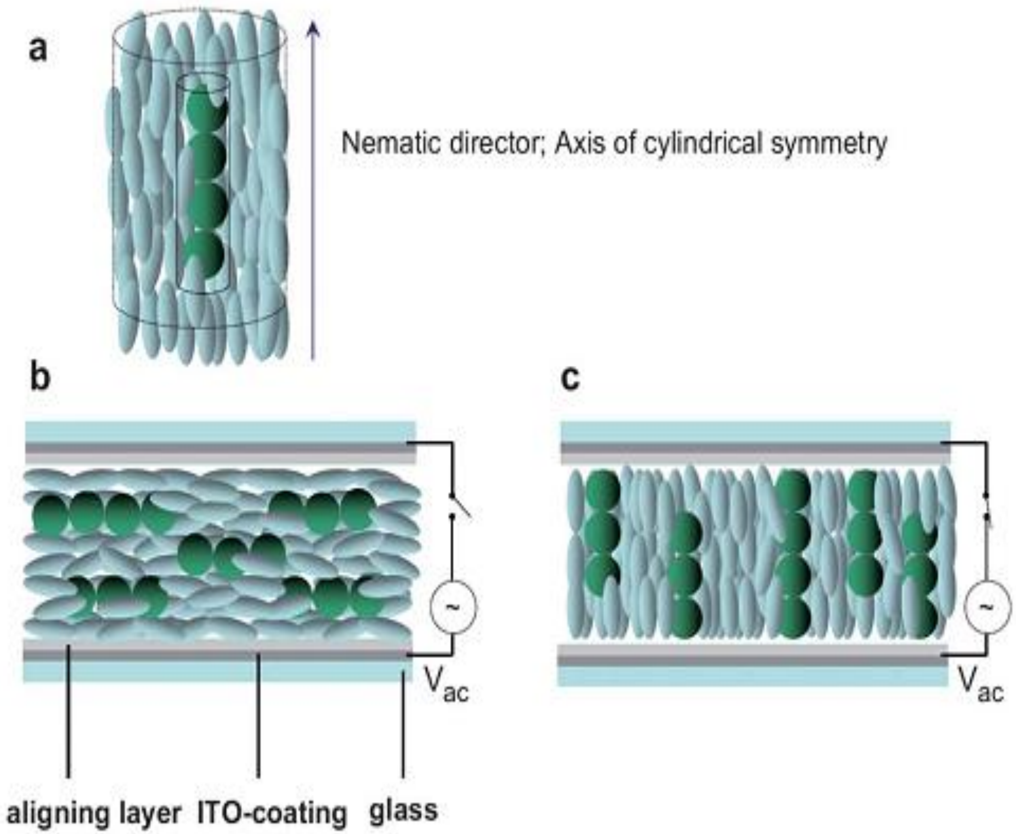
Mesoporous Silica

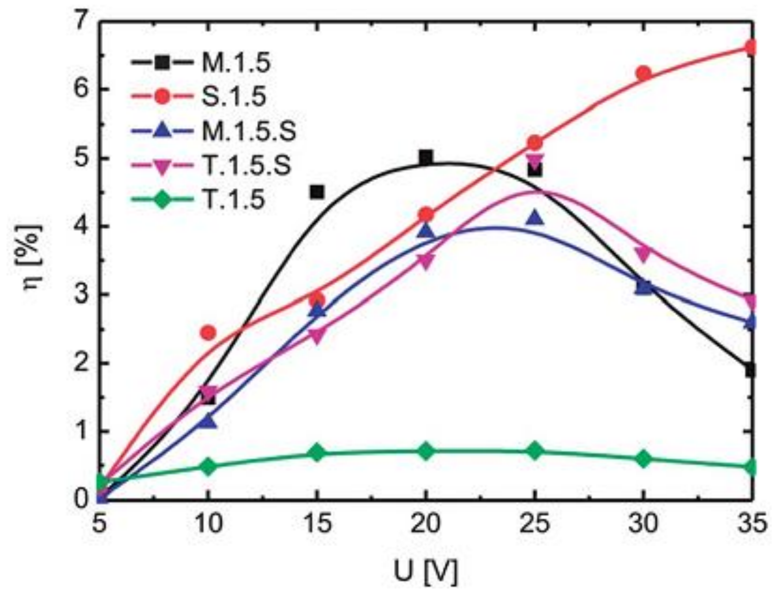
3- **Nanocomposites**

Fe_2O_3, TiO_2, etc.



Q-Dots as Dopants



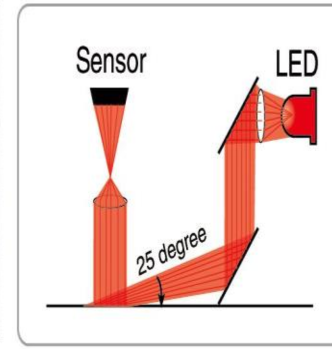


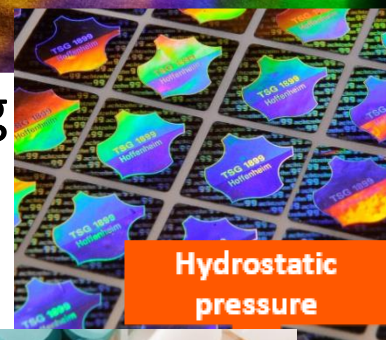
Beyond- Display Applications

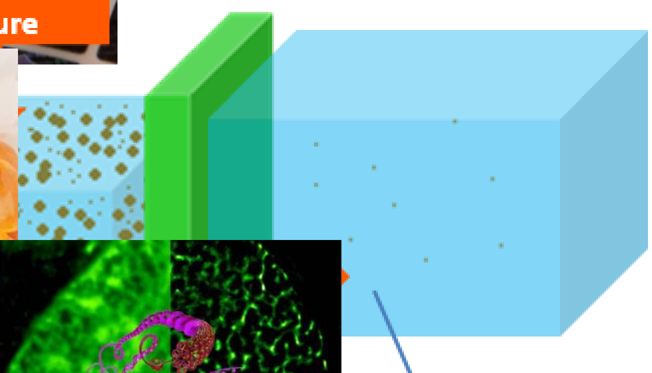
- **Opto-Electronics:**
  Colour Filter
  Sensors
  Holograms and Beam steering

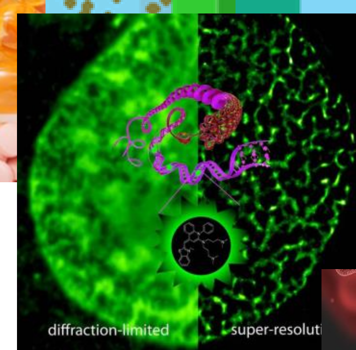
- **Environments:**
  Water Treatment

- **Bio Medical**:
  Drug Delivery
  Fluorescent Imaging
  Protein binding
  Phospholipids labeling
  Microbe detection









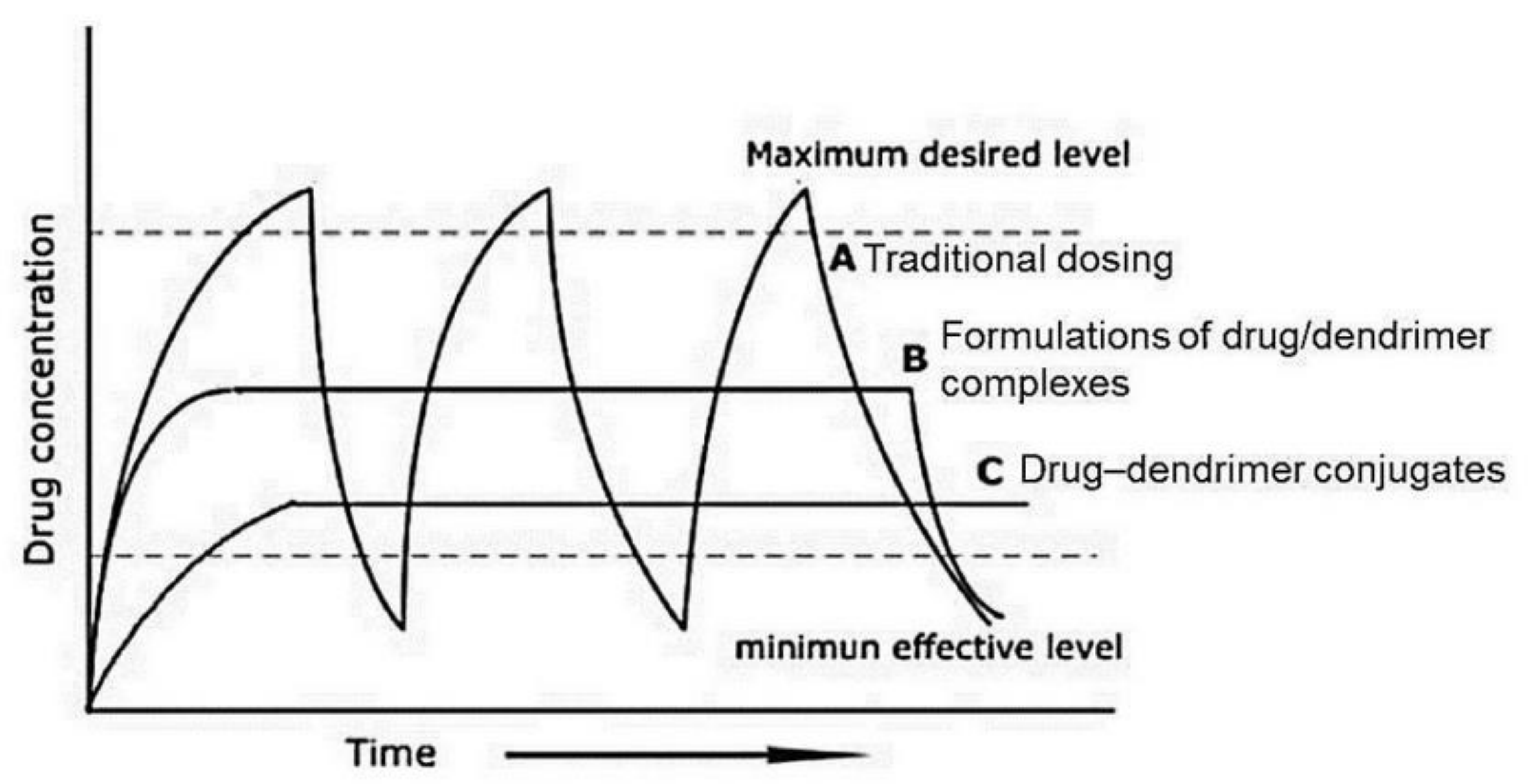
Thanks for kind consideration

Preparation of PLGA Conjugated with Polyurethane Dendrimers Polymeric Micelle and Study on Drug Delivery

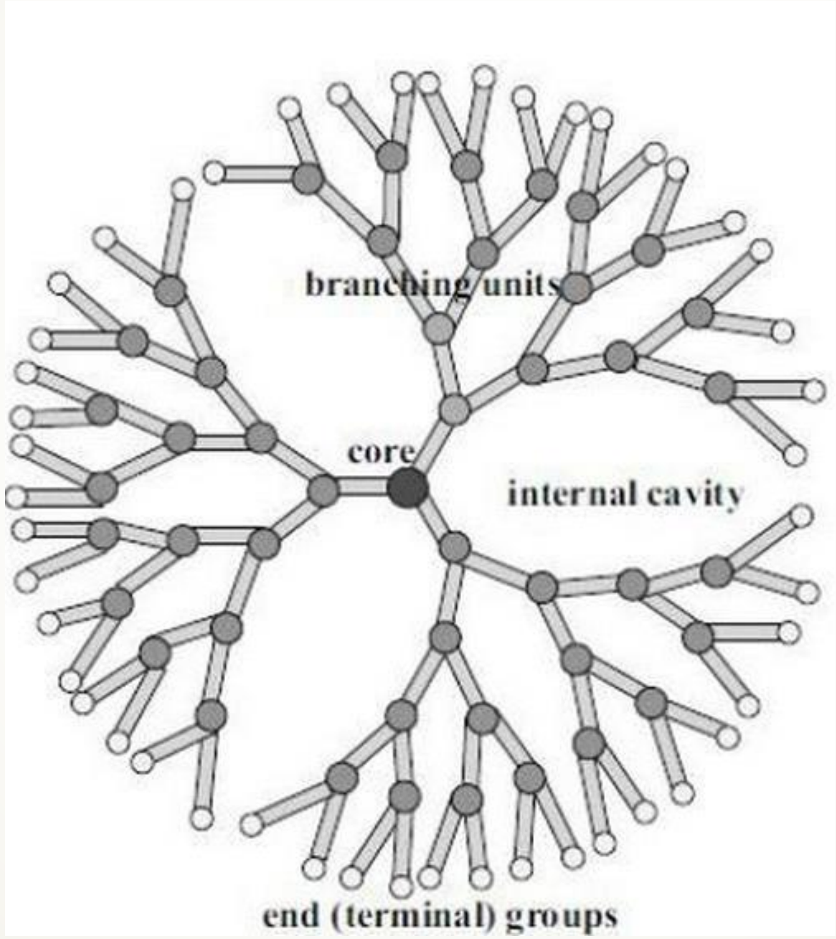
Student：Liou Eva

Introduction

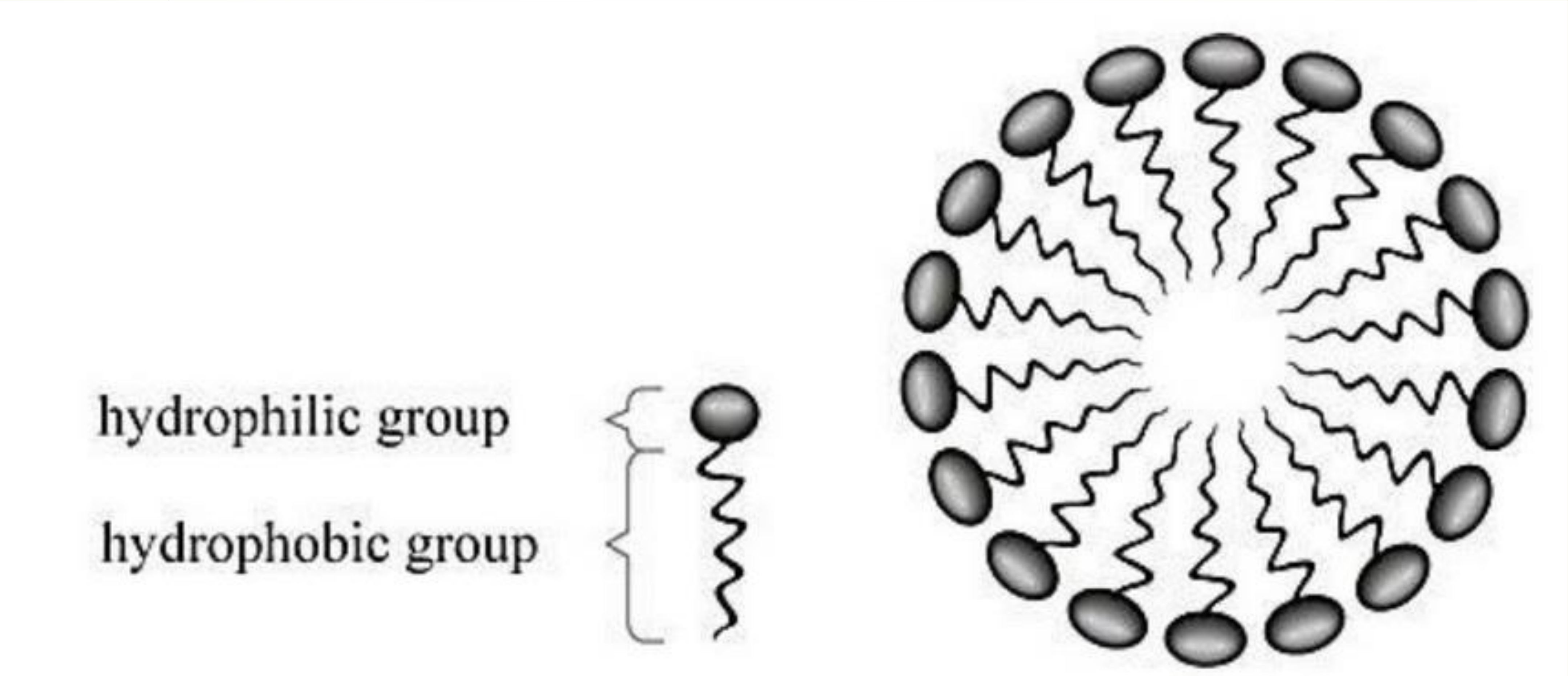
Comparison of Drug System



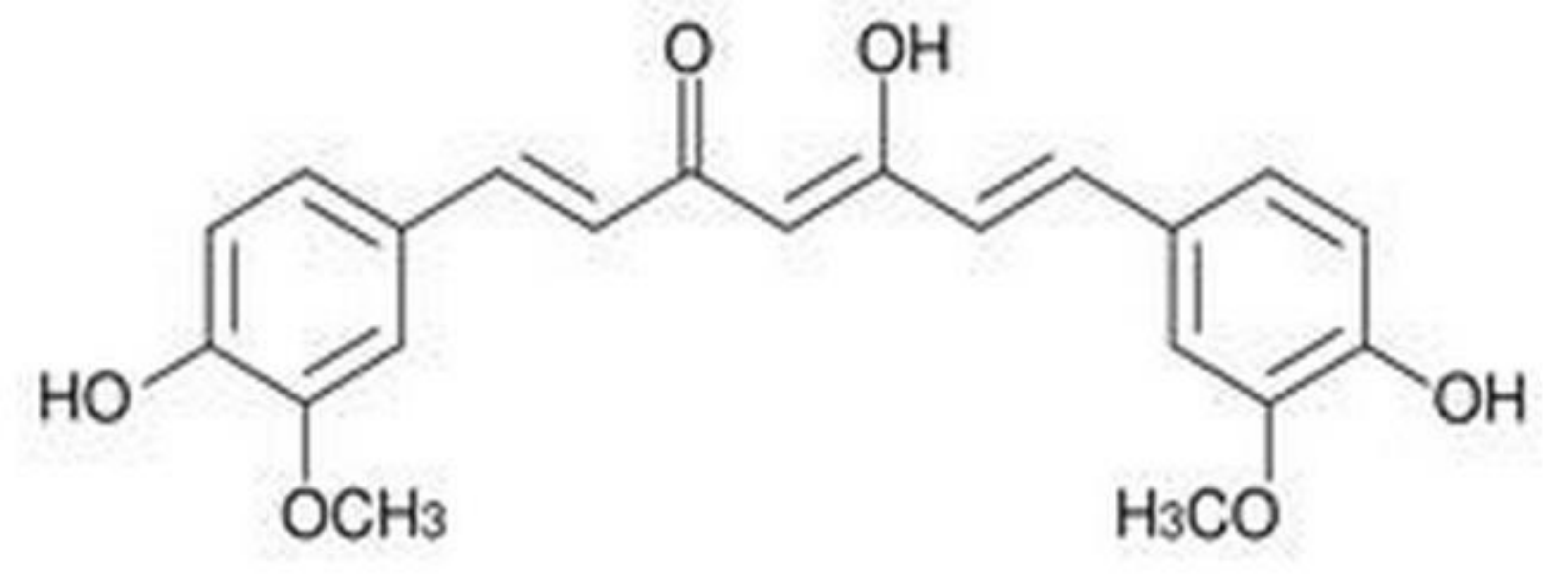
Dendrimers



polymeric micelle

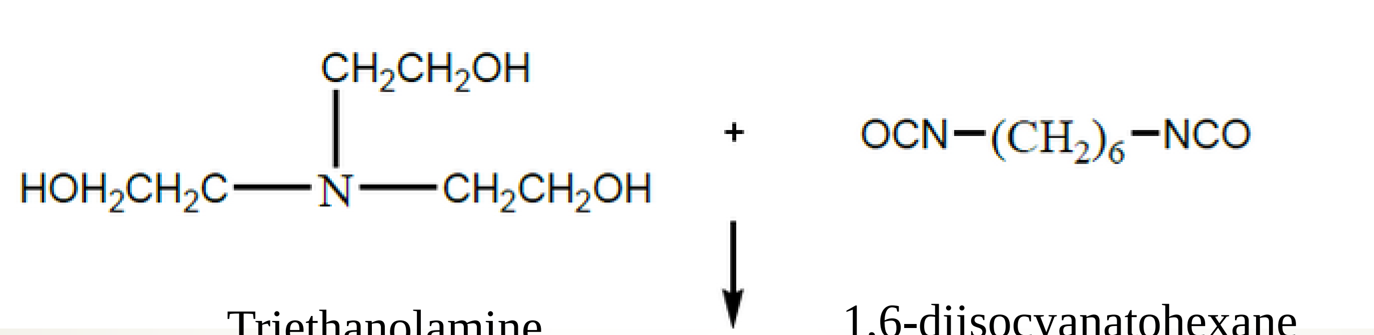


Drug-Curcumin



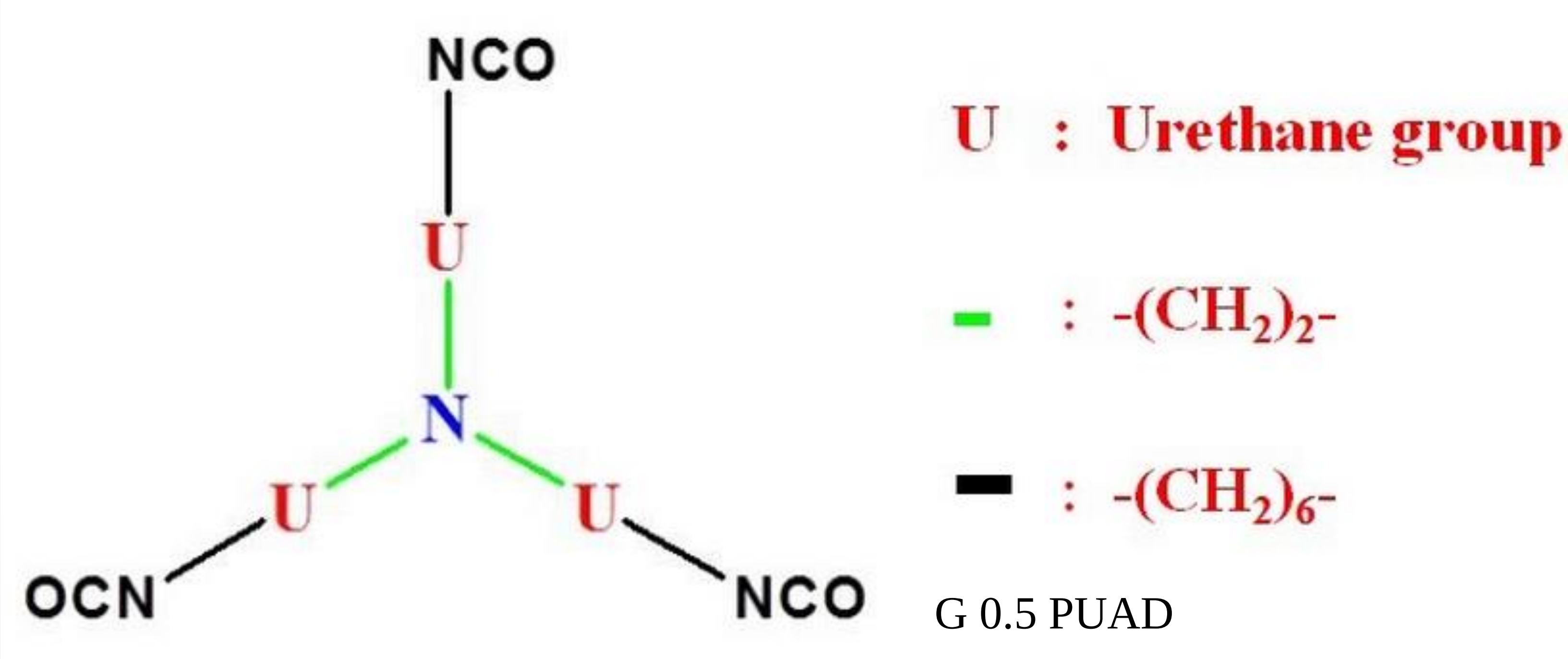
Method

Synthesis



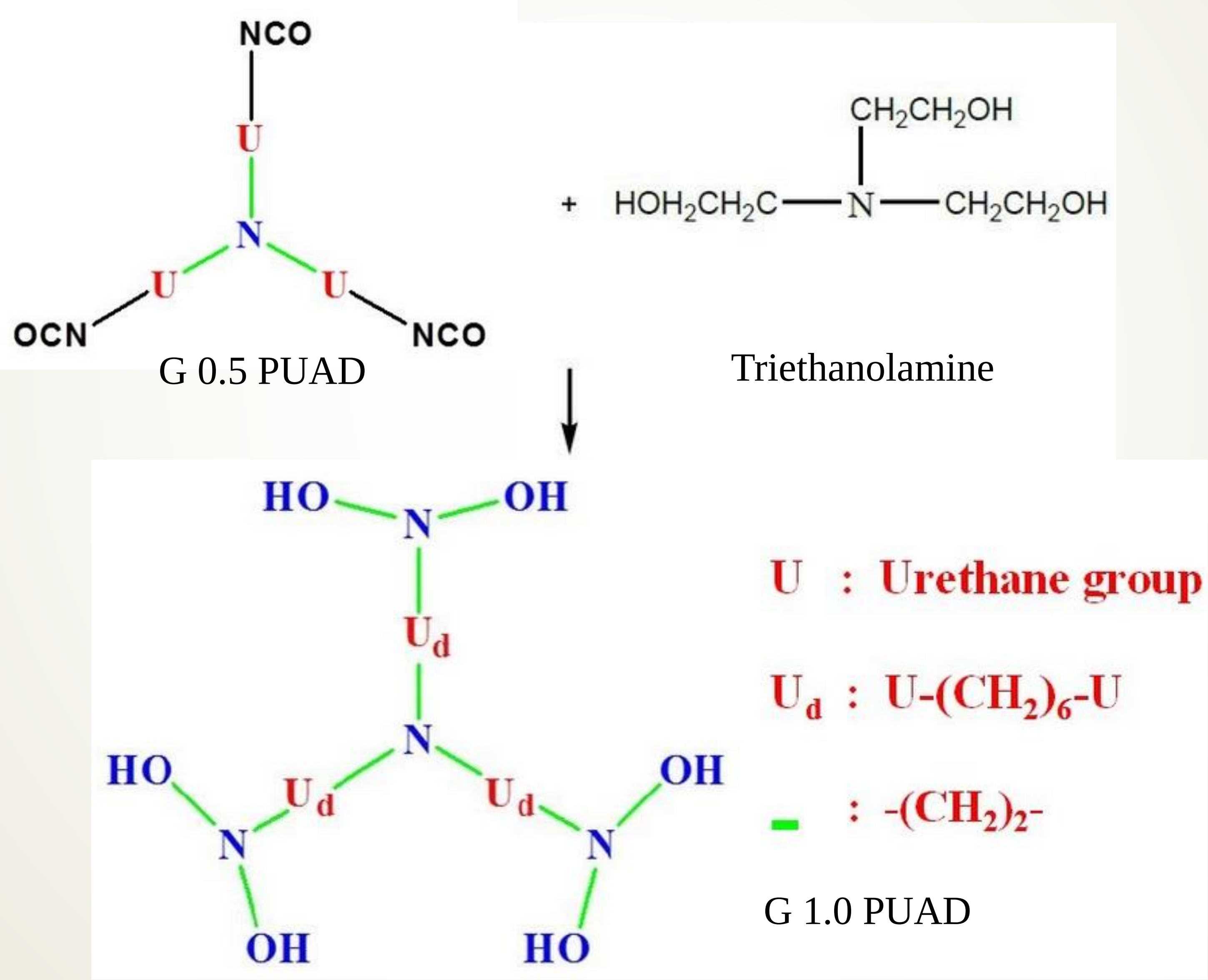
Triethanolamine

1,6-diisocyanatohexane

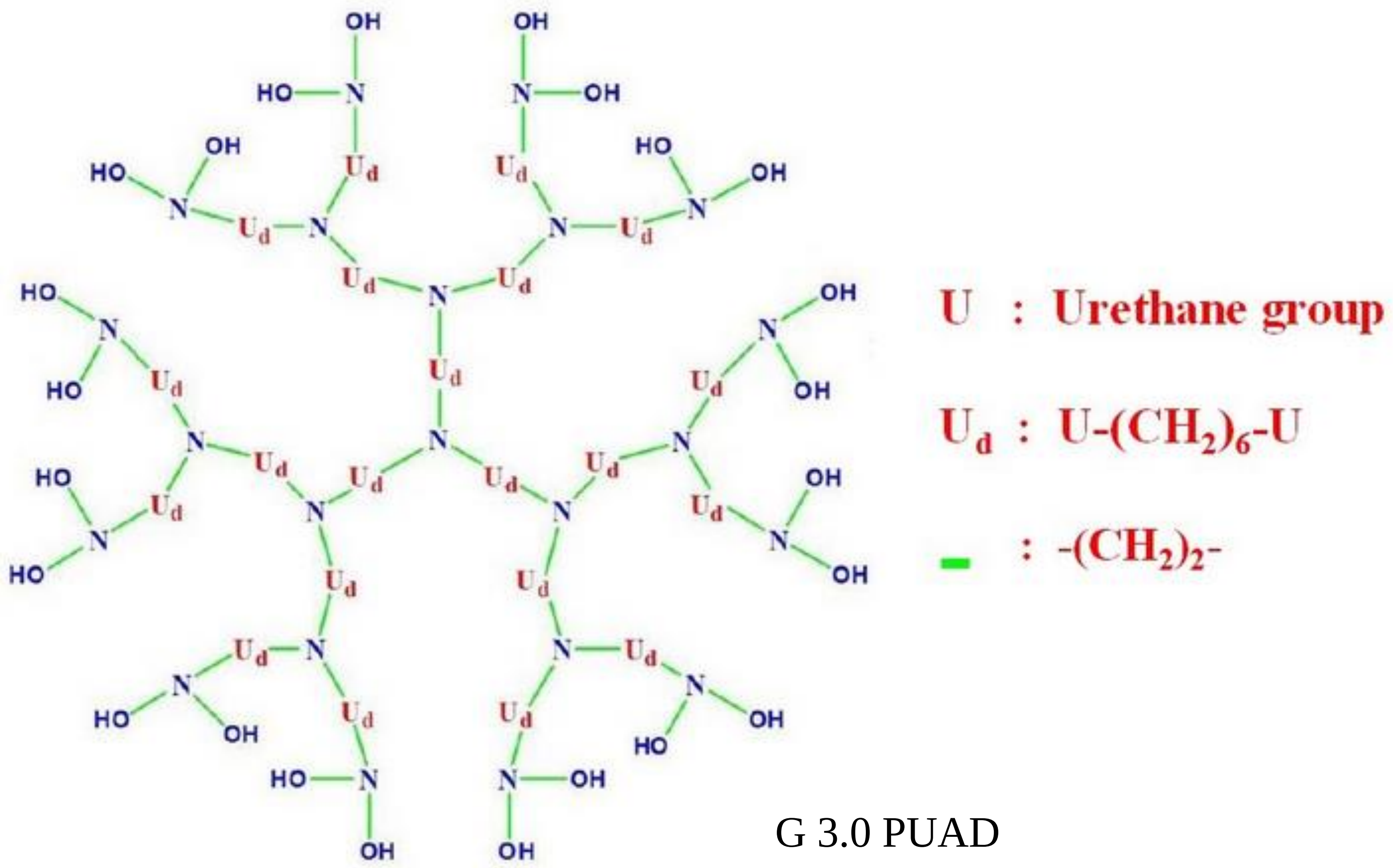


G 0.5 PUAD

Synthesis

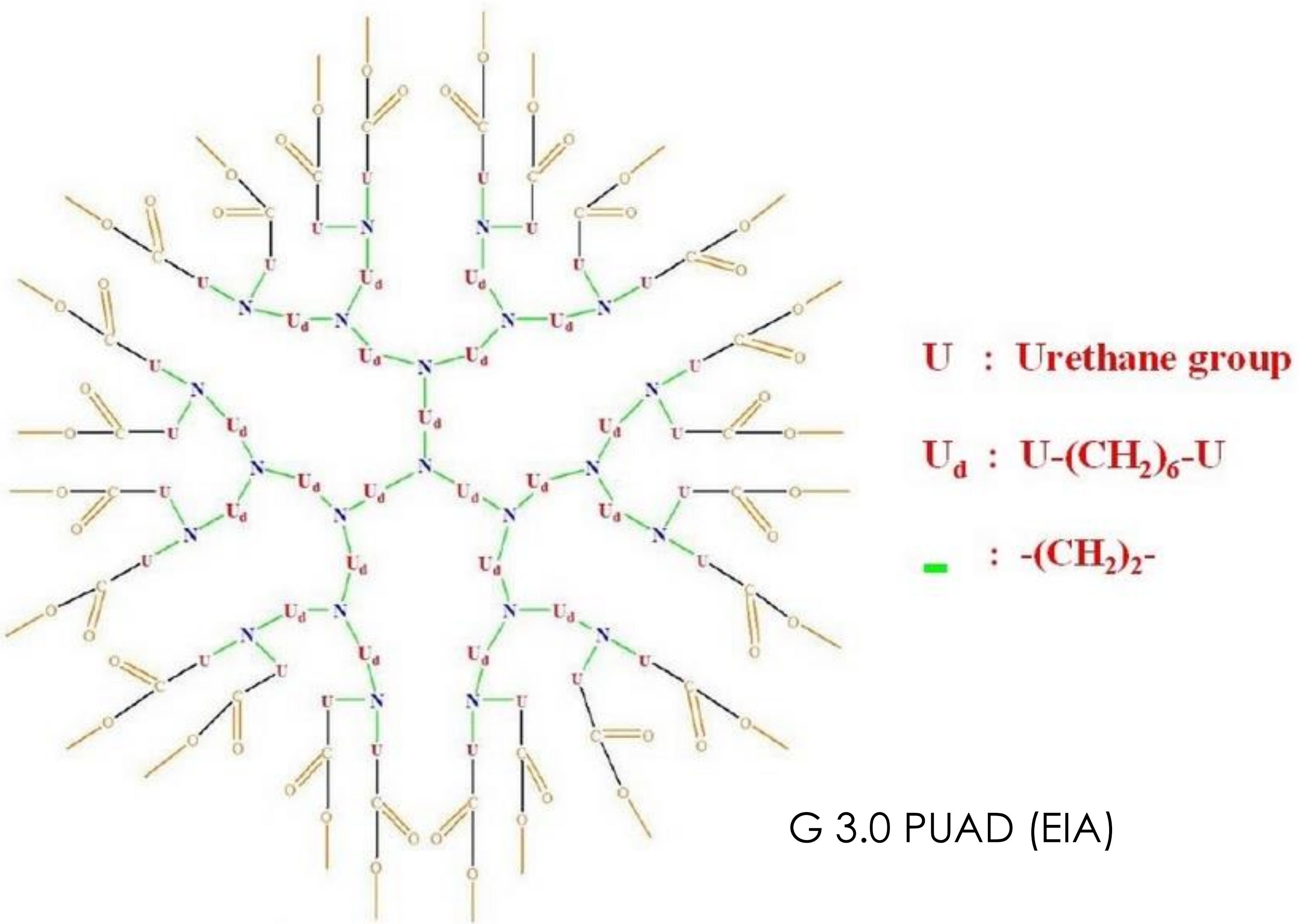

NCO
U
N
U
U
OCN
NCO
G 0.5 PUAD
+
CH2CH2OH
HOH2CH2C—N—CH2CH2OH
Triethanolamine
HO
OH
N
Ud
N
HO
Ud
Ud
OH
N
N
OH
HO
U : Urethane group
Ud : U-(CH2)6-U
: -(CH2)2-
G 1.0 PUAD

Synthesis



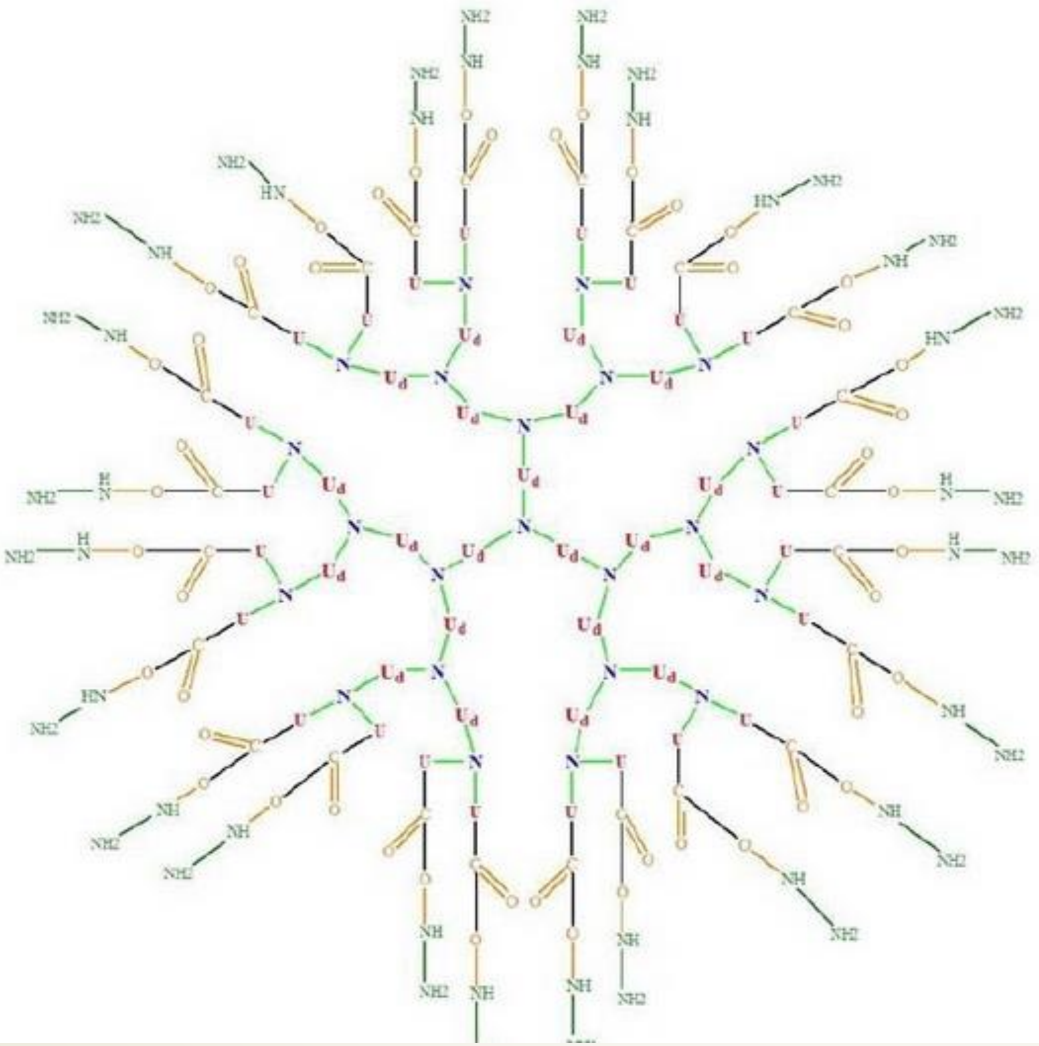
G 3.0 PUAD

Synthesis



G 3.0 PUAD (EIA)

Synthesis

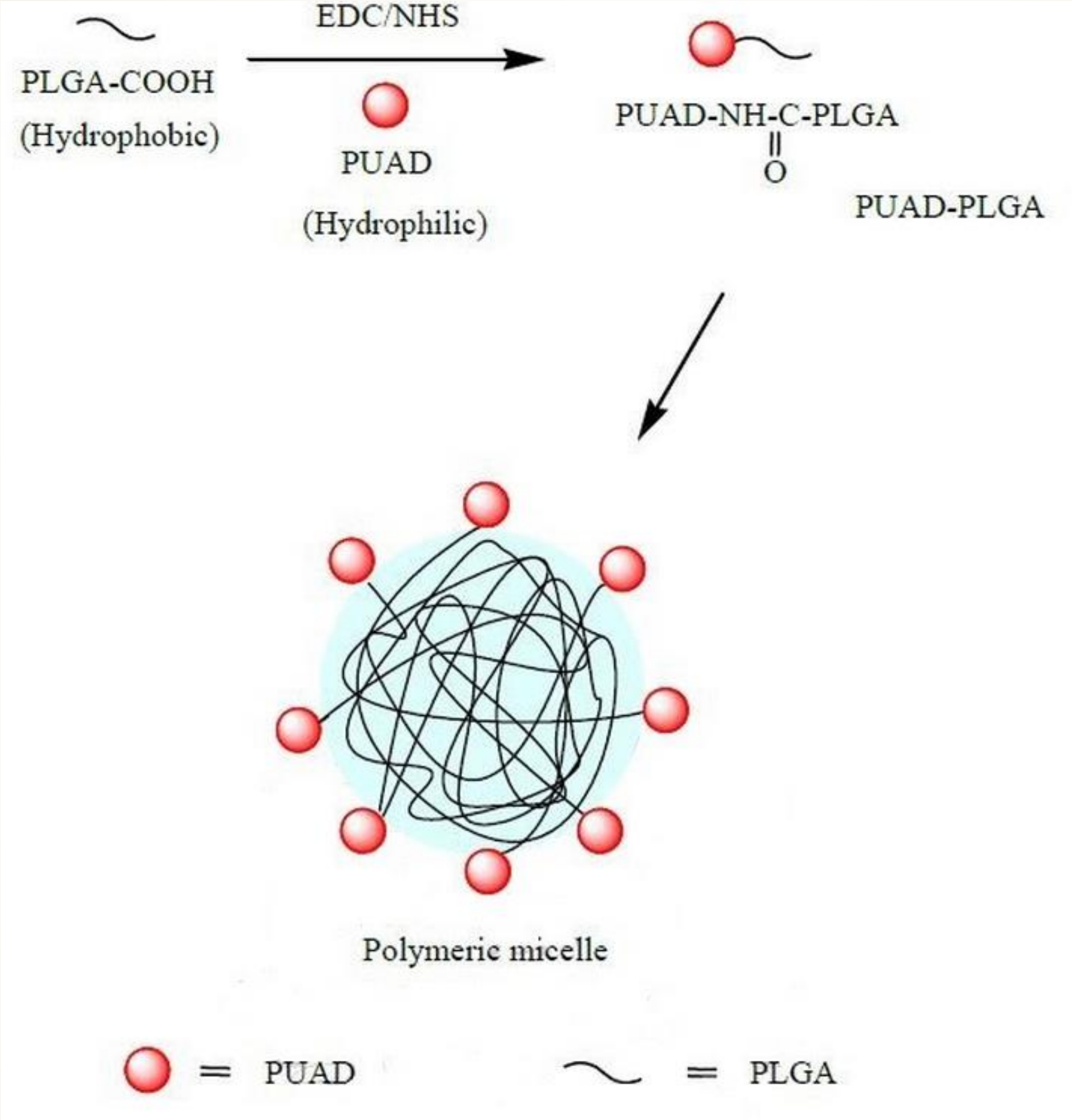


U : Urethane group

U_d : U-$(CH_2)_6$-U

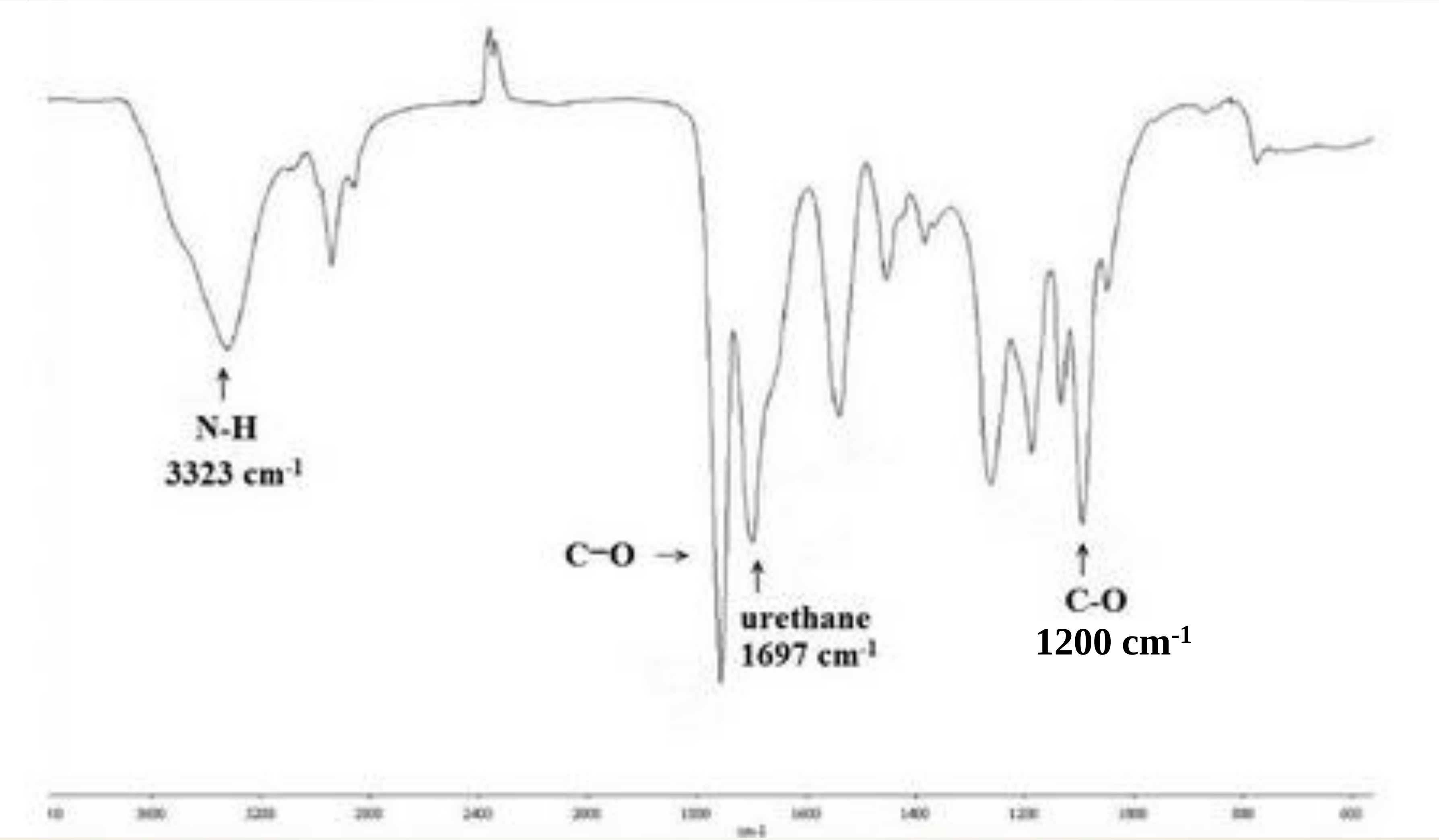
G 3.0 PUAD (NH_2)

Synthesis

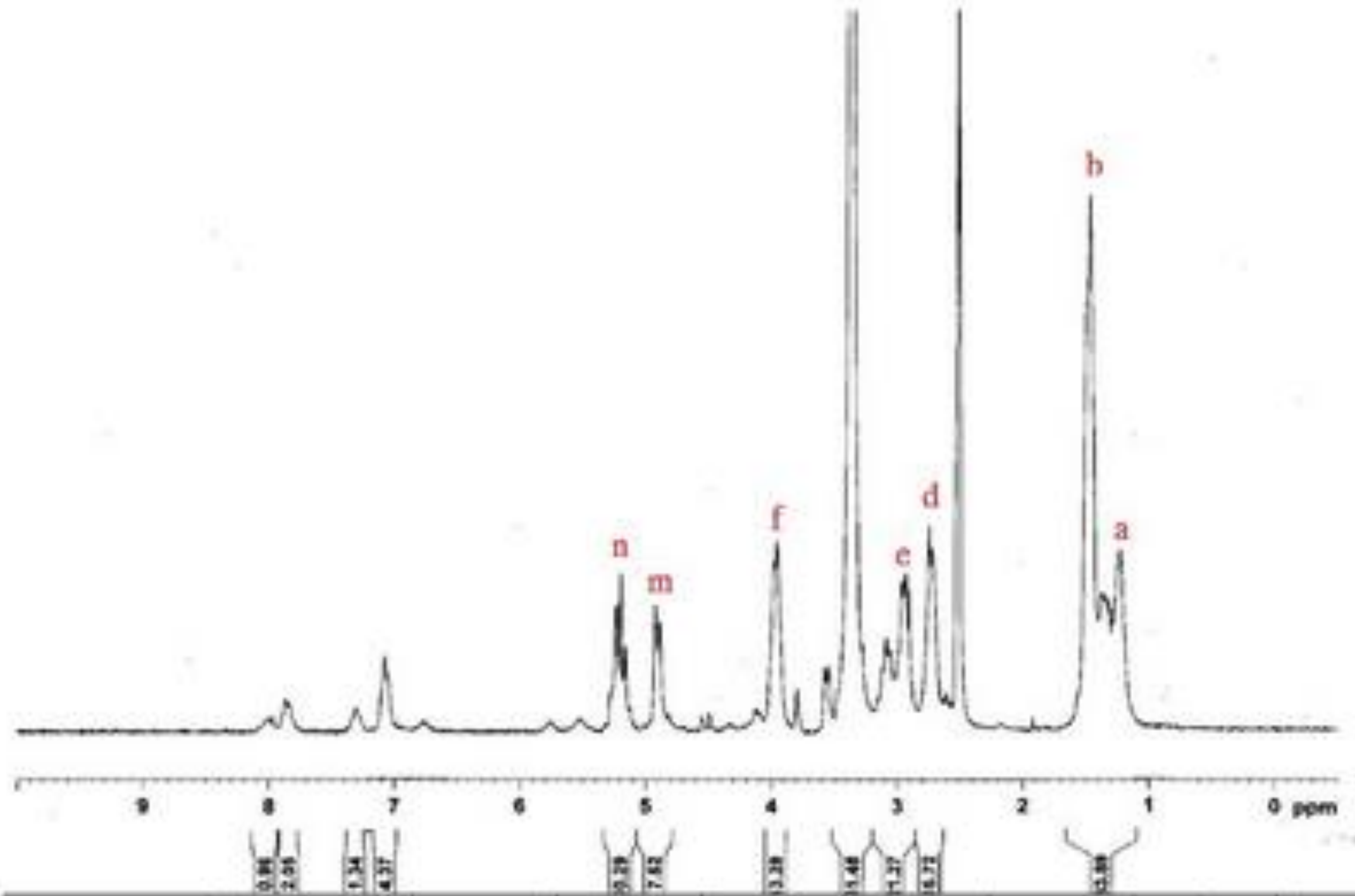

EDC/NHS
PLGA-COOH
(Hydrophobic)
PUAD
(Hydrophilic)
PUAD-NH-C-PLGA
O
PUAD-PLGA
Polymeric micelle
= PUAD
= PLGA

Results

FT-IR-G 3.0 Dendrimers (PLGA)

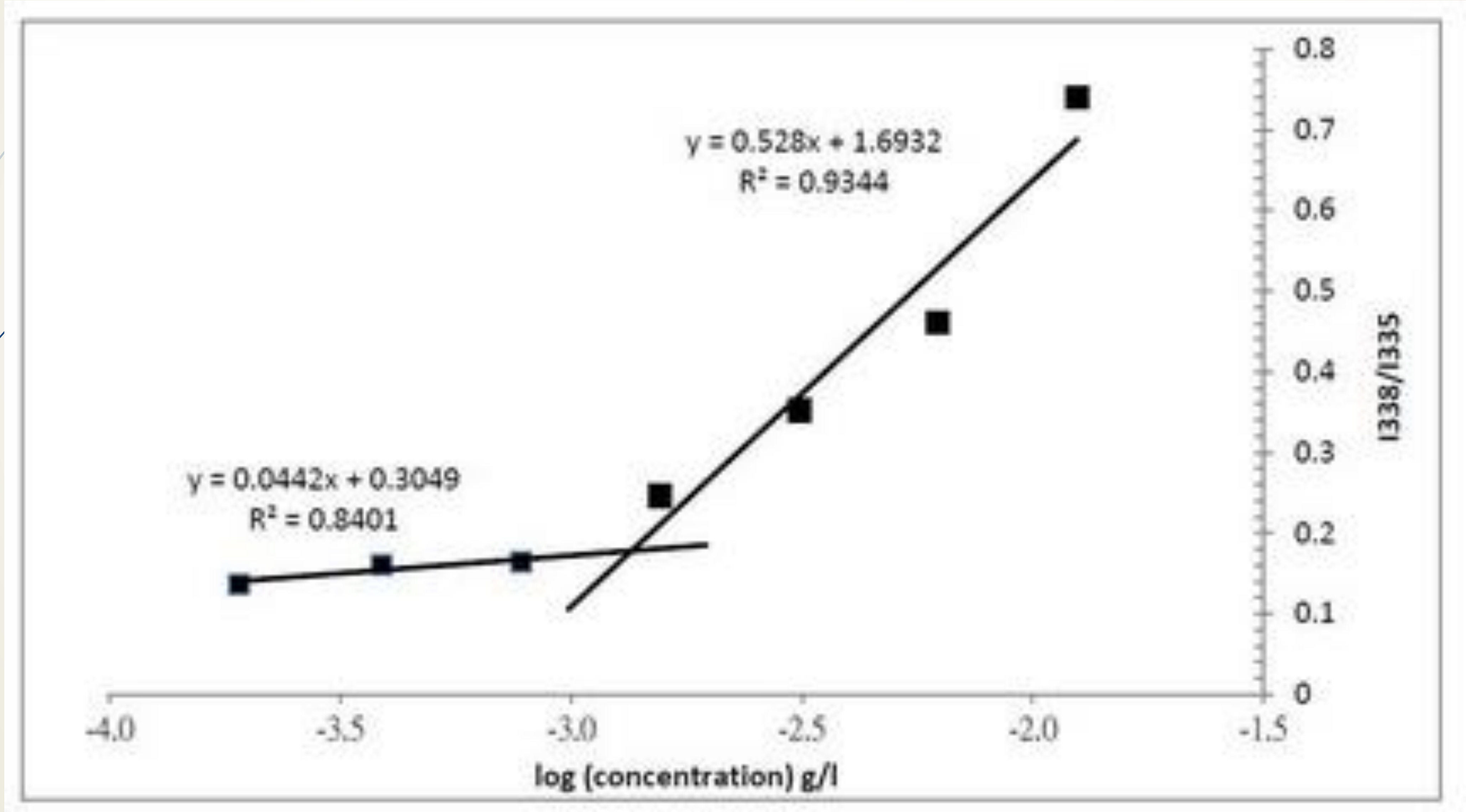


NMR



Types of proton	a	b	c	d	e	f	g
Chemical shift (ppm)	1.17	1.31	2.60	2.68	2.88	3.94	3.34

CMC



y = 0.528x + 1.6932
R² = 0.9344
y = 0.0442x + 0.3049
R² = 0.8401
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
I338/I335
-4.0
-3.5
-3.0
-2.5
-2.0
-1.5
log (concentration) g/l

Conclusion

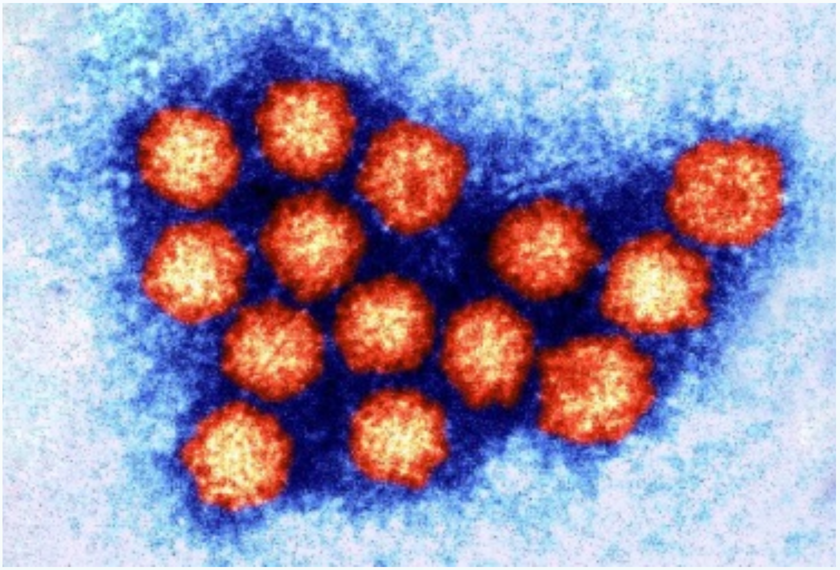
- Polyester-based material selected in this study and the biodegradable hydrophobic PLGA forming amphoteric copolymer, dendritic polyurethanes as a hydrophilic end, to poly (d, l-lactic-co-glycolic acid) as the hydrophobic end PLGA synthesized amphoteric polymer PUAD-PLGA, structure identification via IR, NMR and other structural analysis synthesis correct.

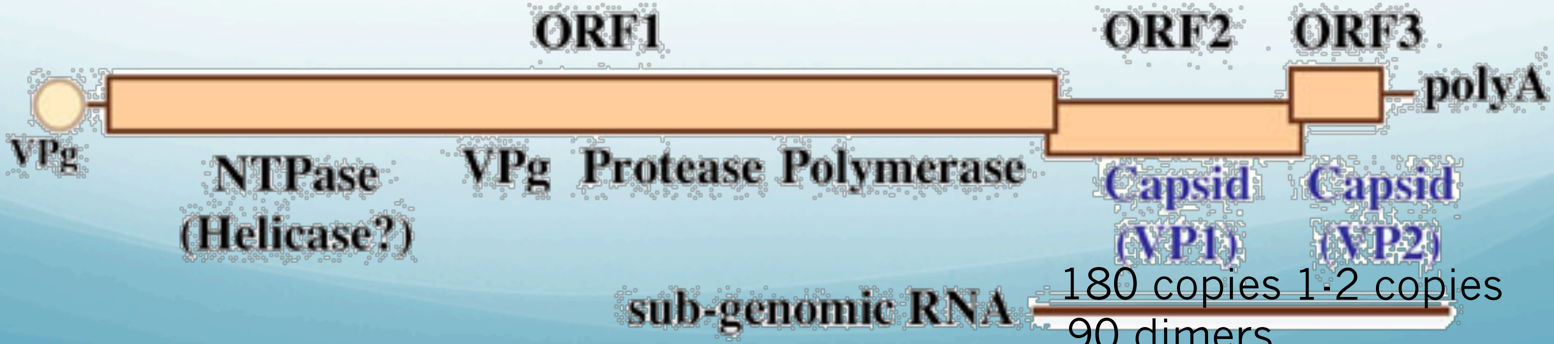
Applications of Noroviral VP1 for Detecting Norovirus Infection

Name : Joey Sin
Date : 2015/01/12

Norovirus

- single-stranded RNA
- non-enveloped viruses
- Caliciviridae family
- Icosahedral symmetry
  - Diameters 27~32 nm
- Length of genome:7.3~7.7kb





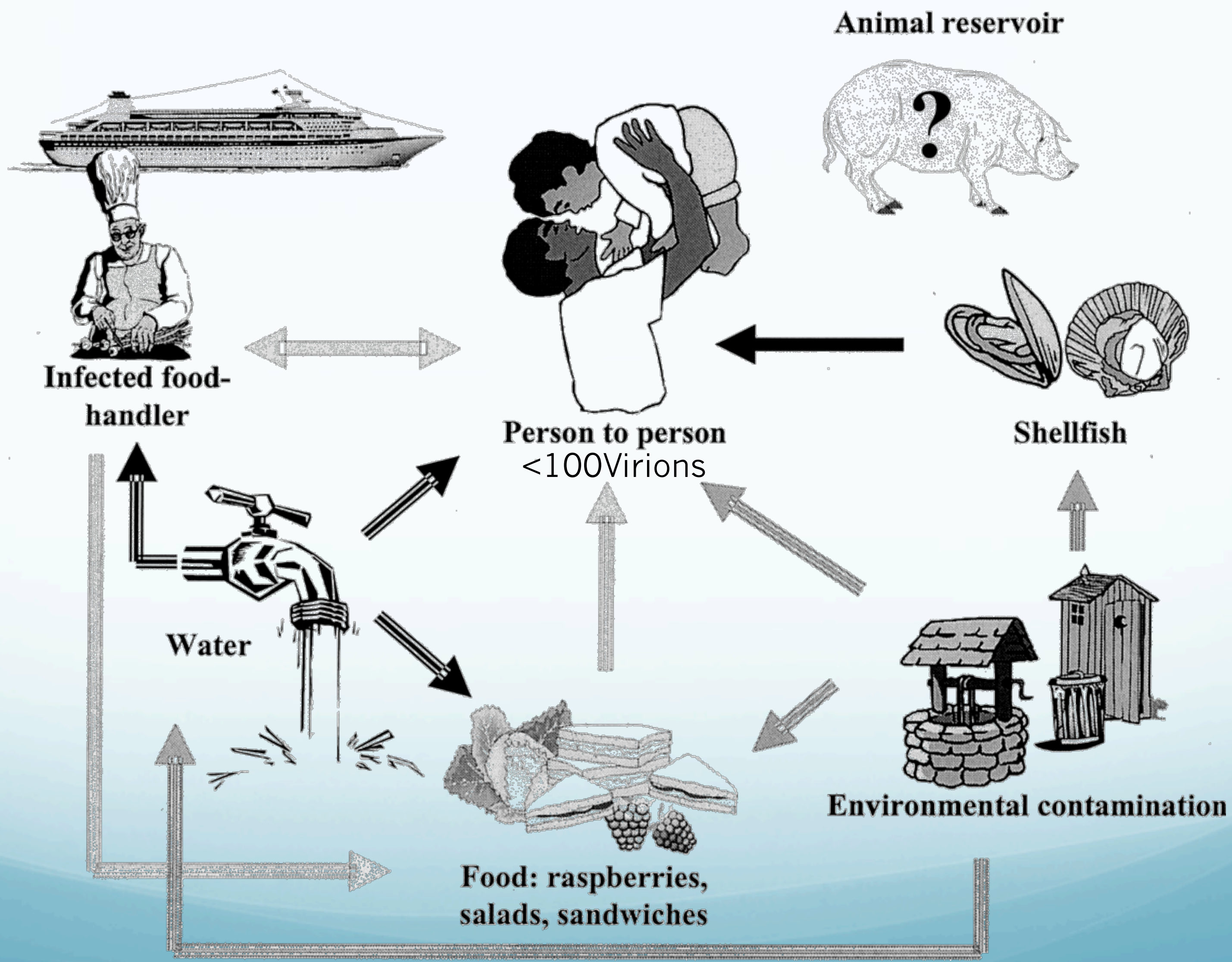
Norovirus

- Can survive in
  - Humans, pigs, bovine, chickens, dogs and mice
- 5 different genogroups
  - Human III
    - GI, GII, GIV, and GV
  - Pigs
    - GII, GIII
  - Bovine species
    - GIII
  - Mice
    - GV

Norovius

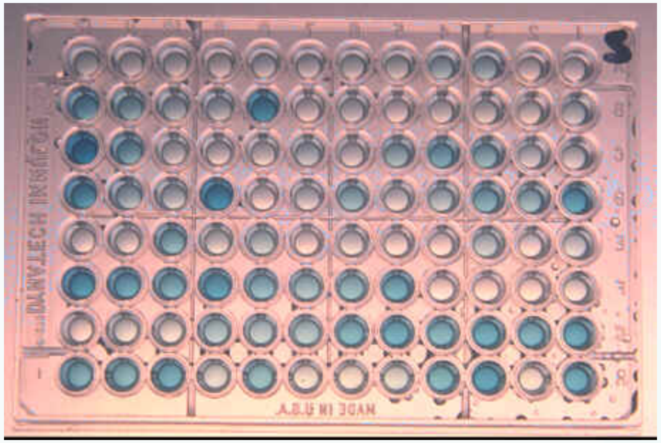
- Pigs
  - Naturally infected GII
  - Pathogenesis and clinical characterization remains unclear
- Human
  - GII norovirus can infect pigs
- Potential Zoonosis
  - Strong pathogenic virus, often resulting in cluster infection
- > 85% of patients with acute viral gastroenteritis
  - Norovirus infection, no age limit
  - Most patients with diarrhea circumstances to maintain 1.5-2 days

Norovirus



Animal reservoir
?
Infected food-
handler
Person to person
<100Virions
Shellfish
Water
Environmental contamination
Food: raspberries,
salads, sandwiches

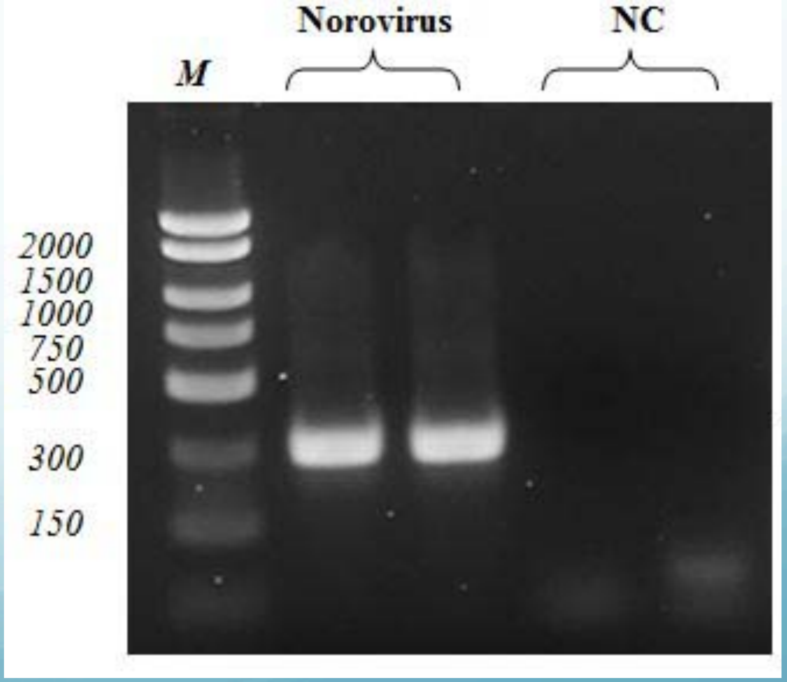
Norovirus detection



- ELISA
  - Direct ELISA
  - Sandwich ELISA
  - Competitive ELISA
- Principle
  - Antigen and antibody binding specifically
  - Enzymes coloring shades
  - Determine whether there is a specific protein
- Shortcoming
  - Higher costs
    - Antibody that can bind with enzyme is needed and enzyme
  - Take more than 4 hours
    - Without timing putting antigen to a 96-well microplate flat disk

Norovirus detection

- RT-PCR
  - reverse transcription that binding RNA
  - technique of cDNA polymerase chain amplification
- Principle
  - RNA was reverse transcribed to cDNA
  - Through PCR to performed amplification
  - Observe exists the fragment
- Shortcoming
  - High Cost
  - Requires the use
    - RNA extraction reagent set
    - reverse transcriptase
    - thermostable DNA polymerase
    - primer nucleic acid synthesis
    - agarose
  - 3～4 hours

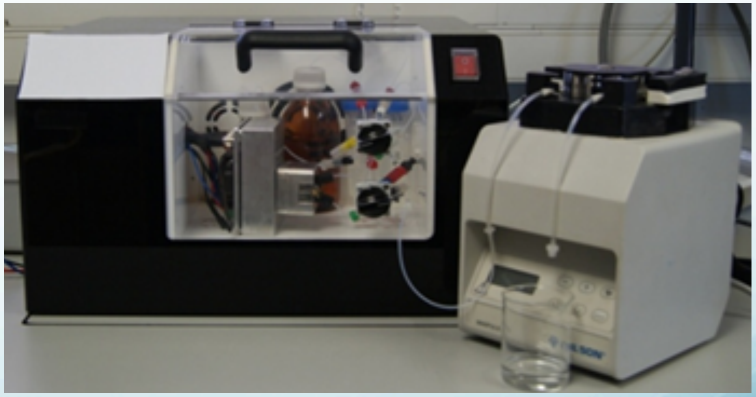


Biochip and Biosensors

- Advantages
  - Rapid analysis
  - Use small amount of specimen and reagent
  - Can get a lot of data at the same time
  - High accuracy
  - High sensitivity
- Medical testing
- Prevention
- Environmental monitoring
- Pollution control
- Food safety

Quartz crystal microbalance

- QCM
  - Electronic oscillator circuit
  - Frequency Calculator
  - Oscillating quartz crystal coated with a layer of gold or silver
- Principle
  - Apply a thin antibodies on the sensing crystal
  - Specific adsorbate is detected
  - Weight difference
  - Determine Norovirus infection
- Advantage
  - Inexpensive
  - Secondary antibodies and enzymes are not need
  - Convenience
  - After adsorption of the antigen can be reused
  - Fast



Thanks for listening!

National Taiwan University of Science and Technology

Department of Material Science and Engineering.

Introduction to Nano-Technology

Presentation Title

Electro spun Nanofiber Fabrication and it's Application

Name: Molla Bahiru

ID: D10304805

Fiber

Fiber is a rope used as a component of composite materials into sheets to make products such as paper.

Fibers are classified into two categories

1. Natural Fibers
2. Manufactured Fibers.

Classification of fibers

1. Natural fibers. :

- Natural fibers are taken from animal, vegetable, or mineral sources.

2. Manufactured fibers. :

- Manufactured fibers are chemically produced. Like Nanofibers are produced by an electrospinning process. It is manufactured fiber.

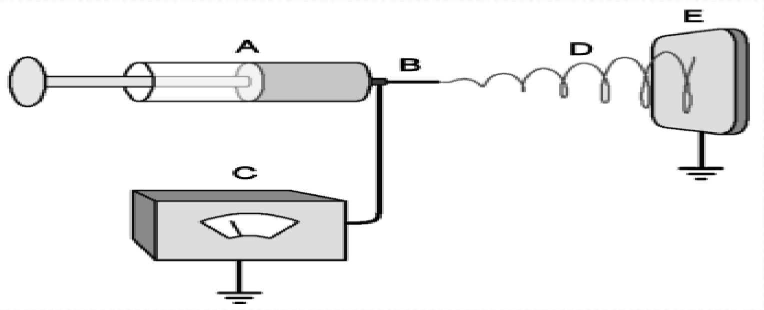
Nanofibers

Nanofibers are defined as fibers with diameters less than 100 nanometers. or smaller.

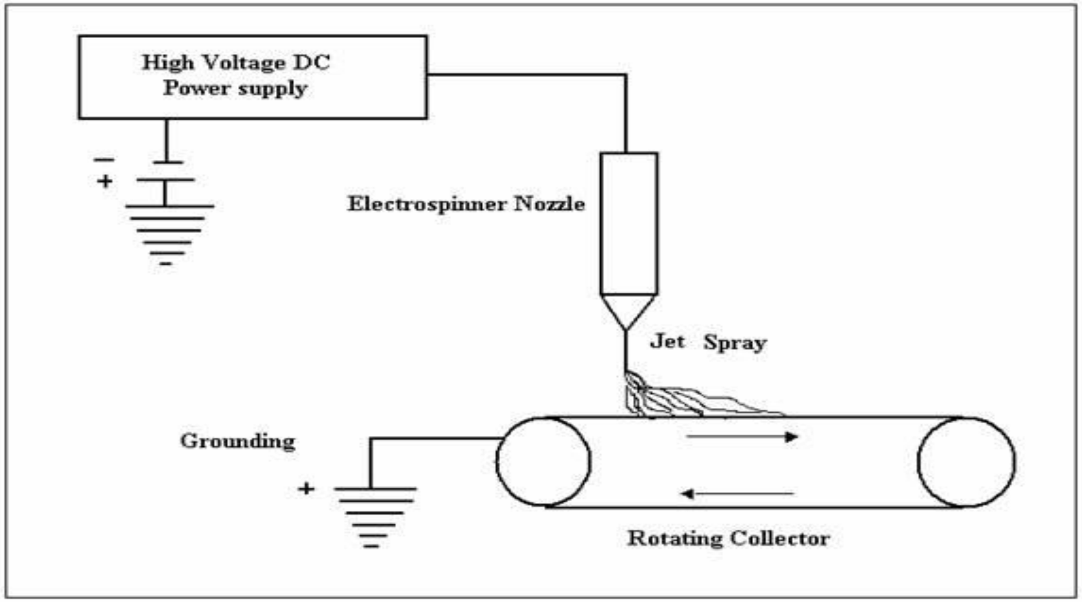
$(1\ nm = 10^{-9}\ m)$

Generally Nanofibers are produced by an electrospinning process

Electrospinning process

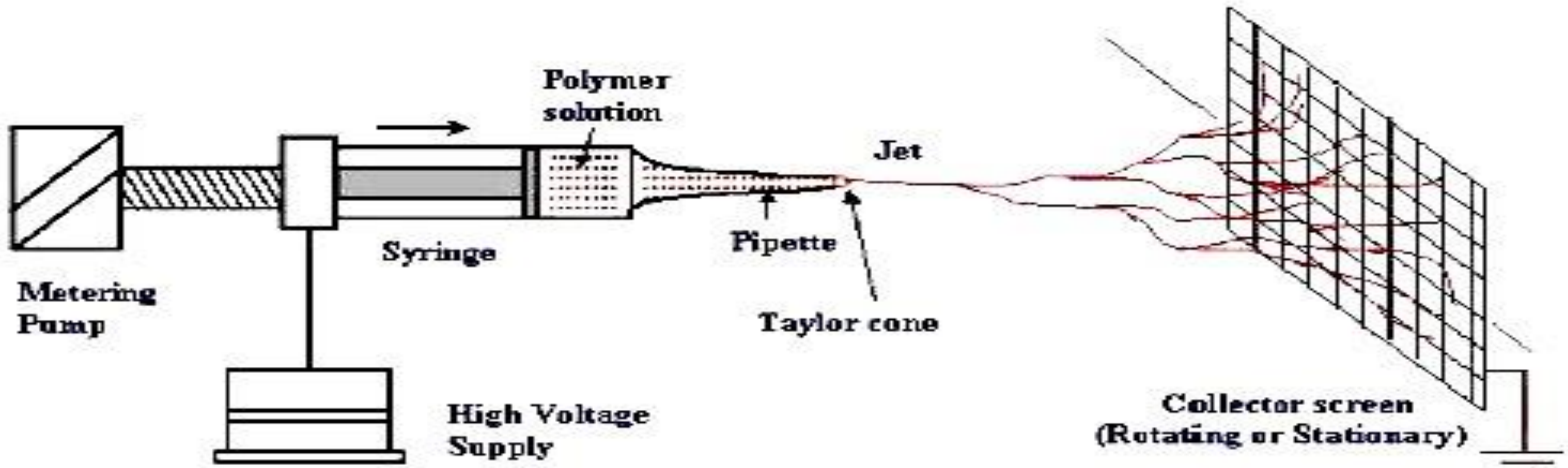


A- polymer solution in syringe
B- metal needle
C- high voltage
D- Nanofibers
E- Nanofibers collection on Rotating collector

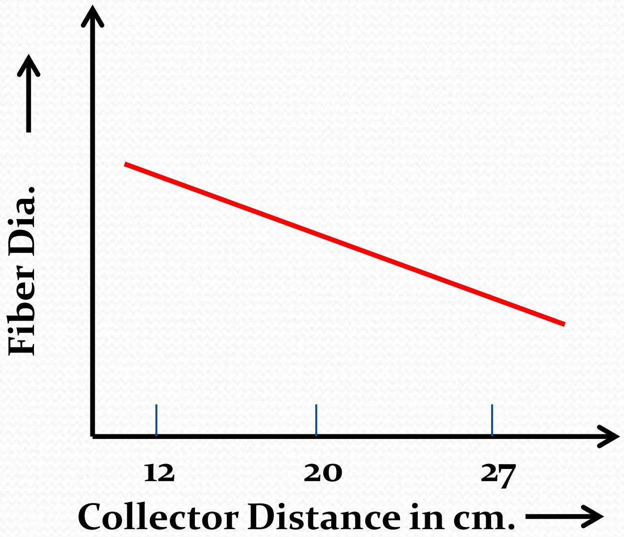


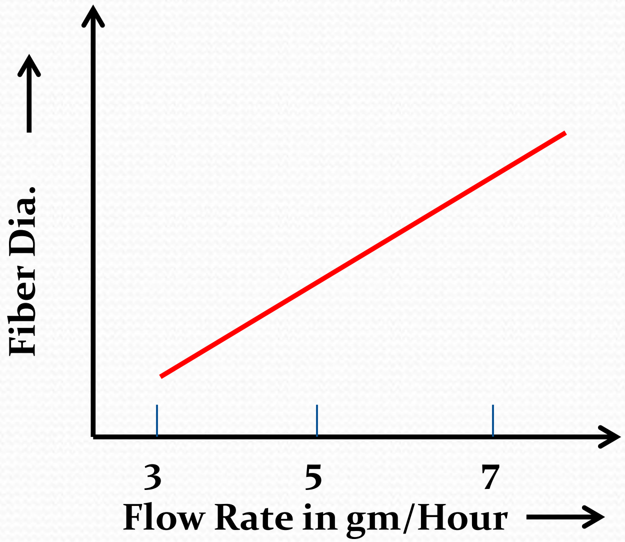
Electrospinning process

- ✓ A polymer solution is injected at a constant feed rate though a nozzle or needle which is charged to a high voltage (10kv to 30kv).
- ✓ The applied voltage is sufficiently high, the surface of the fluid elongates and a Taylor cone is established.
- ✓ On increasing the applied voltage further, a charged liquid jet is ejected from the Taylor cone and attracted to the earthed collector, which is positioned at a fixed distance from the needle. During this process the solvent evaporates from the polymer solution, leaving dry polymer fibers on the collector.



Effect of process parameters on fiber diameter





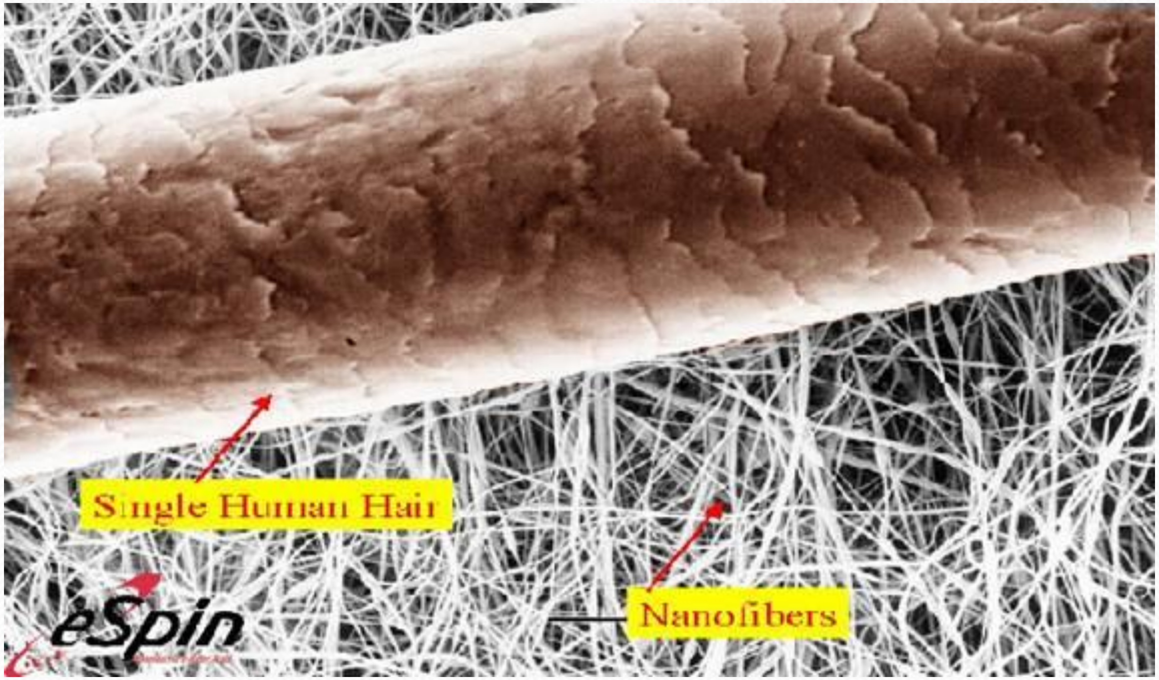
1. Nanofiber properties depend on distance between needle and collector.
2. Flow rate (in grams per hour).

Polymers used for Electrospinning

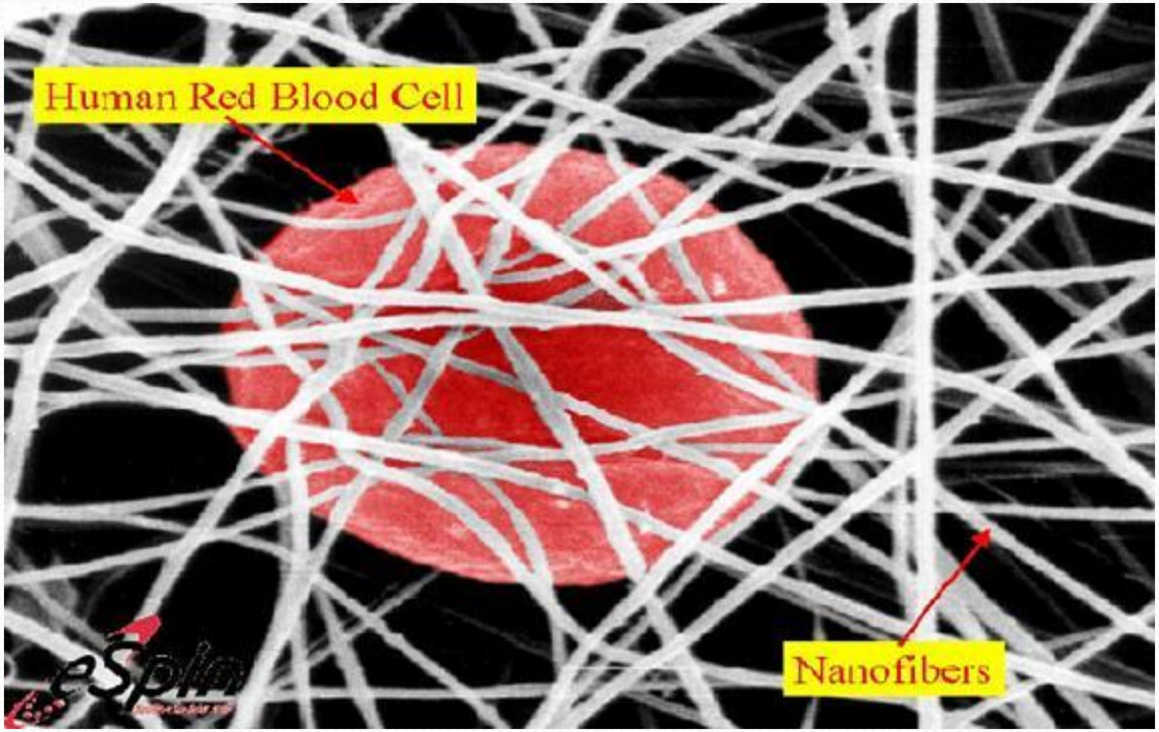
- Polymer solutions or melts
  - Polyglycolic acid (PGA)
  - Polylactic acid (PLA)
  - PGA - PLA
  - Polydioxanone (PDO)
  - Polycaprolactone (PCL)
  - PGA - PDO
  - PLA – PCL
  - PDO - PCL
- More than 30 polymers, including polyethylene oxide, DNA, polyaramids, and polyaniline, have been electrospun.
- These fibers can be made of variety organic (nylon, polyester, acryl) or biological polymers (proteins, collagens).

Comparisons

Comparison between human hair and Nanofibers



Comparison of red blood cell with Nanofibers



❖ Unique Properties of Nanofibers

- Size: nanofibers are very small which gives them unique physical and chemical properties and allows them to be used in very small places.
- Surface-to-volume ratio: nanofibers have a huge surface area compared to their volume.

✓ The huge surface area available on a nanofiber makes it very suitable for new technologies which require smaller and smaller environments for chemical reactions to occur. Increasing the surface area speeds up a chemical reaction.

Application of Nanofibers

Nanofibers use in Cosmetic Application

skin Healing nanofibers

skin Therapy with medicines

skin cleansing Brush

Nanofibers use in Military Protective Cloths

Military Protective Cloths

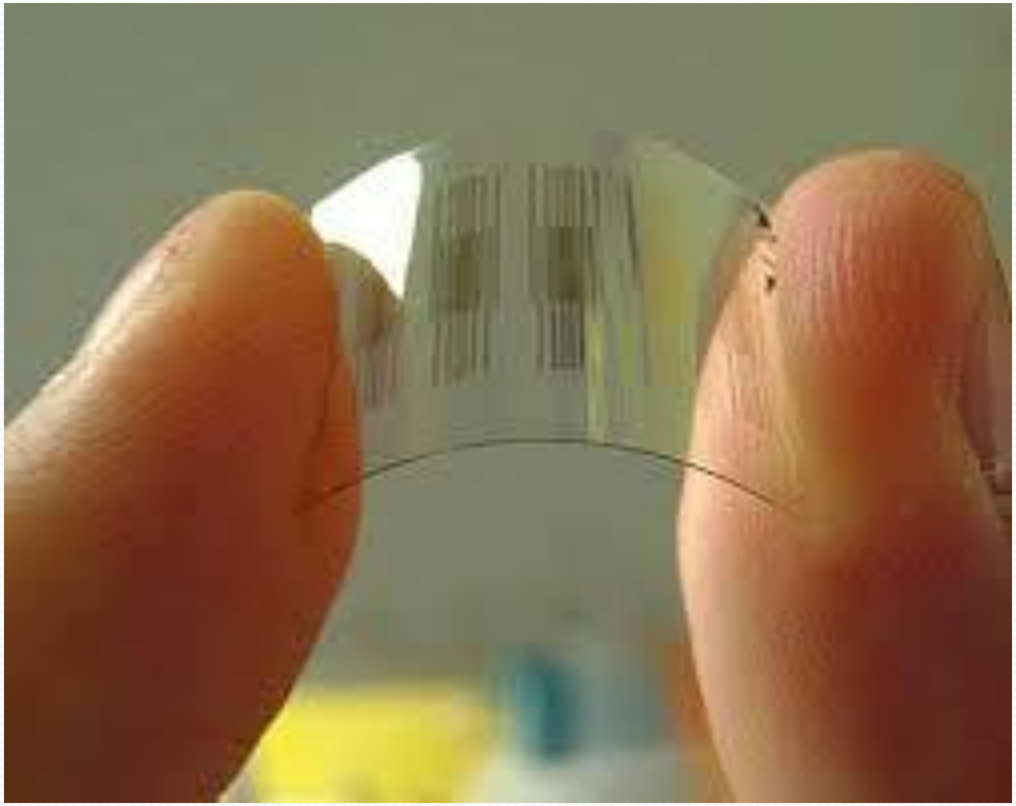
Nanofibers use in Life science

Nanofibers use in Filter Media

Oil Filter

Gas Filter

Nanofibers use in Nano Sensors



References

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http://en.wikipedia.org

www.slideshare.net

http://www.authorstream.com

https://moodle.fp.tul.cz/**nano**/mod/

www.fzu.cz/~**nano**team

Thank You so much

NTUST
NATIONAL TAIWAN UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF CHEMICAL ENGINEERING

INTRODUCTION TO NANOTECHNOLOGY
– INNOVATION PROJECT –

Novel bactericidal material for targeted and reused applications

Professor: **H. Hosseinkhani**

Student: **Au Duong Ai Nhan**

ID number: **D10306802**

January 12th, 2015

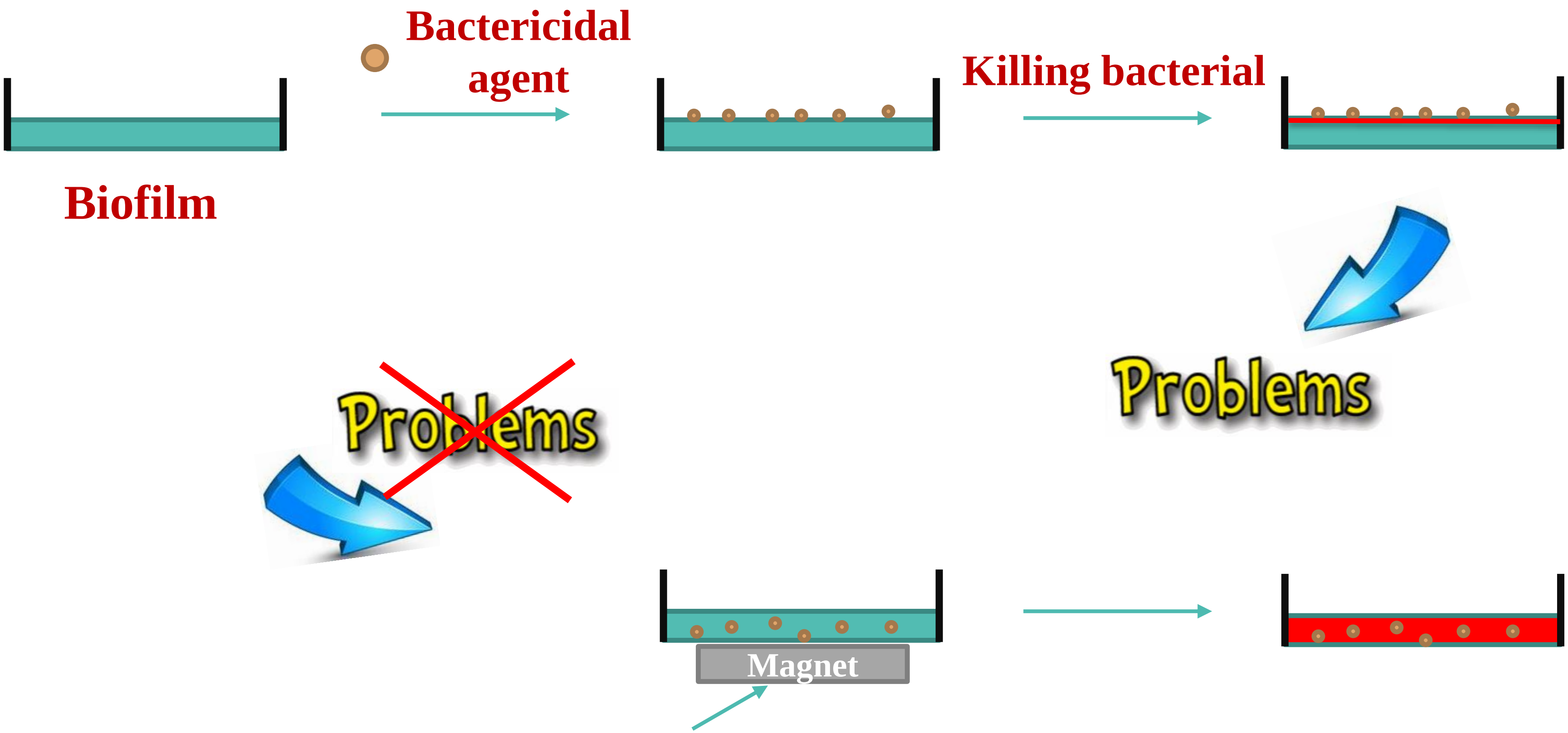
Outline

1. Introduction
2. Approaching and idea
3. Summary

Introduction

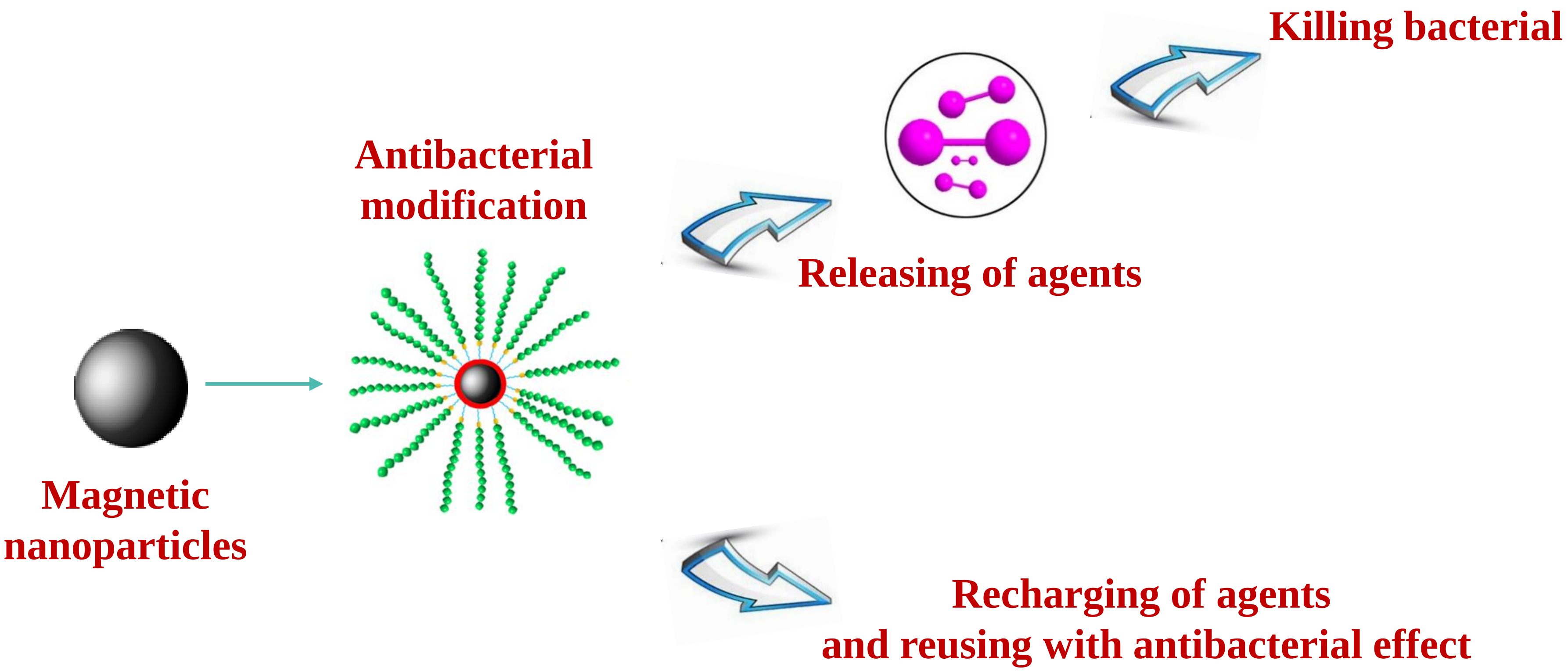
- Dangerous microbial threats on human health and safety is one of the most serious public concern
- Antibacterial materials that can effectively inhibit or eliminate the growth of microorganisms have become very attractive in scientific researches
- People have great interest in using convenient and effective antimicrobial materials
- Bactericidal agents (Ag, chitosan, N-halamine…) has been developed in nanomaterials but still have disadvantage issues

Approaching and idea

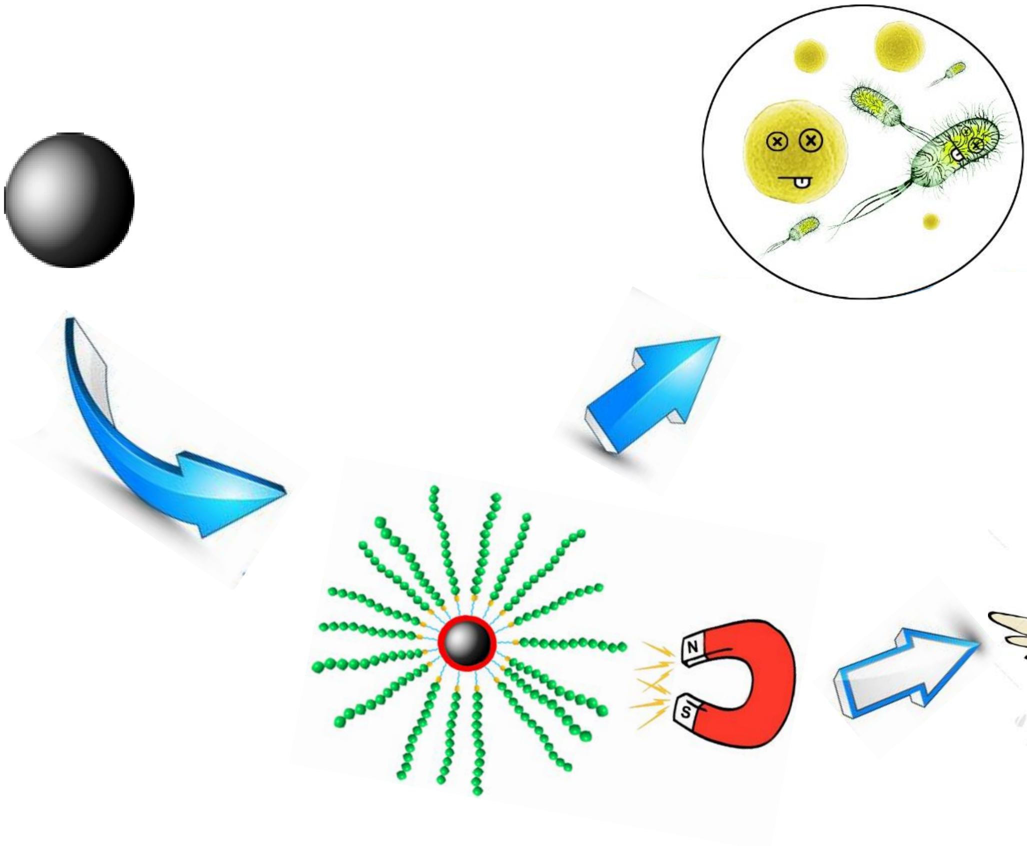


Targeted transport of antibacterial agent
by using captured-agent magnetic nanoparticles

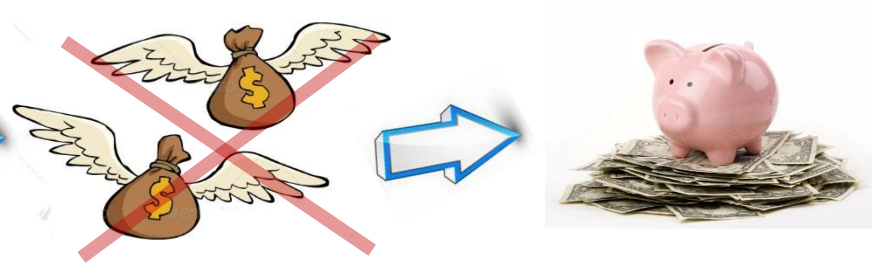
Approaching and idea



Summary



Targeted and rechargeable bactericidal magnetic nanoparticles



Thank You !

National Taiwan University of Science and Technology

Application of Nanotechnology for Human Immunodeficiency Virus (HIV) Treatment

ID: D10304801
Osman Ahmed

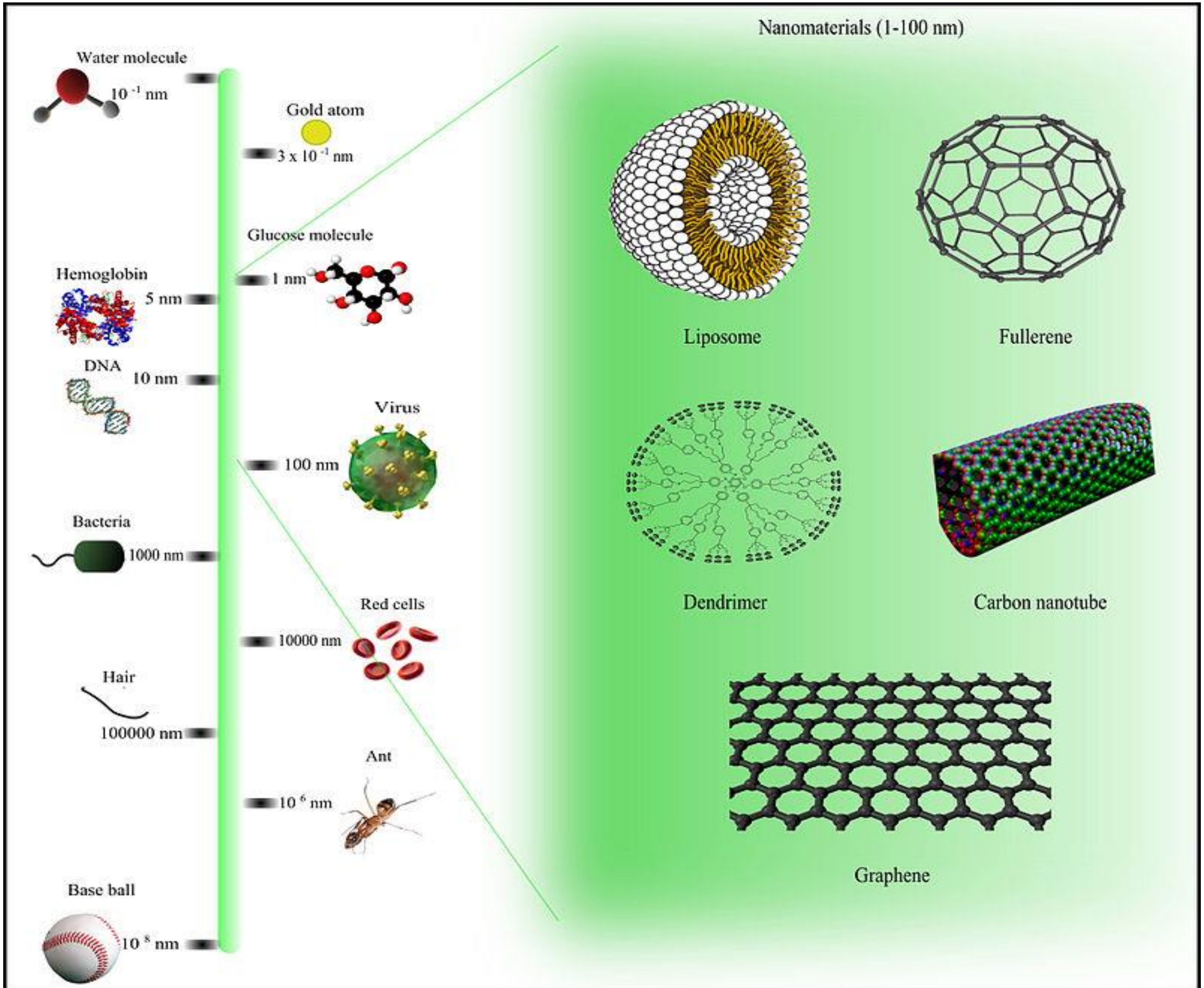
Outlines

- Introduction
- Applications of nanotechnology
- Nanomedicine and its applications
- Nanoparticles in anti-HIV/AIDS drug delivery
- Conclusions

1. Introduction

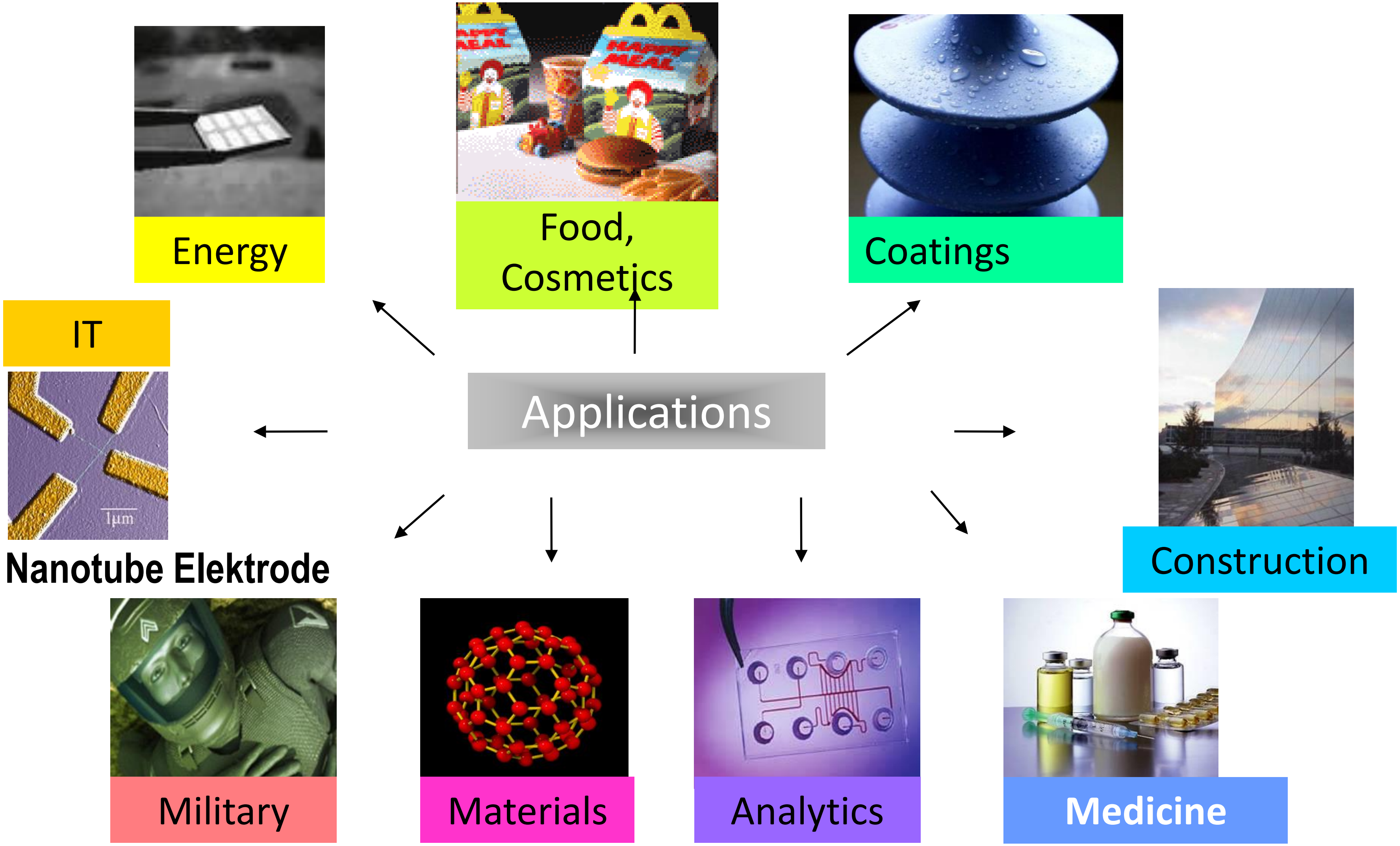
- Nanotechnology is a science & technology conducted at the nanoscale(1-100nm).

- It is the creation of functional devices in nm scale & the exploitation of the unique properties of these devices in various fields.



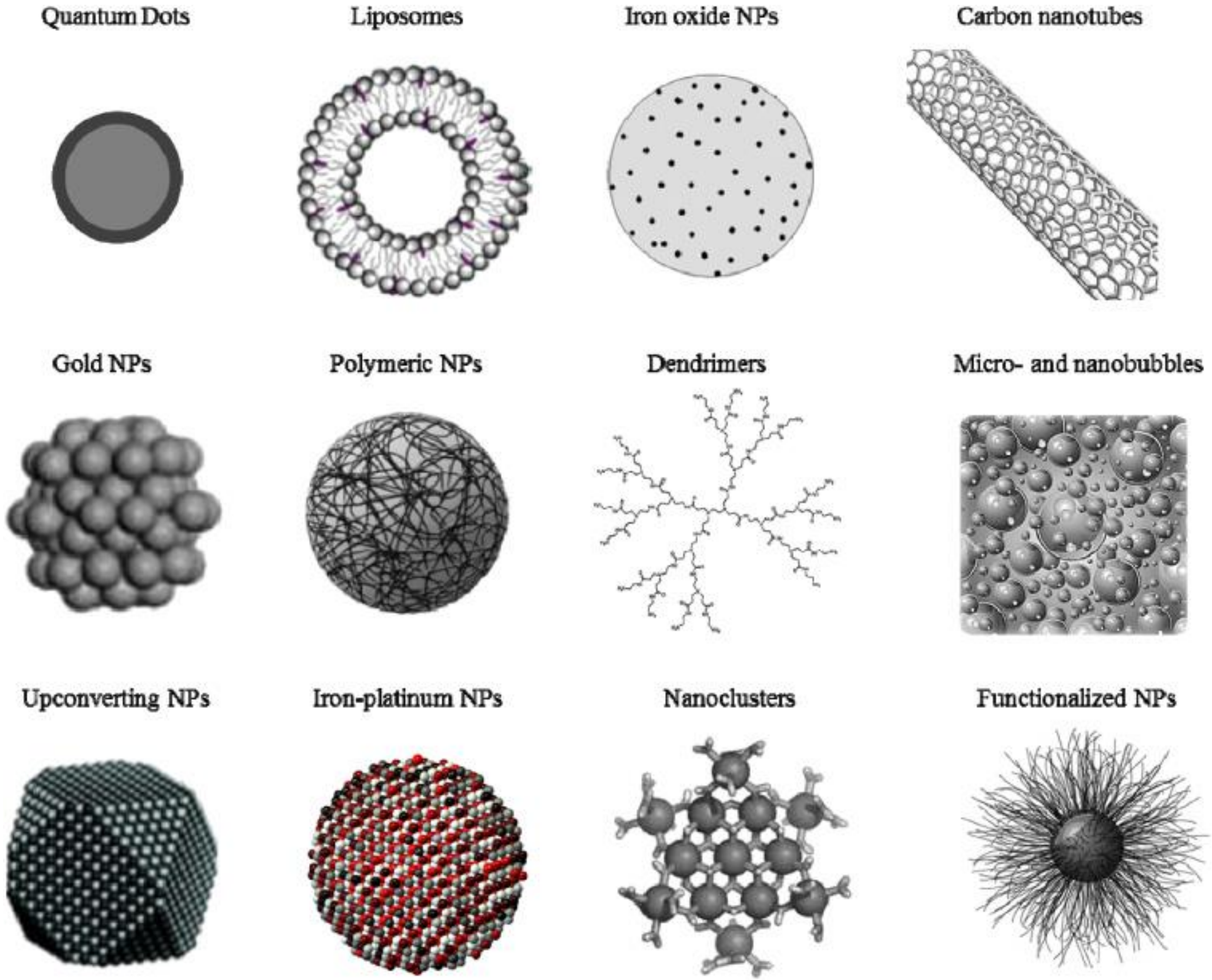
http://en.wikipedia.org/wiki/Nanotechnology

2. Applications of Nanotechnology

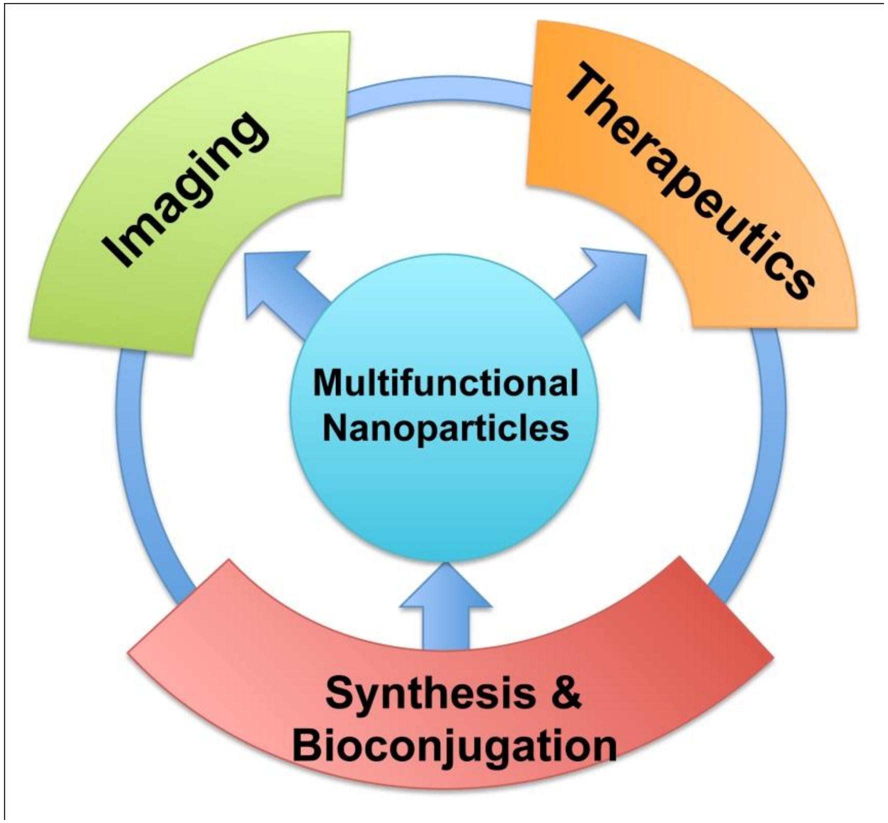


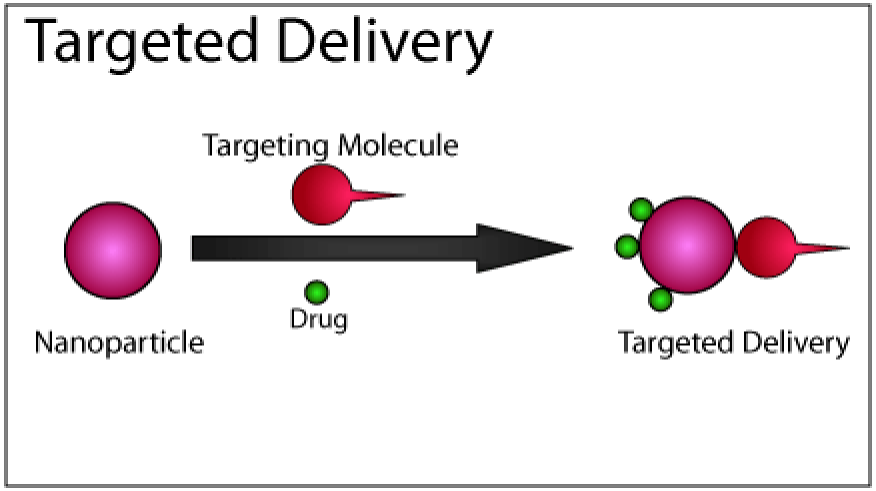
3. Nanomedicine and its applications

- Nanomedicine is the applications of nano-scale technologies to the practice of medicine.
- used for treatment, diagnostic, monitoring and controlling of biological systems.
- It also includes
  - ✓delivery and targeting
  - ✓ pharmaceutical,
  - ✓therapeutic, and
  - ✓diagnostic agents using nanoparticles to cancer and other cells



F, Moresco R, Masserini M. Nanoparticles for neuroimaging. Journal of Physics D: Applied Physics. 2012;45(7):073001.





http://www.intechopen.com/books/biomedicalengineering-from-theory-toapplications/nanoparticles-inbiomedical-applications-and-their-safety-concerns

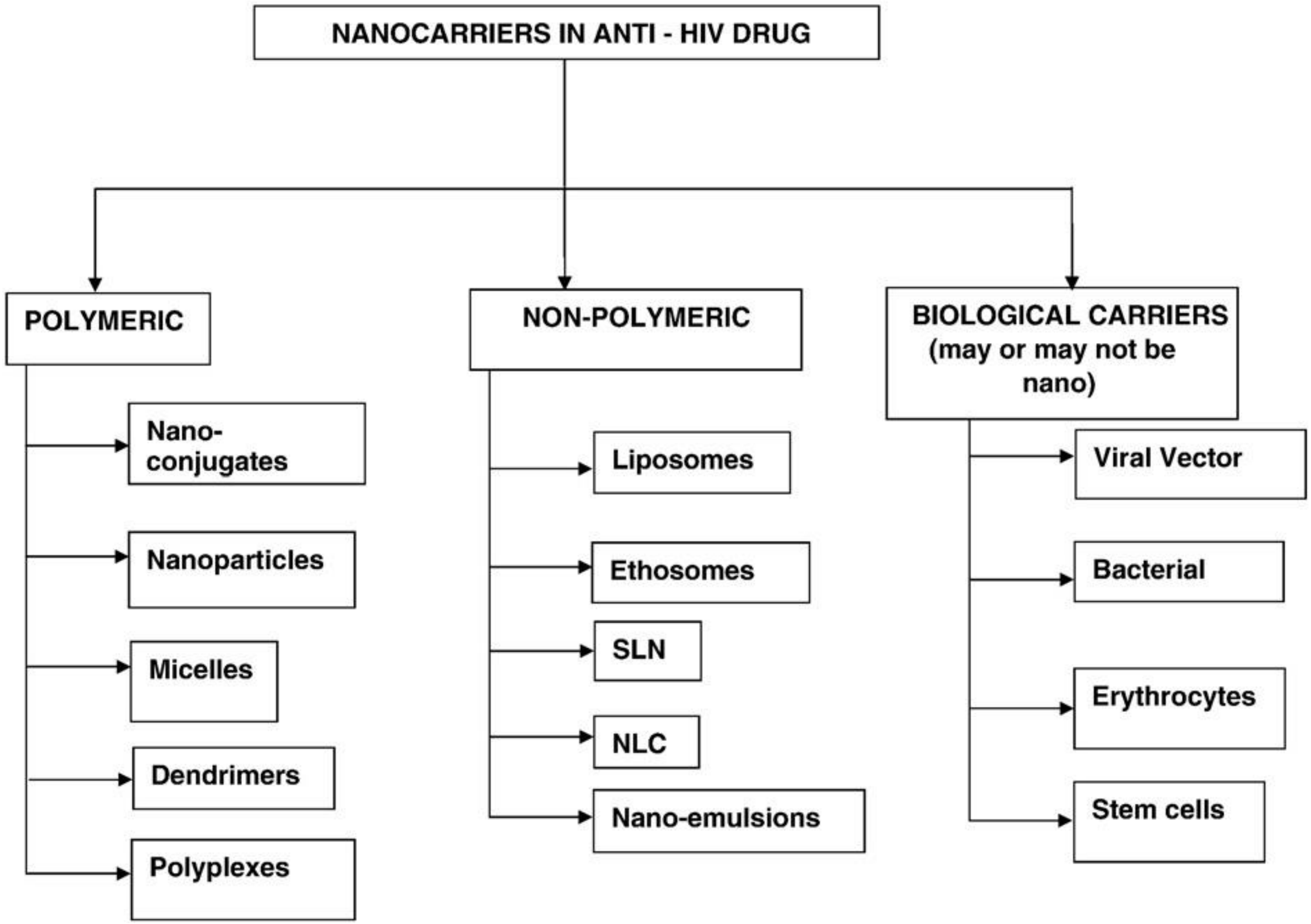
4. Nanoparticles in anti-HIV/AIDS drug delivery

- Nowadays, effective drug delivery has emerged as a major concern for treatment of diseases like,
  - ✓ cardiovascular disorders
  - ✓ cancer
  - ✓ Malaria
  - ✓ HIV/ AIDS etc. , which primarily require systemically administered therapies.
- effective drug delivery is to assure greater fractional distribution of the therapeutic agent at the target site.
- none or negligible distribution at the non-target site in the body.
- As a result, nanotechnology is gaining prominence globally.

Cont…

- The nanometric size of carrier systems allows
  - ✓ efficient crossing of biological barriers,
  - ✓ improved cellular uptake and transport,
  - ✓ enabling efficient delivery of the therapeutic agents to the target sites like liver, brain and solid tumor.

- There is a wide range of nanoparticulate carriers used in the anti HIV/AIDS drug delivery.

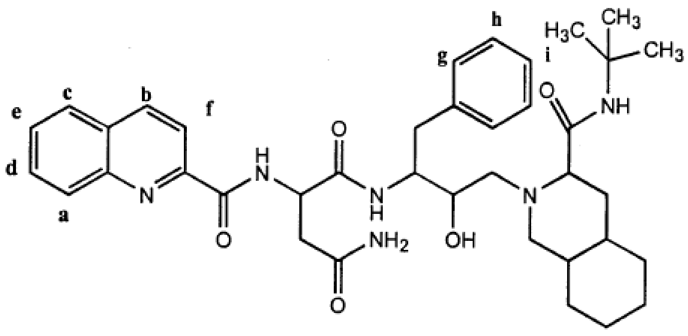

NANOCARRIERS IN ANTI - HIV DRUG
POLYMERIC
Nano-conjugates
Nanoparticles
Micelles
Dendrimers
Polyplexes
NON-POLYMERIC
Liposomes
Ethosomes
SLN
NLC
Nano-emulsions
BIOLOGICAL CARRIERS (may or may not be nano)
Viral Vector
Bacterial
Erythrocytes
Stem cells

4.1 Nanoparticles applications in anti-HIV/AIDS drug delivery

- Improving physico-chemical properties of HIV drugs

✓ Effective oral administration of Saquinavir is a challenge.

✓ It has poor solubility (35 µg/ml).

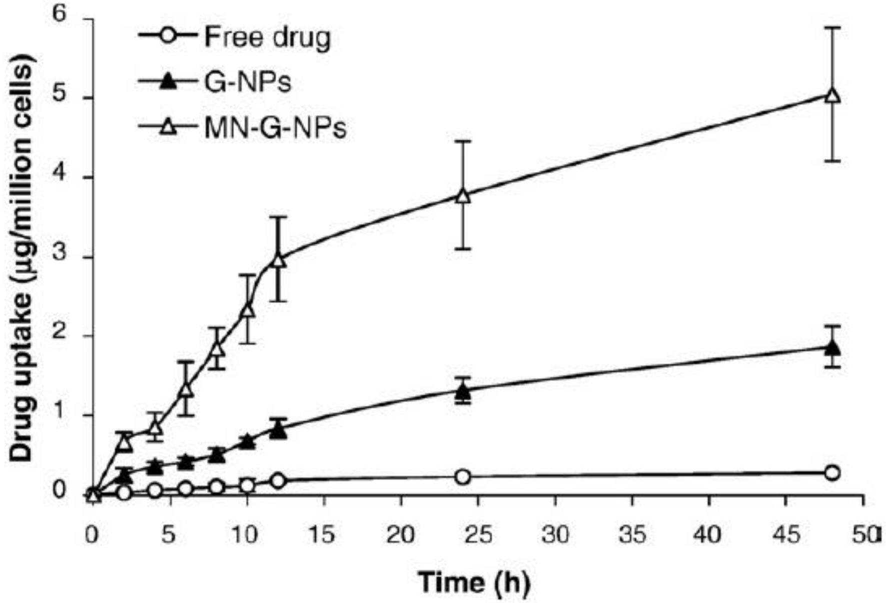


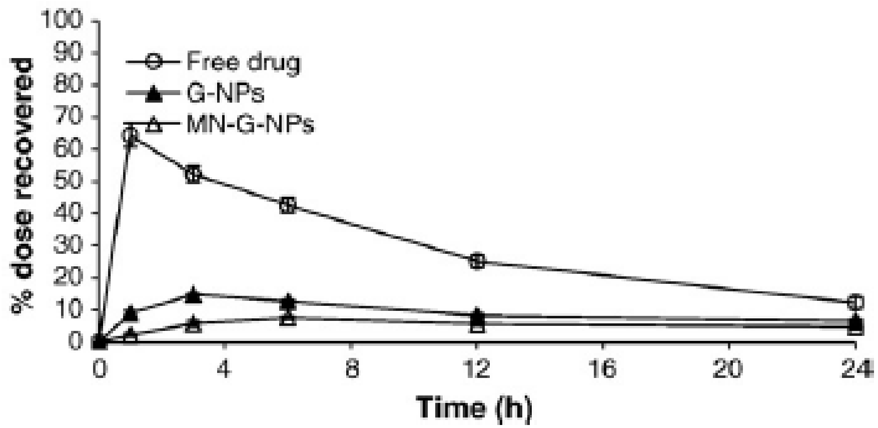
Saquinavir

✓ **Solubility increased 400 fold** through encapsulation in cyclodextrin and polyalkylcyanoacrylate nanoparticles (15.8 mg/ml)

Boudad, H., Legrand, P., Lebas, G., Cheron, M., Duchêne, D., & Ponchel, G. (2001). Combined hydroxypropyl-β-cyclodextrin and poly(alkylcyanoacrylate) nanoparticles intended for oral administration of saquinavir. *International Journal of Pharmaceutics, 218*(1-2), 113-124.

▪Improving cellular and organ concentrations of HIV drugs





18 fold increase in uptake of Didanosine in macrophages following encapsulation in nanoparticles (mannosylated)

Jain, S. K., Gupta, Y., Jain, A., Saxena, A. R., Khare, P., & Jain, A. (2008). Mannosylated gelatin nanoparticles bearing an anti-HIV drug didanosine for site-specific delivery. *Nanomedicine : nanotechnology, biology, and medicine, 4*(1), 41-48.

Conclusions

- ✓ Nanotechnology has a wide application.
- ✓ Nanomedicine offers new prospects for HIV efficacy.
- ✓ more experiments and technologies are required for nanomedicines HIV treatment.

Thank you

References

1. http://en.wikipedia.org/wiki/Nanotechnology
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6. http://www.nanoed.org/concepts_apps/AuNanoShells/InDepthIntroPg1.html#InDepthIntro
7. Jain, S. K., Gupta, Y., Jain, A., Saxena, A. R., Khare, P., & Jain, A. (2008). Mannosylated gelatin nanoparticles bearing an anti-HIV drug didanosine for site-specific delivery. Nanomedicine : nanotechnology, biology, and medicine, 4(1), 41-48.
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10. José das Neves a, Mansoor M. Amiji b, Maria Fernanda Bahia a, Bruno Sarmento. Nanotechnology-based systems for the treatment and prevention of HIV/AIDS, Advanced Drug Delivery, Reviews, 2010, 62 458–477.

Self-illuminating Rainbow Plants

Reza Mohammadinejad Prof. Hosseinkhani

Biotechnology

Nanotechnology

GIFT

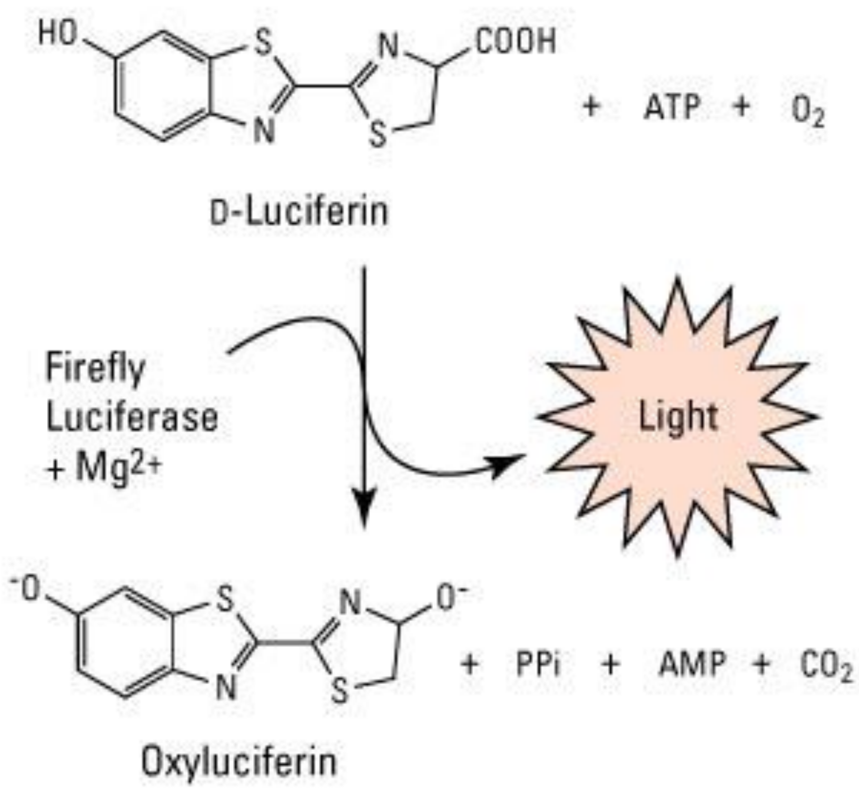
Bioluminescence is the production and emission of light by a living organism.

Bioluminescence occurs widely in marine vertebrates and invertebrates, as well as in some fungi, microorganisms including some bioluminescent bacteria and terrestrial invertebrates such as fireflies.

In some animals, the light is produced by symbiotic organisms such as *Vibrio* bacteria.

The principal chemical reaction in bioluminescence involves the light-emitting pigment luciferin and the enzyme luciferase.

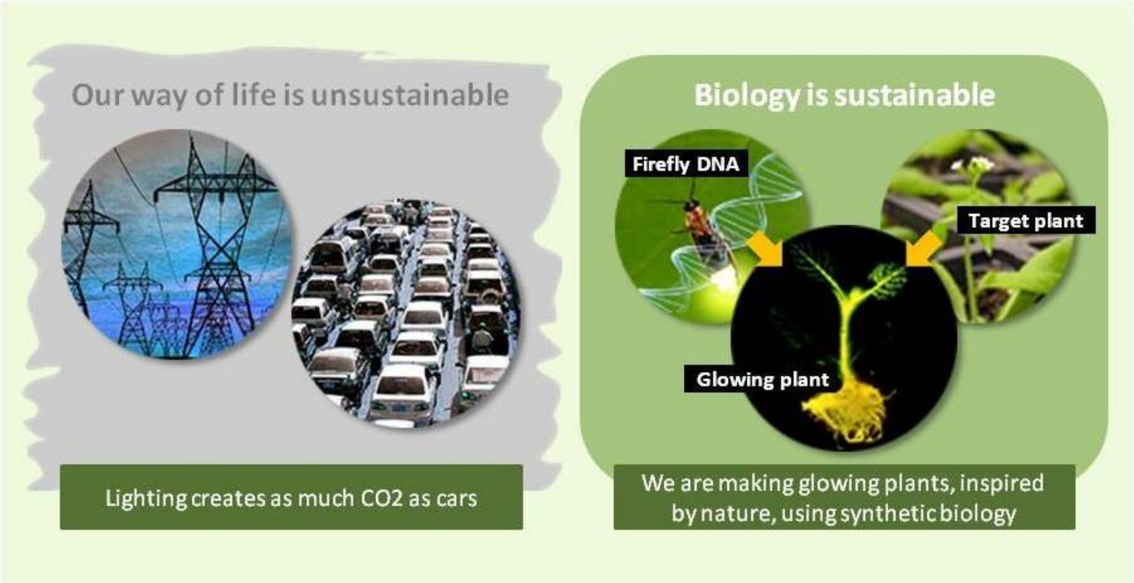
The enzyme catalyzes the oxidation of luciferin.



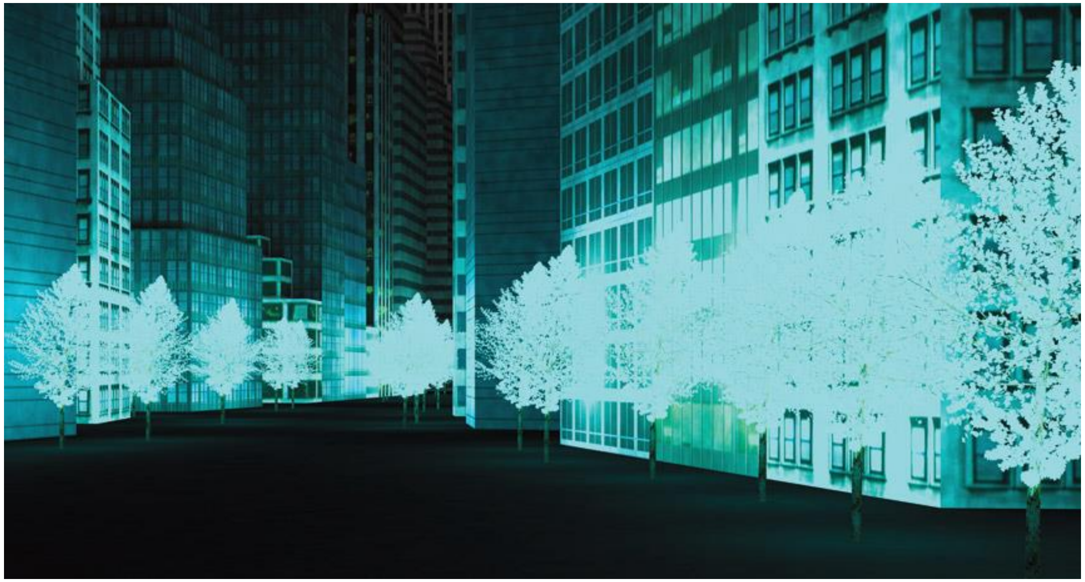
Biotechnology

Transgenic Autoluminescent Plants

Prospects of obtaining plants glowing in the dark have captivated the imagination of scientists and layman alike.
While light emission has been developed into a useful marker of gene expression, bioluminescence in plants remained dependent on externally supplied substrate.



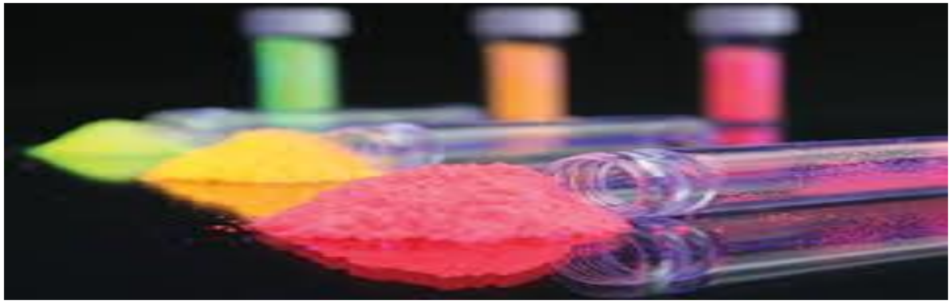
Alexander Krichevsky and co-workers generated the first autonomously luminescent (autoluminescent) transplastomic plants, containing a fully functional bacterial luciferase pathway, which emits visible light detectable by the naked eye



End of the street lamp? Glowing trees inspired by fireflies could soon light up our night skies

Nanotechnology

Self-illuminating Quantum dot

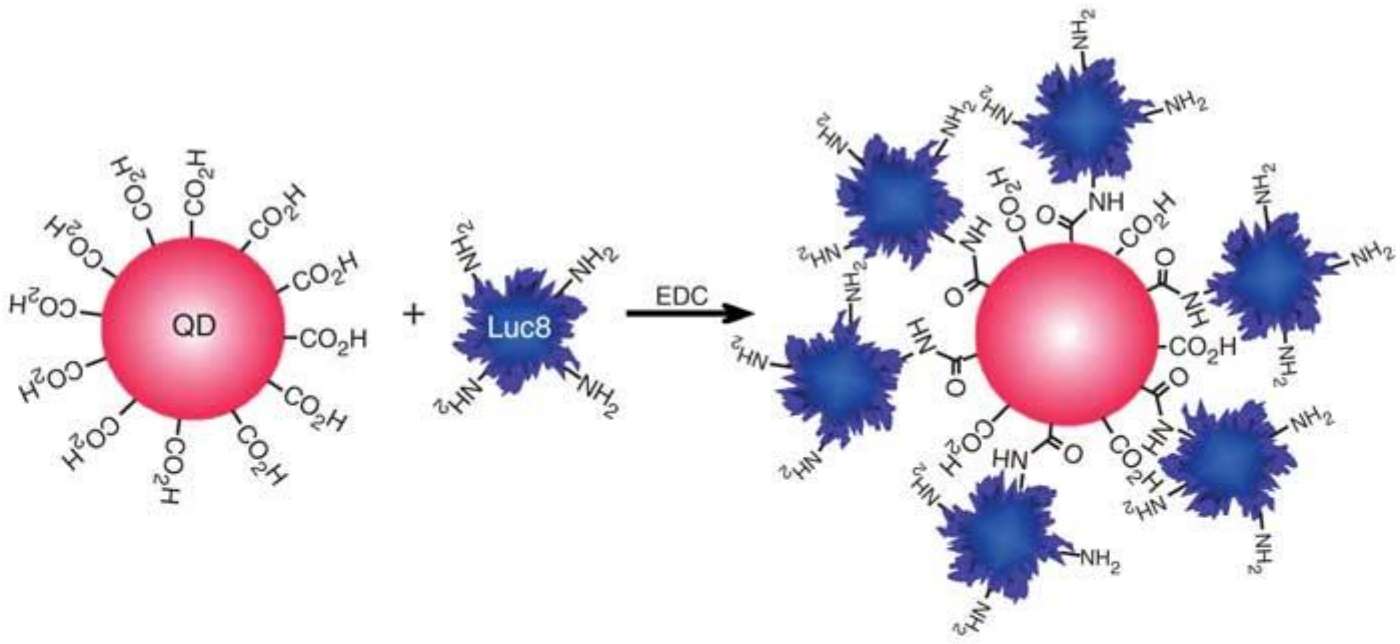


Fluorescent semiconductor quantum dots hold great potential for molecular imaging in vivo.

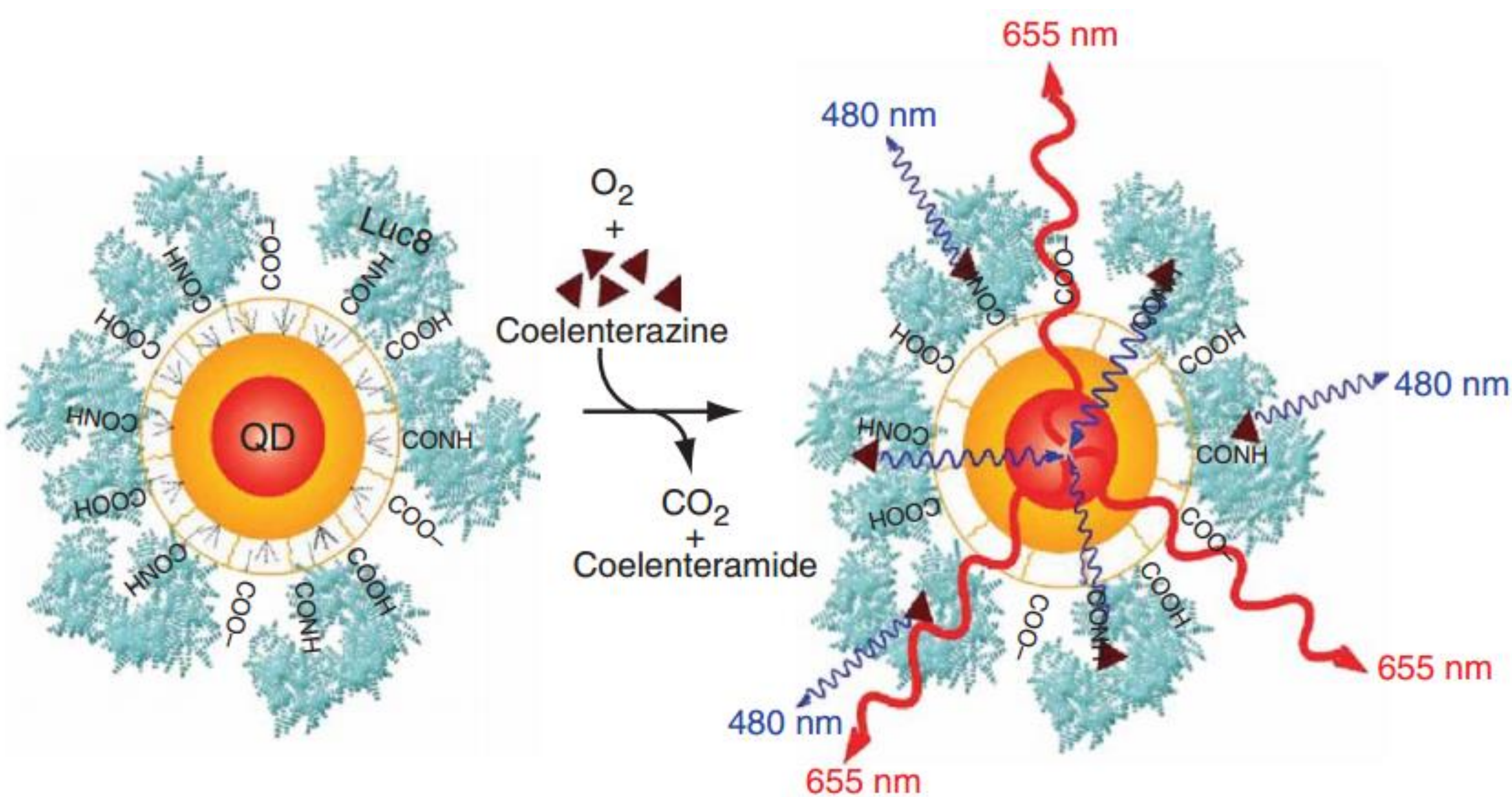
However, the utility of existing quantum dots for in vivo imaging is limited **because they require excitation from external illumination sources to fluoresce**.

Min-Kyung So and co-workers presented quantum dot conjugates that luminesce by bioluminescence resonance energy transfer in the absence of external excitation.

The conjugates are prepared by coupling quantum dots to a mutant of the bioluminescent protein *Renilla reniformis* luciferase.

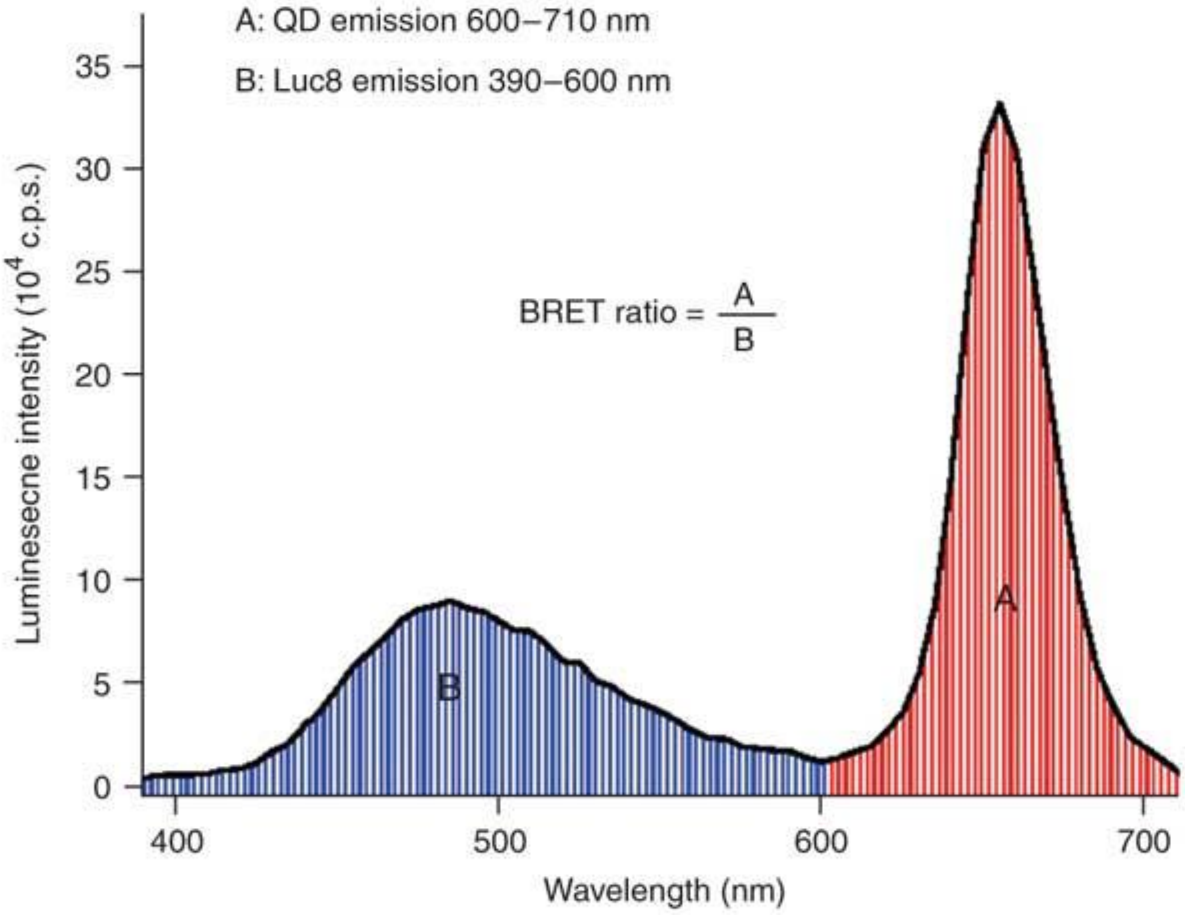


conjugation of the bioluminescence protein Luc8 to quantum dots (QD)

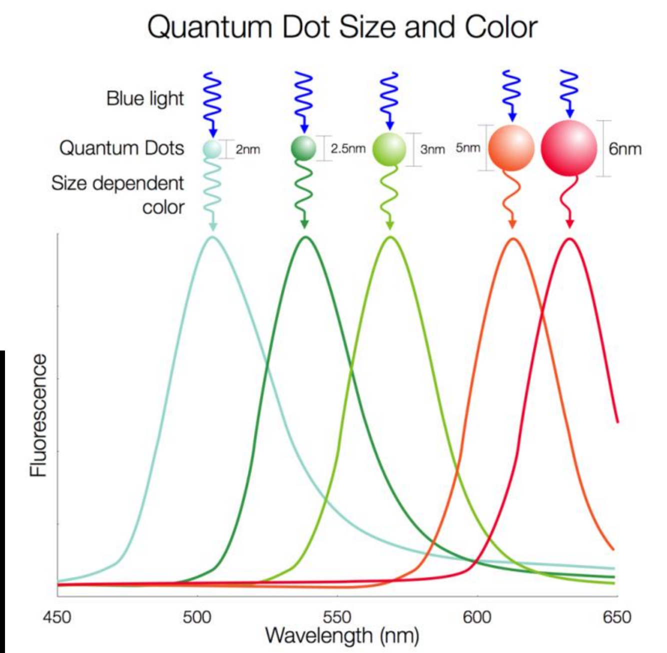


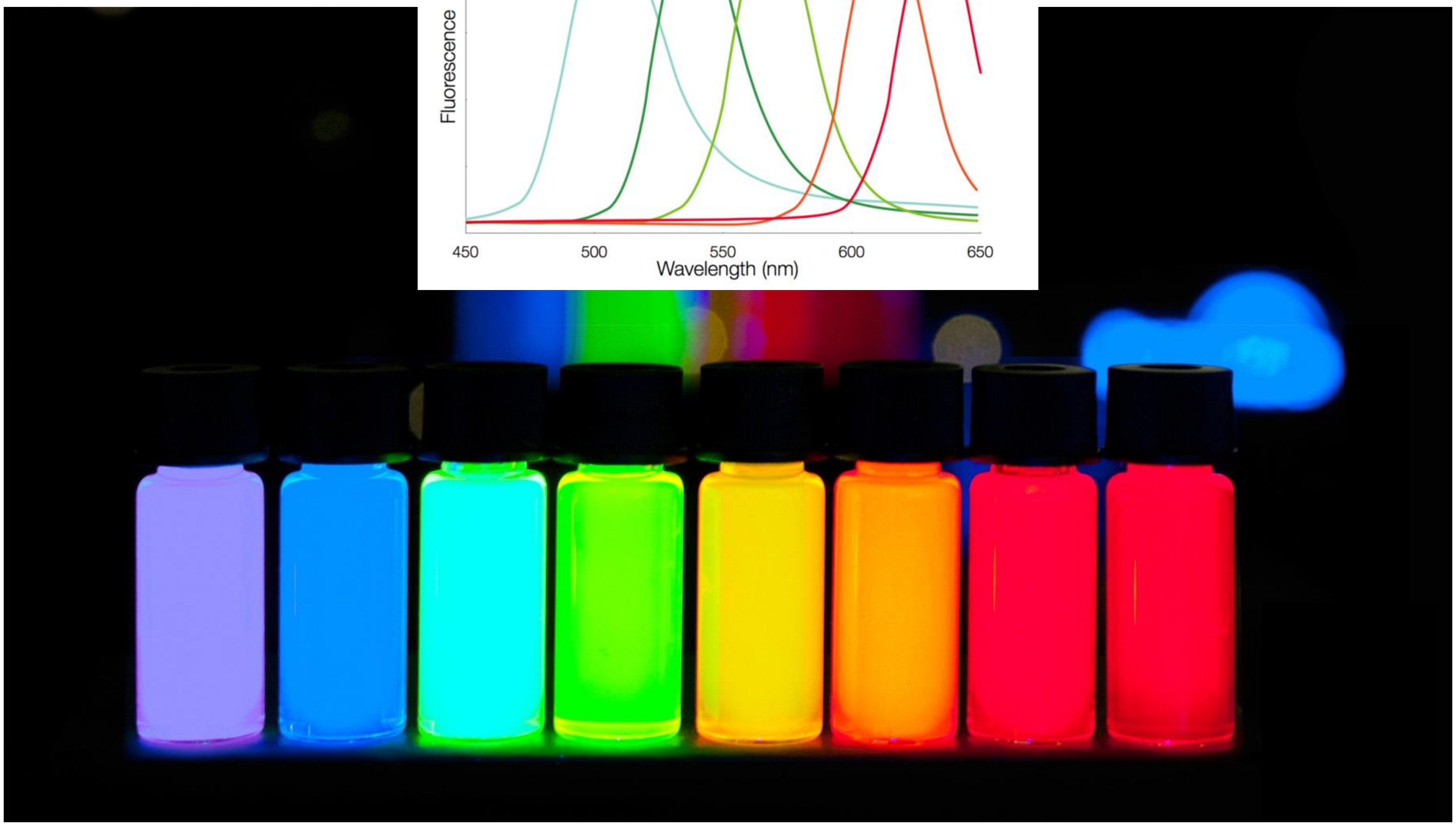
The bioluminescence energy of Luc8-catalyzed oxidation of coelenterazine is transferred to the quantum dots, resulting in quantum dot emission.

Luminescence emission spectrum of self-illuminating quantum dot conjugates



Area A is the integrated total emission (600–710 nm) from the quantum dots; area B is the integrated total emission from Luc8 (390–600 nm)


Quantum Dot Size and Color
Blue light
Quantum Dots
Size dependent color
2nm
2.5nm
3nm
5nm
6nm
Fluorescence
450
500
550
600
650
Wavelength (nm)



Self-illuminating Rainbow Plants

Key References:

Krichevsky A, Meyers B, Vainstein A, Maliga P, Citovsky V (2010) Autoluminescent Plants. PLoS ONE 5(11): e15461. doi:10.1371/journal.pone.0015461

So M.K, Xu C, Loening A.M, Gambhir S.S, Jianghong R (2006) Self-illuminating quantum dot conjugates for in vivo imaging. Nature Biotechnology 339 - 343. doi:10.1038/nbt1188

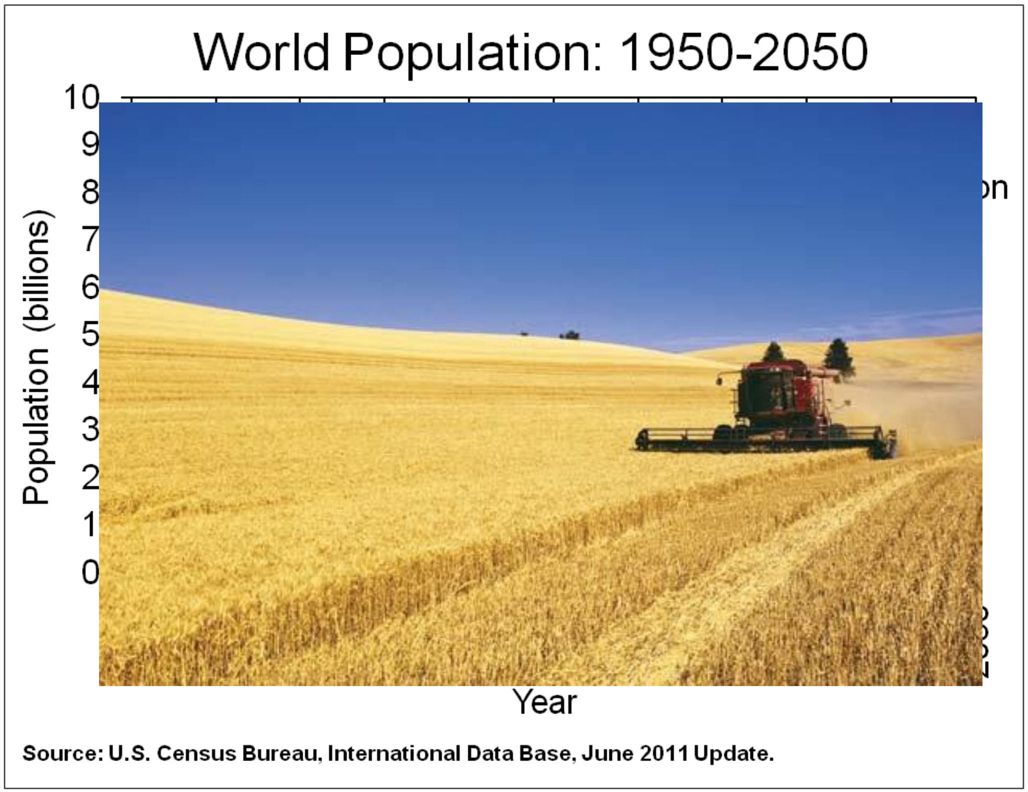
THANK YOU

Idea

3D-tomography of non-uniform porous channel

Rusdy Zulfan (R02524100)

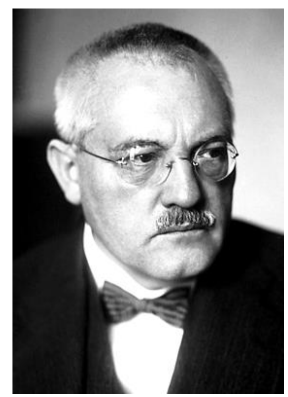
History



Fritz Haber (Nobel 1919)

$$N_2 + 3H_2 \rightarrow 2NH_3$$

Note :
Osmium catalyst

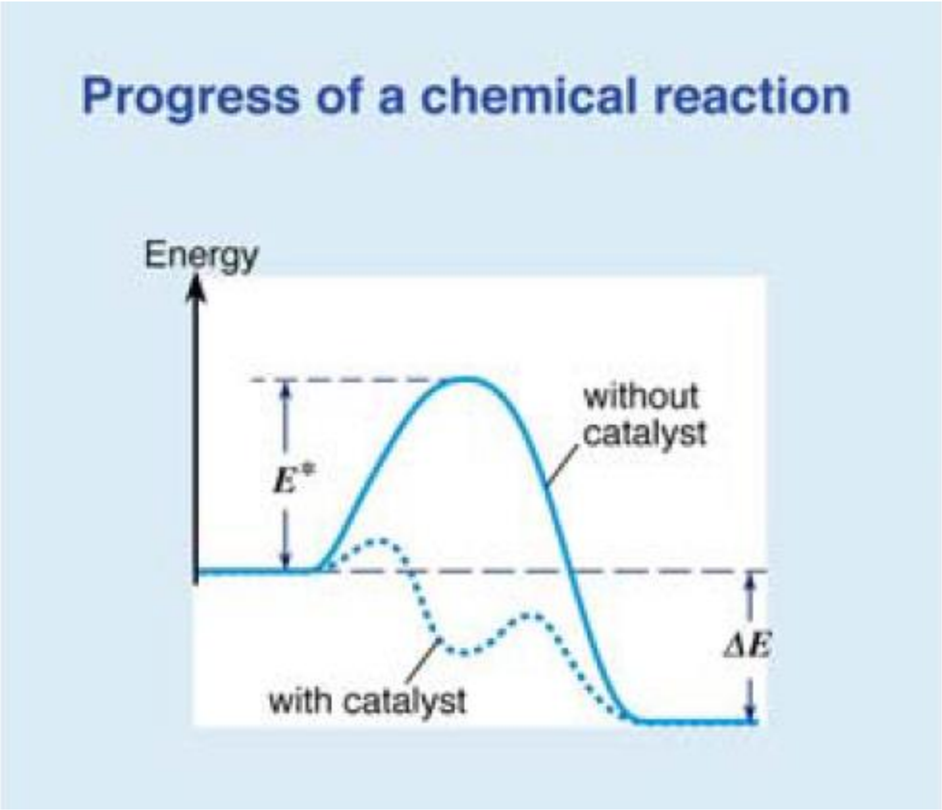


Carl Bosch (Nobel 1931)

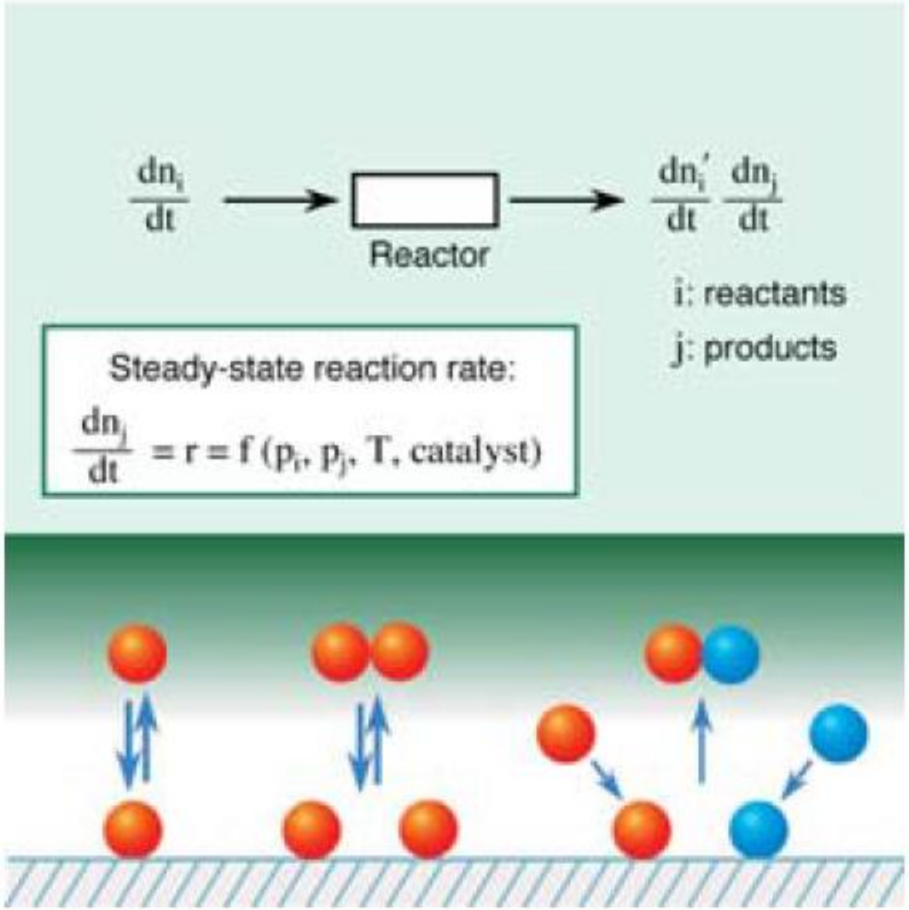
Invention & Development
Chemical high pressure methods

Note :
$Fe\text{-}Al_2O_3$

Principles of catalysis



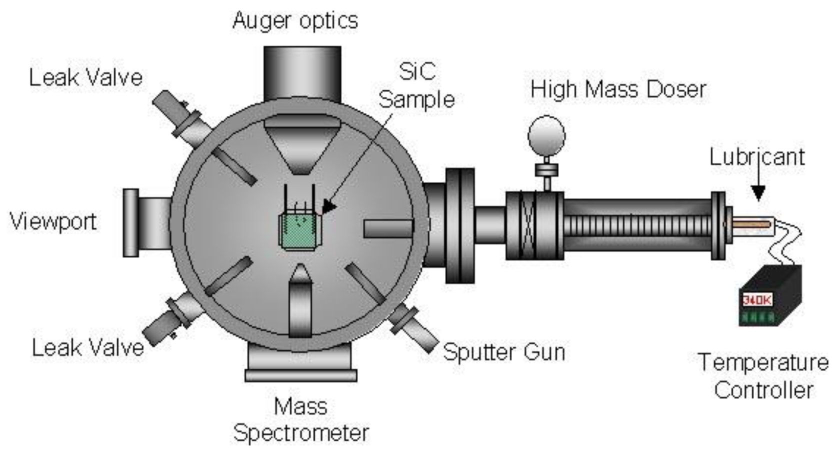
Heterogeneous catalysis



Surface science approach to Heterogeneous Catalysis : Ammonia Synthesis

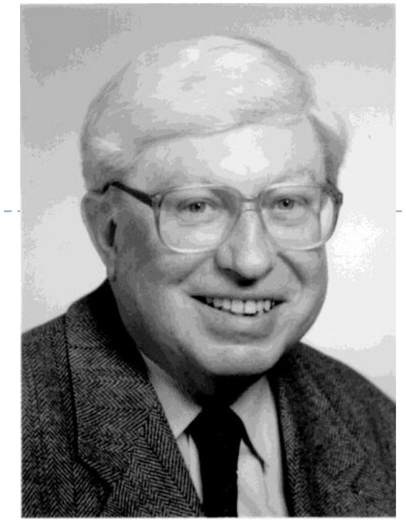
Mittasch proposed :
- Metallic iron act as 'electronic' promoter
- Framework of Al_2O_3 act as 'structural' promotor

Langmuir (Nobel 1932) :
"Most finely divided catalysts must have structures of great complexity. In order to simplify our theoretical consideration of reactions at surfaces, let us confine our attention to reactions on plane surfaces. If the principles in this case are well understood, it should then be possible to extend the theory to the case of porous bodies. In general, we should look upon the surface as consisting of a checkerboard…"



Ultra High Vacuum (UHV) System

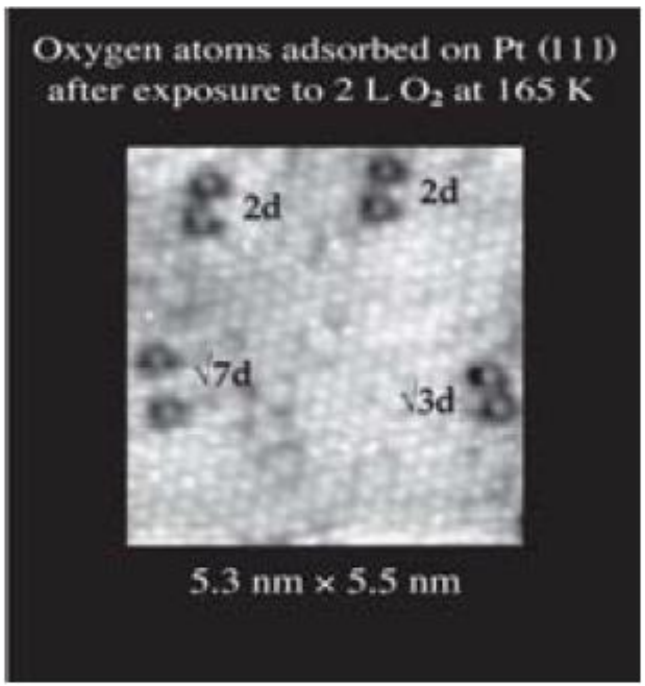
Discovery of UHV by 1960's

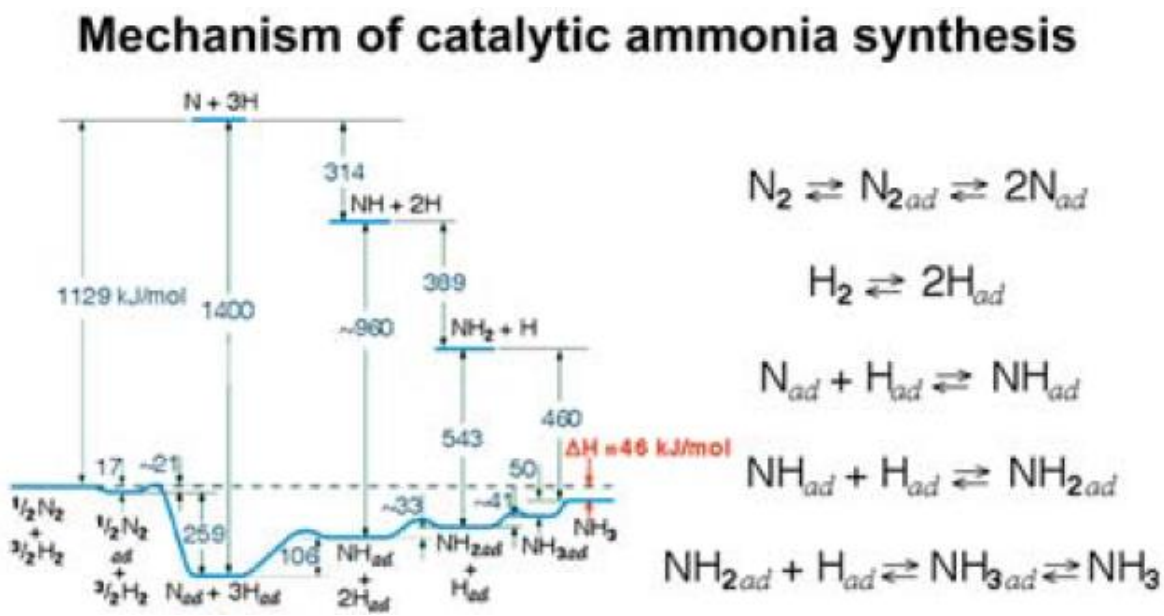


Gerhard ertl (Nobel 2007)

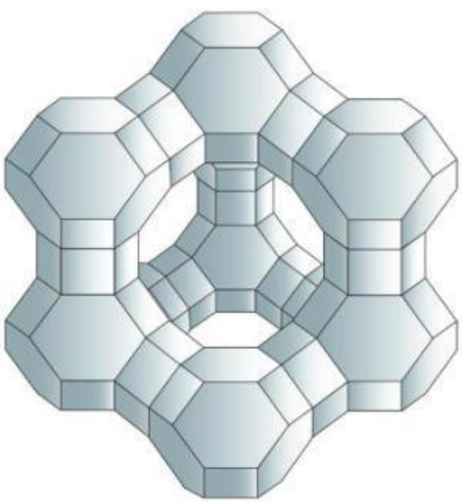
"for his studies of chemical processes on solid surfaces"

Discovery of STM

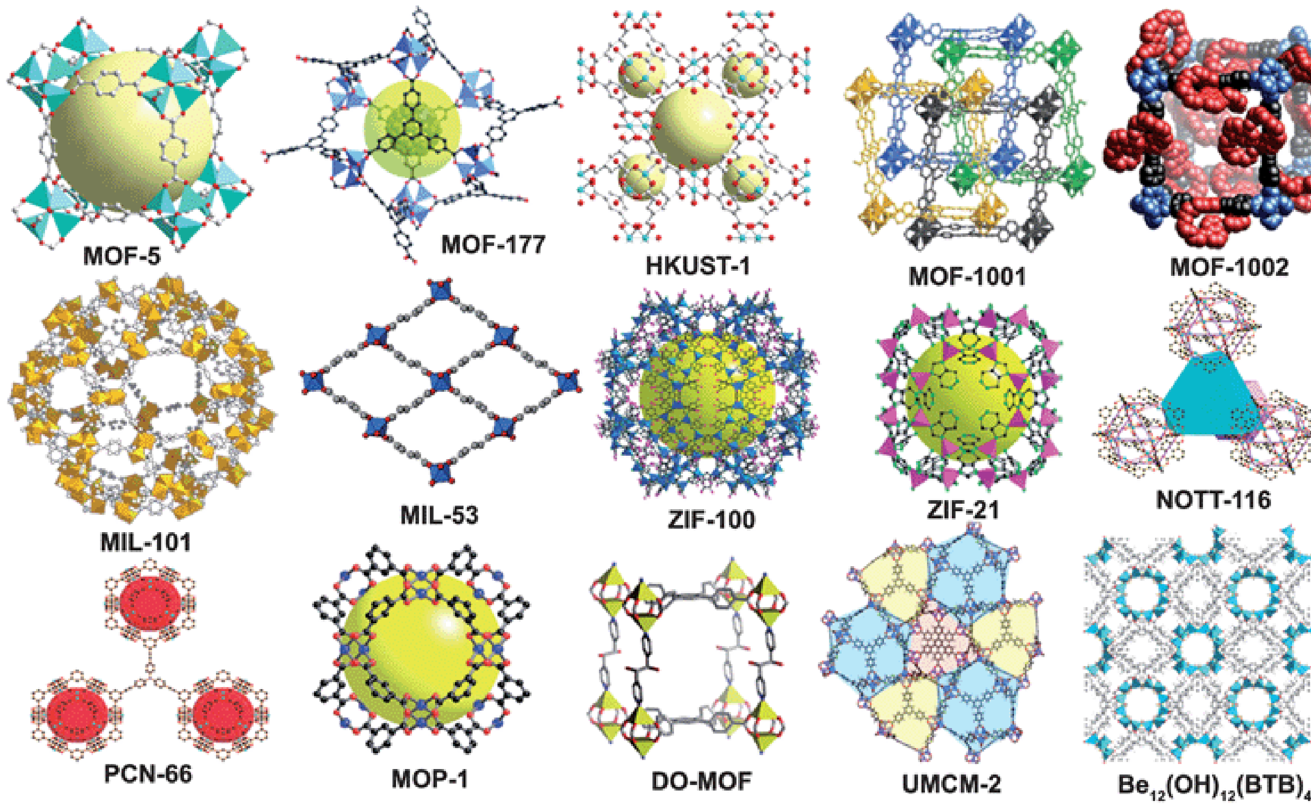




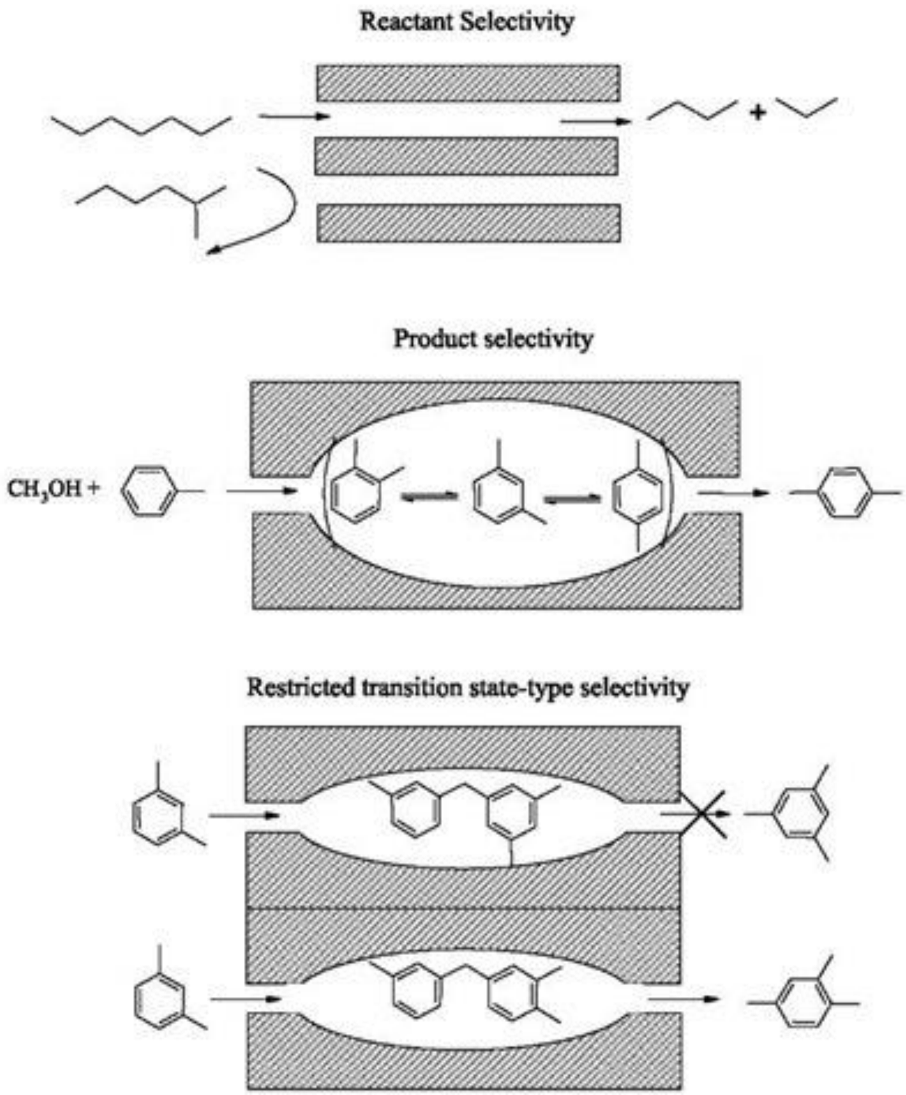
Porous catalysts era



Zeolite Y



Case : zeolite ZSM-5

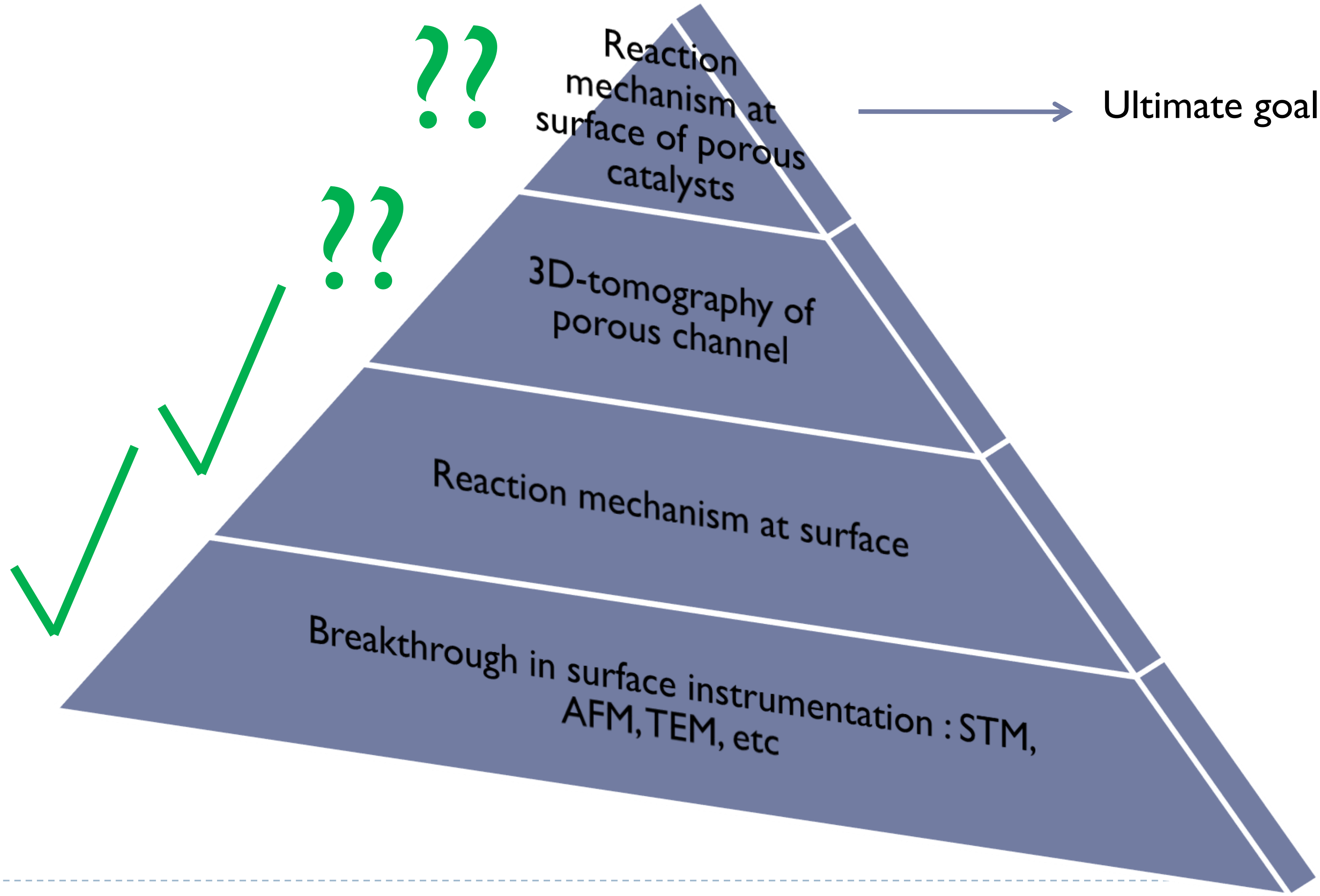


Advantages of porous catalysts (heterogenous)
- Porous catalysts show selectivity
- High specific surface area
- High range of pores size (adjustable)
- Wide range applications

Pore size analysis :

Gas sorption

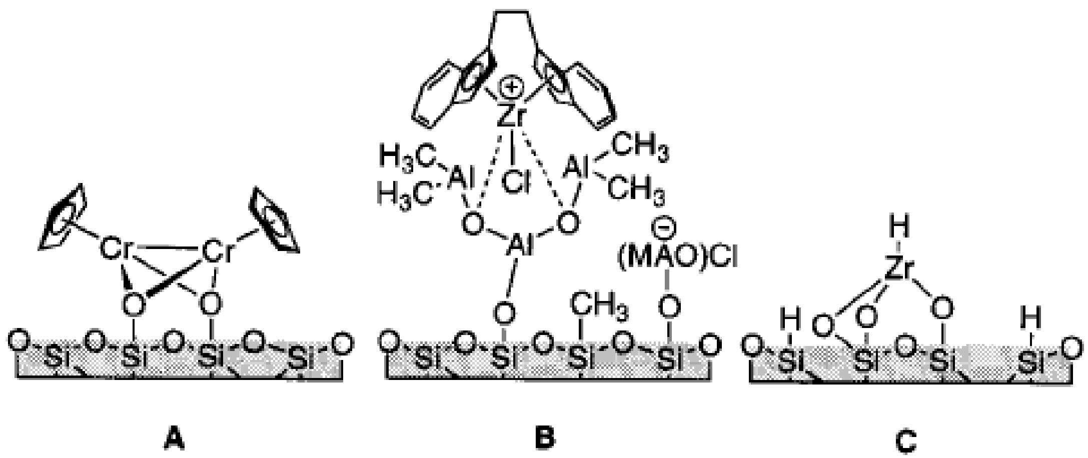
Future Goal



??
??
Reaction mechanism at surface of porous catalysts
3D-tomography of porous channel
Reaction mechanism at surface
Breakthrough in surface instrumentation : STM, AFM, TEM, etc
Ultimate goal

- Introducing concepts:
  - Surface Organometallic Chemistry (SOMC)

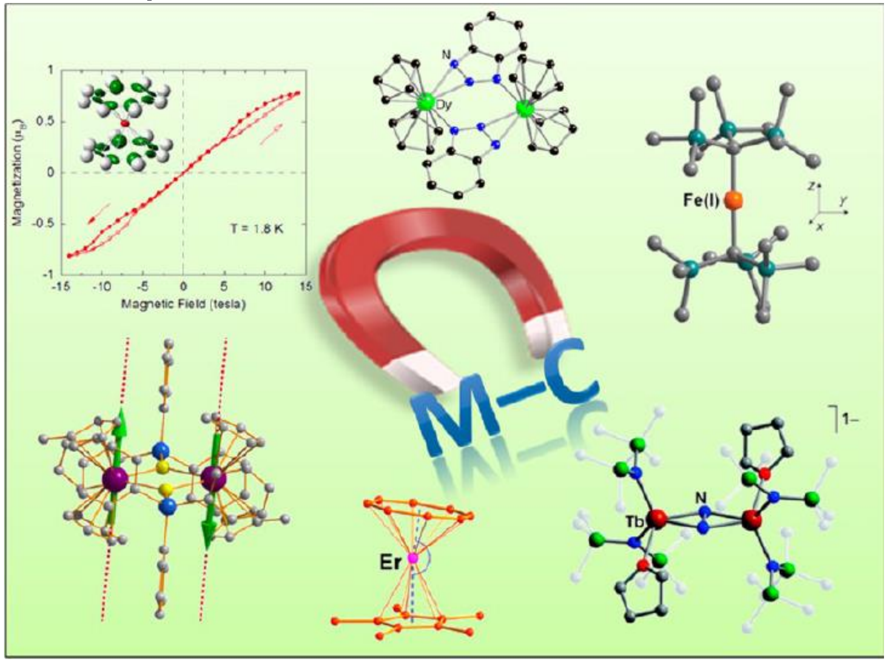
    = postsynthetic derivatization of chemically and thermally robust condensed solid materials with molecularly well-defined organometallic compounds



Highly reactive surface species obtained via SOMC on silica

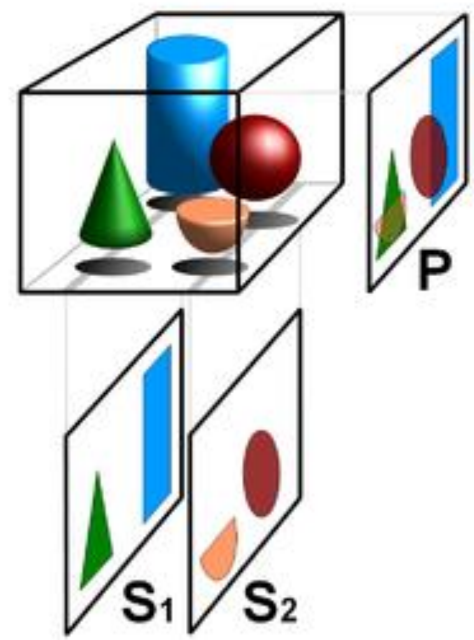
- Introducing concepts:
  - Organometallic Single-Molecule Magnets (SMMs)

    = organometallic molecule which possess ability to retain magnetization for relatively long periods of time in the absence of an applied magnetic field, invariably at very low temperature



- # Introducing concepts:
  - ## Tomography

    = imaging by sections or sectioning, through the use of any kind of penetrating wave

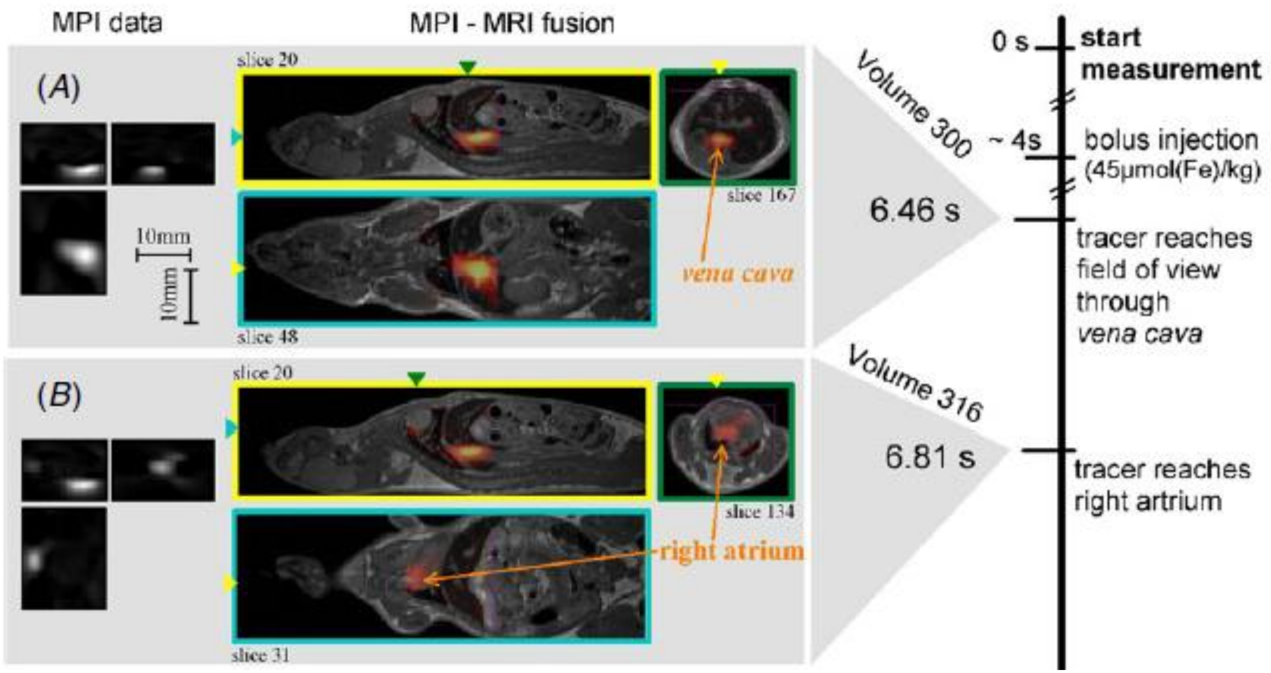


Basic principle of tomography: superposition free tomographic cross sections S_1 and S_2 compared with the projected image P

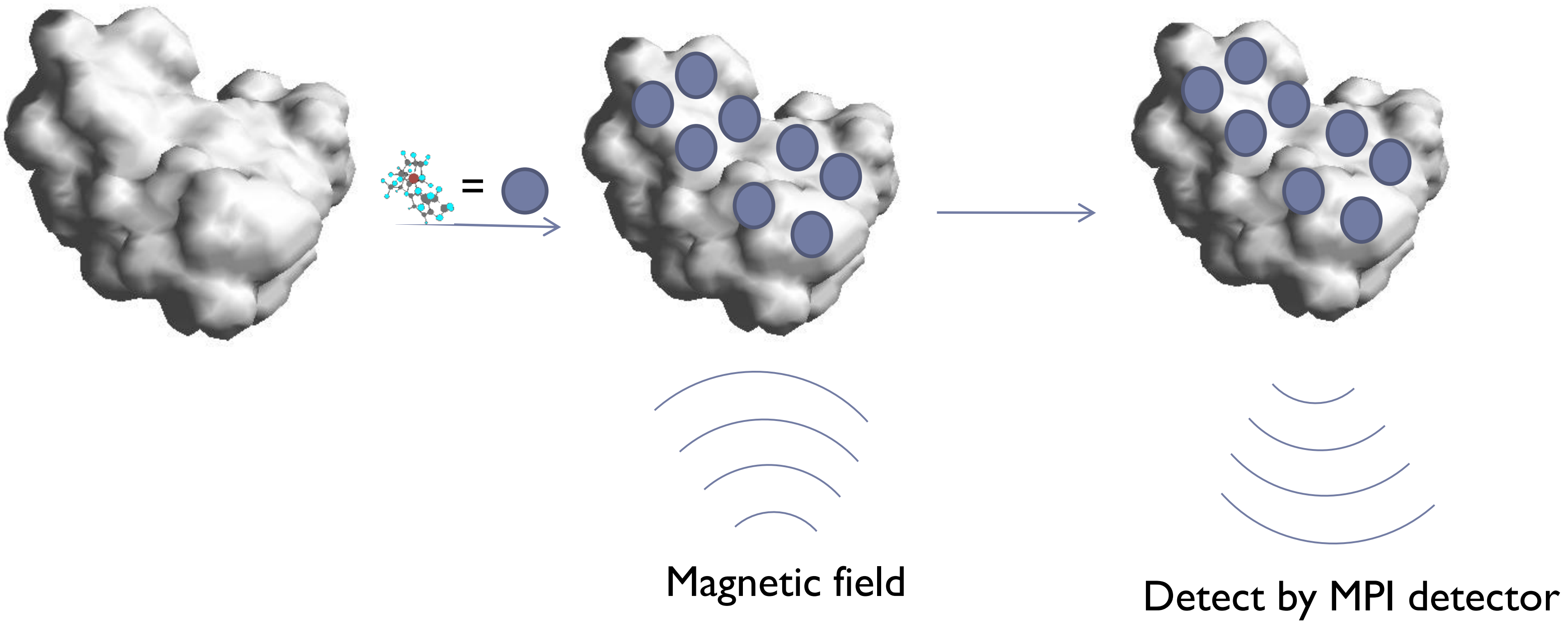
Introducing concepts :

Magnetic Particle Imaging (MPI)

= tomographic imaging method potentially capable of rapid 3D imaging of magnetic tracer materials



Idea



Limitations

- Porous materials
  - High inorganic elements (e.g : porous silica) → able to be functionalized
  - Limited to mesoporous-macroporous → because the size of adsorbate
- Adsorbate
  - Need to small enough, (comparison N_2 = ~1.2 Å) → less ligands, but has single-molecule magnets properties
  - Low boiling points
  - Less interaction between 2 molecules → couldn't form multilayer
- MPI detector
  - 360° detector
- Advanced mathematics skill
  - To deconstruct the EM signal → simulate into 3D images


Thank You

RIFAMPICIN (TB DRUG) MONITORING SENSOR
GK HEALTH SYSTEMS

Sreerupa Sarkar
103011863

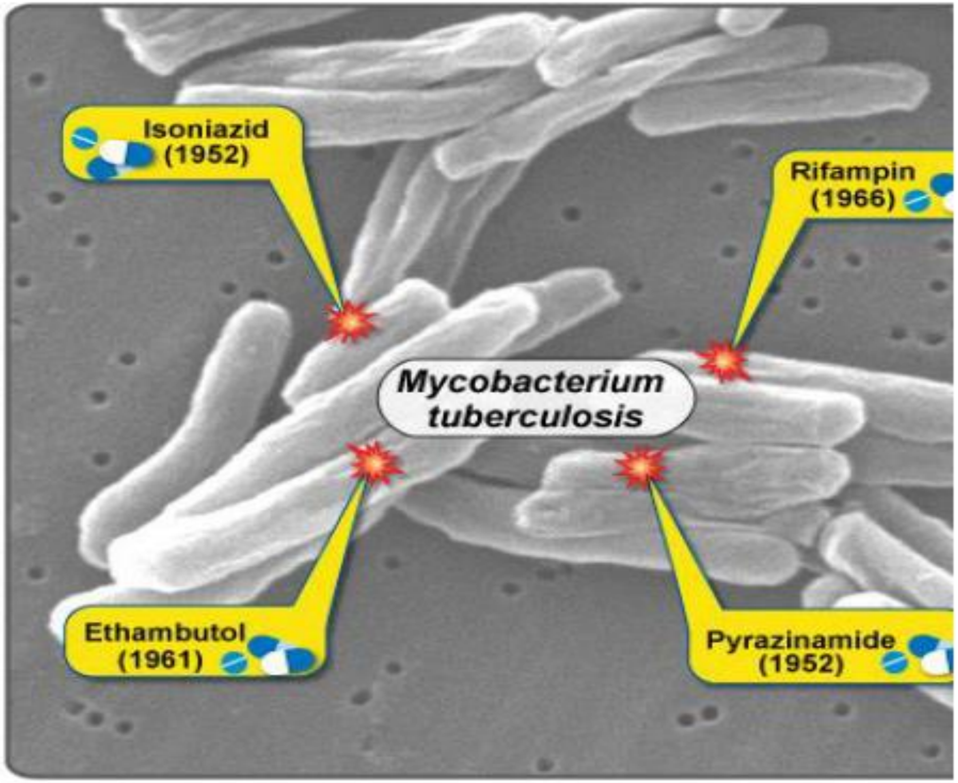
Contents

Introduction

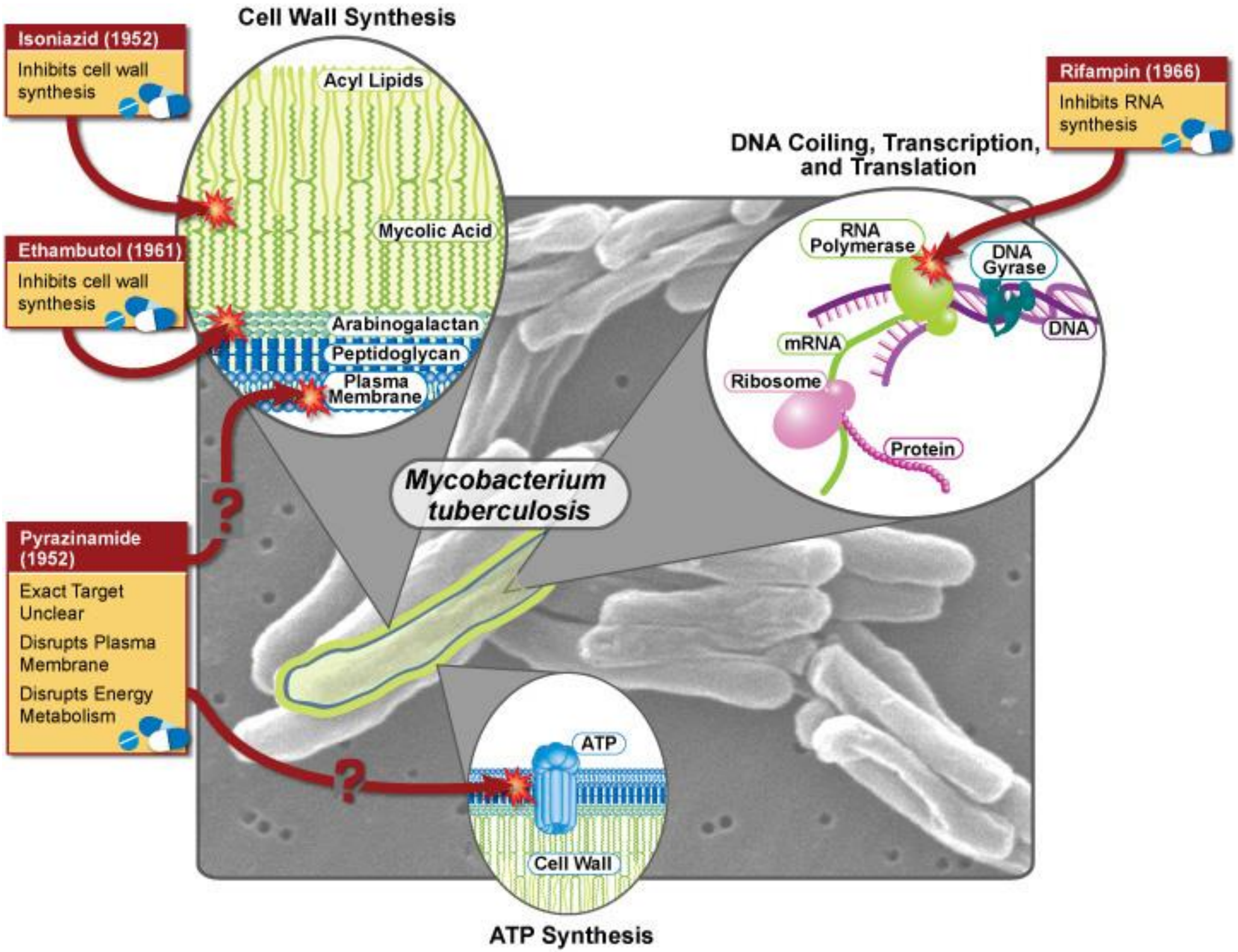
- Tuberculosis is generally caused by *mycobacterium tuberculosis.*
- One-third of the world population is infected with this disease and the rate of spread of infection is as high as one very second.
- More than 20 million people are affected worldwide with nearly 1.5 million associated deaths till 2010.
- The four frontline drugs used for the treatment of TB are isoniazid (INZ), rifampicin (R), ethambutol (E) & Pyrazinamide (P).
- There exists a need to monitor the patients and develop a sensor to monitor that whether the patients are taking the prescribe amount of drug or not??
- The goals and objectives of GK Health Systems is development of a sensor for detection of R possible in quicktime but also it is quite attractive owing to its paper based testing.

TB Drugs

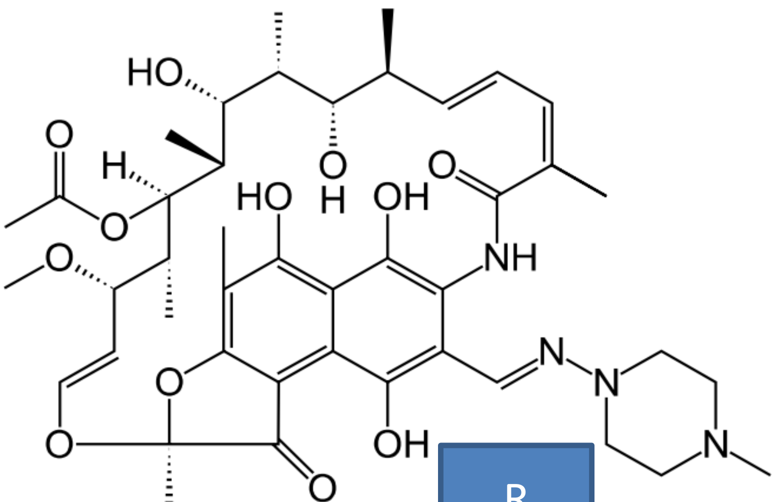
- **Why Rifampicin??**
  - ➢ First line drug for TB
  - ➢ Develops drug-resistant
  - ➢ Dosage adjusted (cause of renal failure)
  - ➢ Needs careful monitoring else can become resistant other drugs need not be adjusted in renal failure)



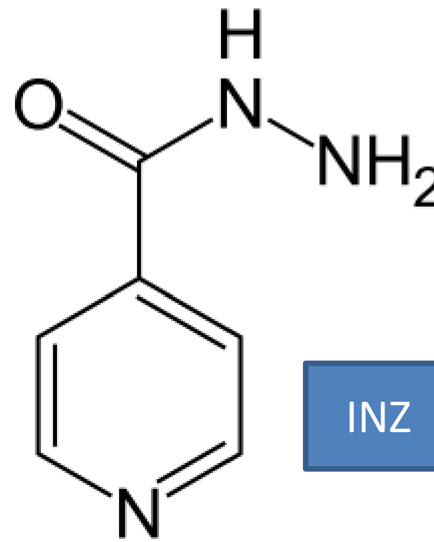
Mode of Action



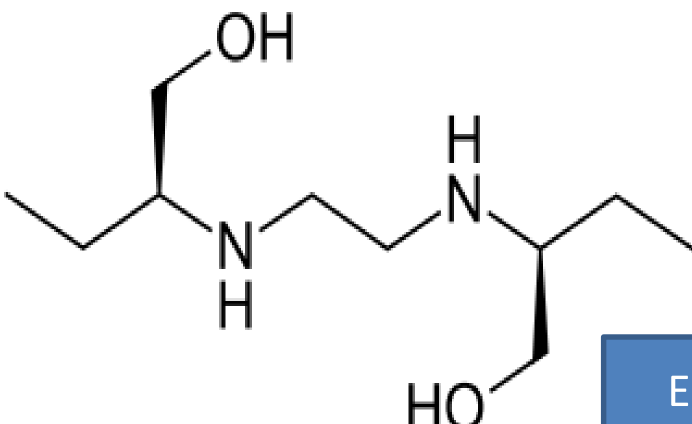
Structure



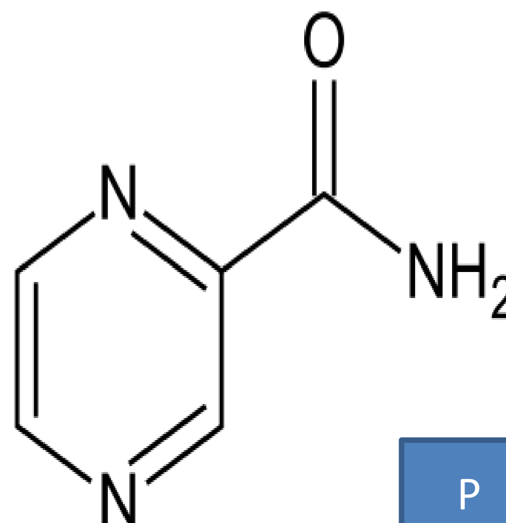
R



INZ



E



P

Rifampicin sensor based on BSA-Au NCs

- **HPLC with UV-vis, single MS, tandem MS, LC used to monitor antibiotics in urine and plasma.**

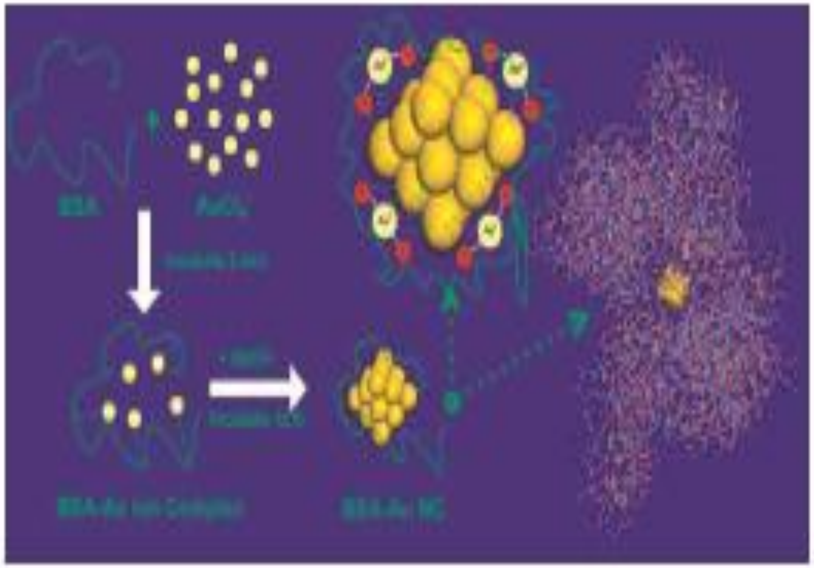
- **R binds to BSA quite strongly [Yu O.Y et al., 2011]**

- **INH, E and Z are not usually binding strongly with proteins—fluorescence quenching based sensor.**

- **Novelty-paper based testing!!**

Sensor Methodology

- **Preparation of BSA-Au NC**
  Advantages-



Au with red NIR emission:

✓ **Improves tissue penetration**

✓ **Reduce background fluorescenc**

✓ **BSA retains biological activity**

✓ **Modification of surface**

✓ **Analyte recognition**

✓ **Change in emission spectra**

[Xie et al., 2007]

Characterization-using FTIR/CD spectra, fluorescence spectra, TEM

Fluorescent Quenching based sensor

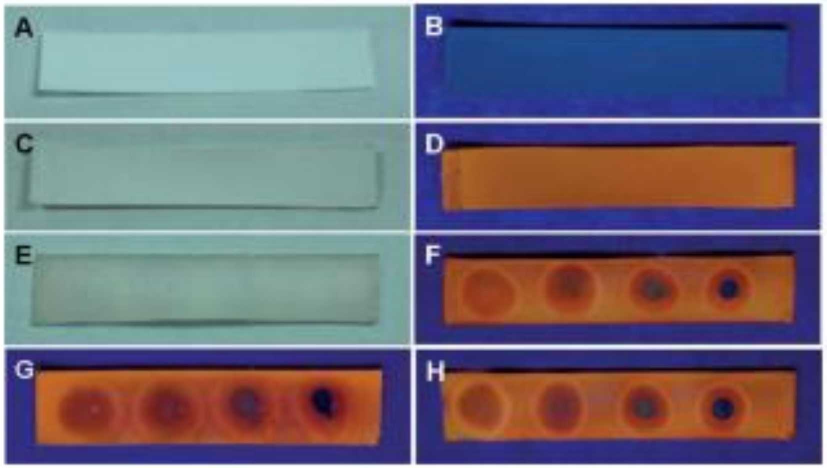
Detection of unknown quantity of R

Sensor Methodology

Novelty- Test papers for detection of R

A & B-Before modification with Ag NC

C & D-After modification with Ag NC



E & F- Addition of Cu ions in deionized water
G- Addition of Cu ions in river water
H- Addition of Cu ions in barelled drinking water
Paper based assay: **[Liu X et al., 2012]**
Robust, simple, inexpensive, quick determination

Global Demand For R Sensor

- The overall cost of treatment ranges from **$30-$50,** depending on location, availability of drugs and duration of treatment.
- Around **25-30% patient are not fully cured** and have to go through the same treatment for further time.
- Dr. Raviglione of the WHO said the fact that most Indians couldn't afford therapy for multidrug-resistant TB—which costs about $2,000 to treat in India
- This product would also significantly reduce the cost of personal cost and thus decreasing the **overall cost of treatment by around 30-35%.**

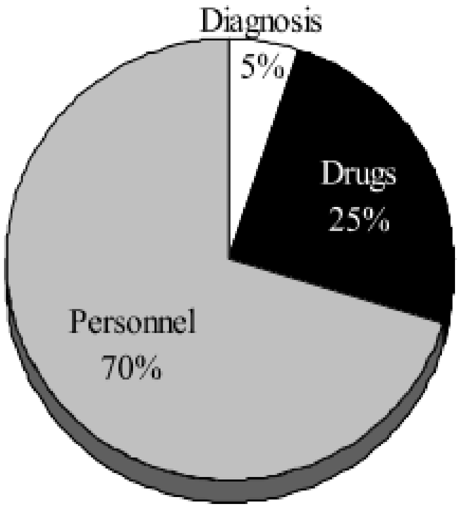


Fig 1: The proportion of cost spent for diagnosis, personal and drugs for treatment of TB.

Global Demand For R Sensor

Rank of Overall TB Burden*	Country
1	India
2	China
3	Indonesia
5	South Africa
6	Bangladesh
8	Pakistan
9	Philippines
11	Russian Federation
12	Vietnam
18	Thailand

Fig 2: Countries with most no of cases in descending order.

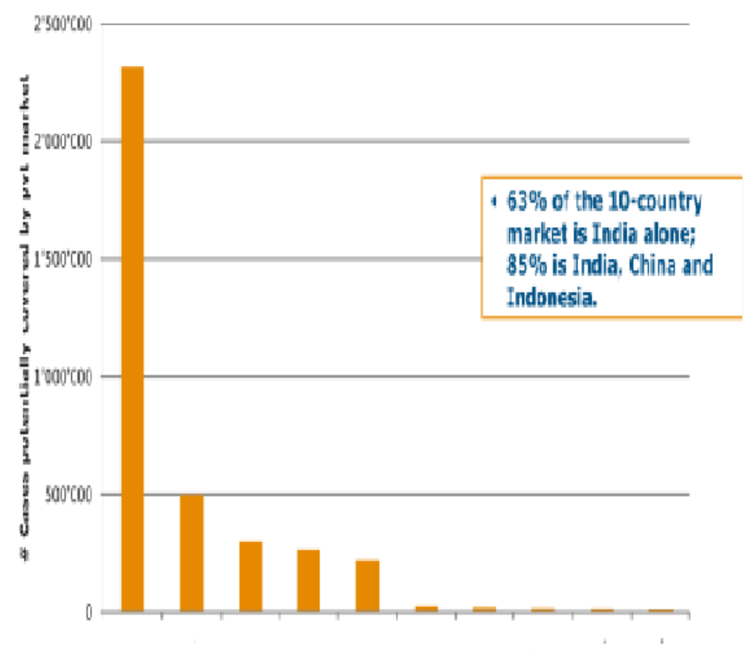


Fig 3: The overall break up of TB cases globally in the above countries

Competition & Sales Revenue Forecast

- The preferred choices of monitoring by various methods are the main competition.
- The merits of the product would soon outlive the utility of these various methods of monitoring of rifampicin.
- The pricing would also make it quite effective since the prices would be atleast 50% cheaper than any methodology present today.
- According to McEvoy & Farmer, the total clinical diagnostics market in India (reagents + instruments) is about $530 million (2010), with an average annual growth rate of about 16 – 18%
- Our target is to **reach $25 million in annual revenue by year three.**

Conclusion

- The future looks bright for our current product and we hope that it would prove to be a big help in the successful treatment of TB patients globally.
- An average annual growth rate of about 16 – 18% is predicted.
- The expansion of marketing division in China by 2014.
- Our target is to reach $25 million in annual revenue by year three.
- A great opportunity to introduce a novel product which has the potential to change the life of many affected TB patients and cure them fully, as well as earn investors a quick as well as ample return on their investment.

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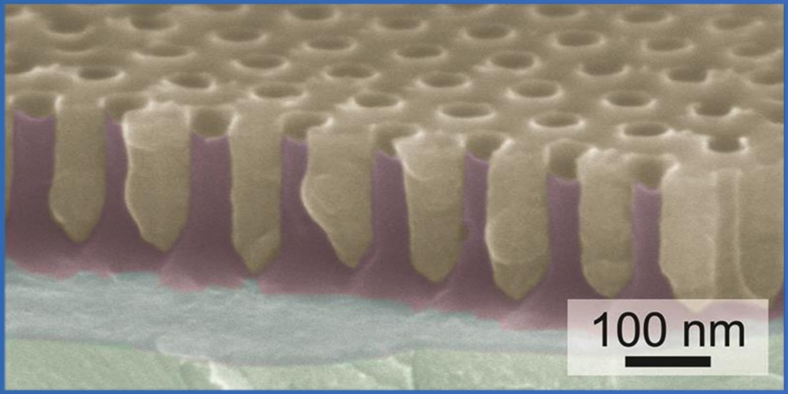
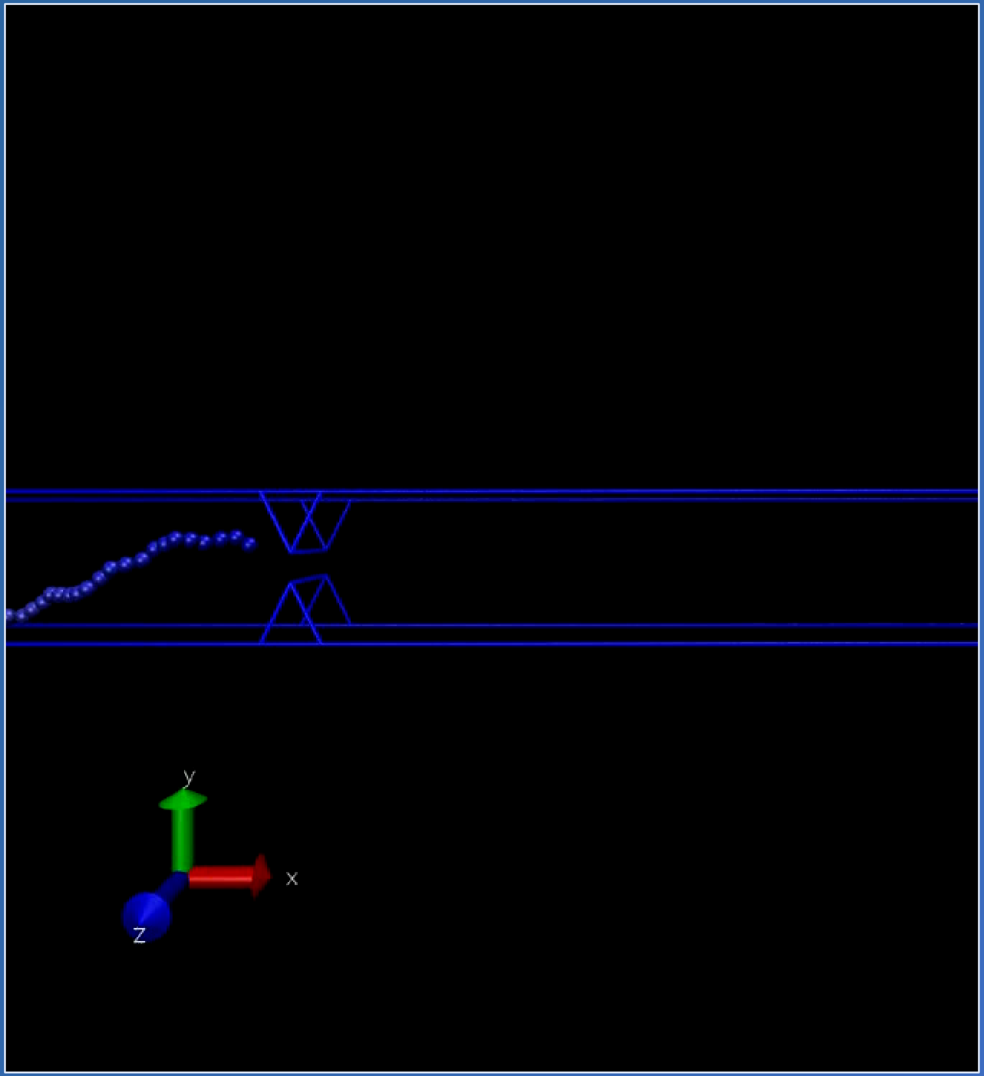
THANK
YOU

MOLECULAR DYNAMIC SIMULATION OF POLYMER MOLECULE IN NANOCONFINMENT AND ITS POSSIBLE APPLICATION TO HYBRID SOLAR CELLS

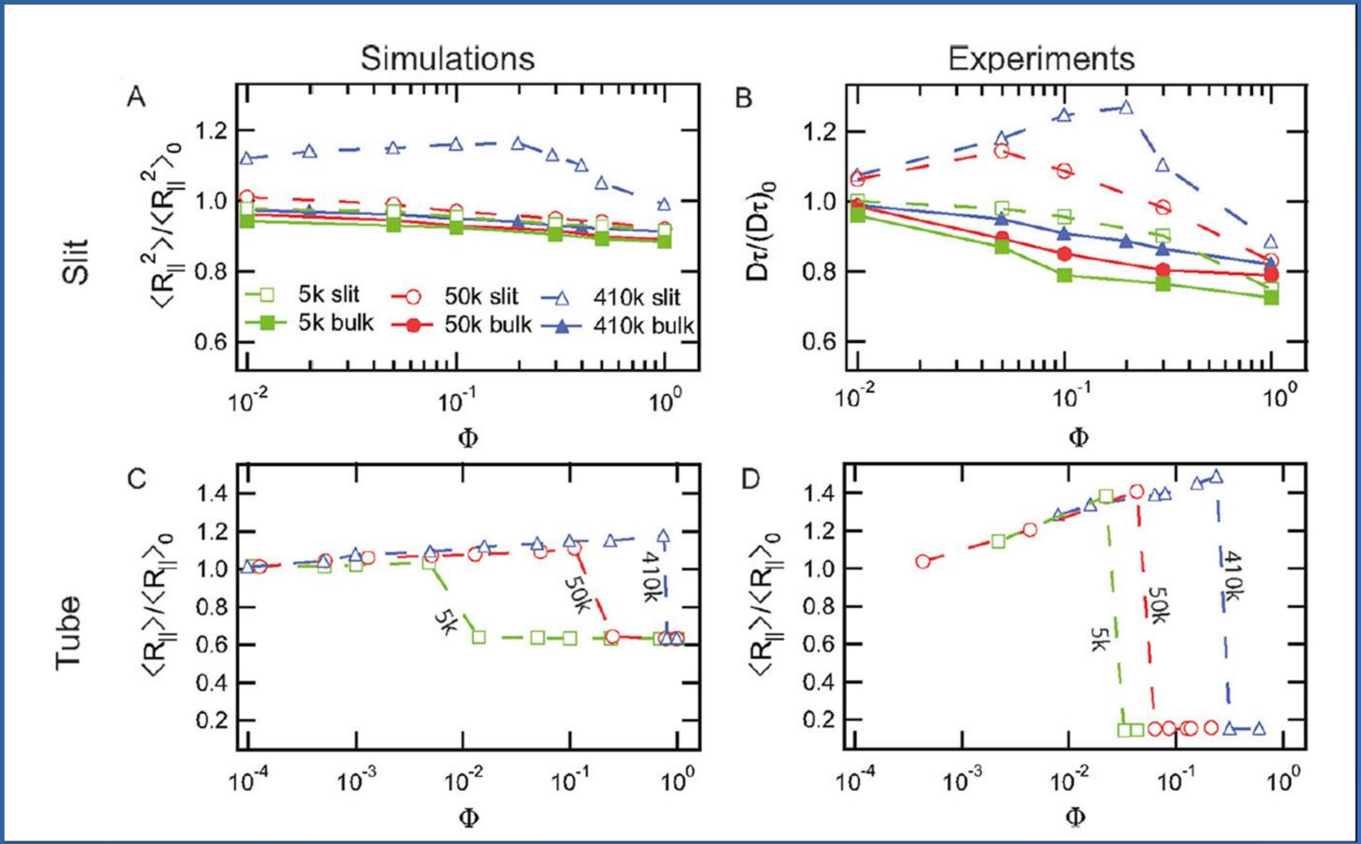


Behavior of polymer in square nano-channel confinement



Courtesy: Fan-Tso Chien - http://www.phys.sinica.edu.tw/~polyphys/index.html

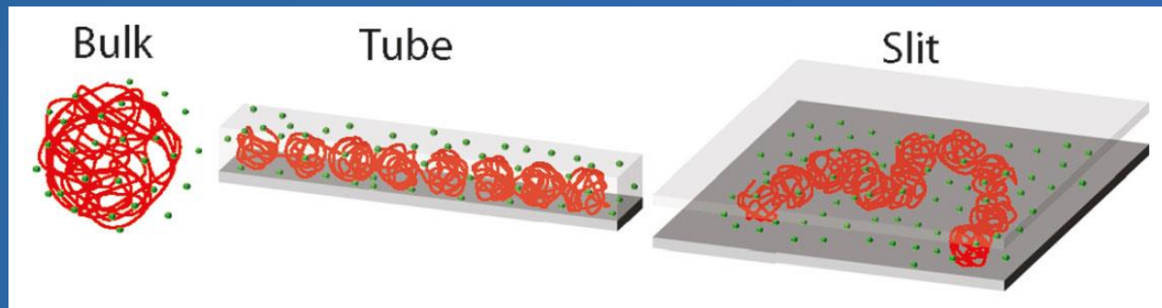
Dynamic simulation of DNA molecule inside nanoconfinment in presense of dextran

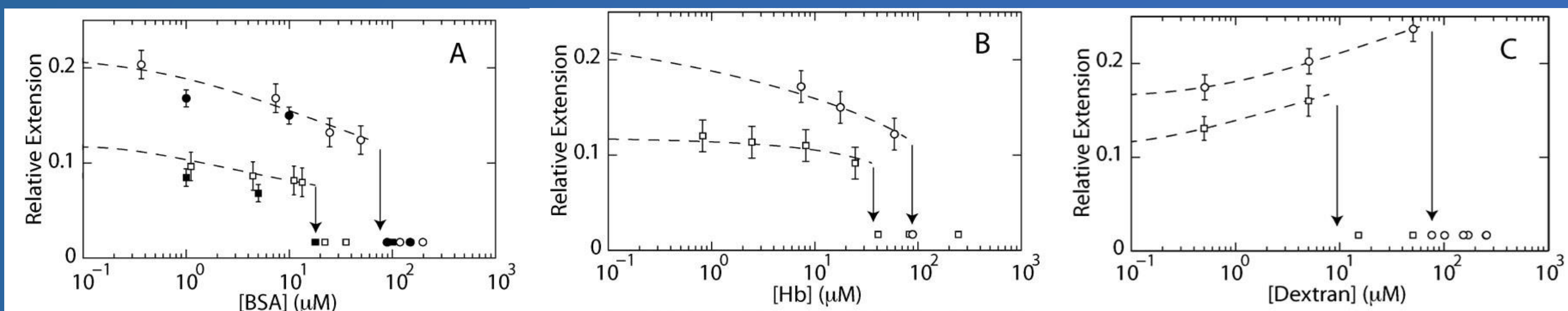


(A) in plane squared radius of gyration from dynamic simulations and (B) experimental measurements of effective mean squared coil size for λ-DNA in bulk and slit channel confinement. (C) normalize mean extension for simulations of λ-DNA in tube (width 250 nm) compared to (D) Zhang et al.26 experimental measurements of T4-DNA mean extension (tube width 300 nm). Solid lines and symbols indicate bulk and the dotted lines with open symbols correspond to channels. < > represents an ensemble average quantity.

Effect of Nanochannel Geometry on DNA Structure in the Presence of Macromolecular Crowding Agent
Jeremy J. Jones, Johan R. C. van der Maarel, and Patrick S. Doyle - Nano Letters, 10-2011

Compactation of DNA molecule in nanoconfinment in presence of BSA, Hb and dextran crowders





(A) Relative extension R‖/L of T4-DNA (open symbols, YOYO-1 stained) and λ-DNA (closed symbols, Alexa stained) versus the concentration of BSA in 200 × 300 nm2 channels. (B) R‖/L of T4-DNA versus the concentration of Hb in 200 × 300 nm2 channels. (C) R‖/L of T4-DNA versus the concentration of dextran (Mw = 50 kDa) in 300 × 300 nm2 (○) and 200 × 300 nm2 (□) channels. For all panels, the buffers are 10 mM Tris/HCl (°) or 10 mM Tris/HCl with 25 mM NaCl (□). The dashed curves extrapolate to the protein/dextran-free values at the y-axis, and the arrows demarcate the condensation thresholds

Simulation Model:

- Wall-NP interactions
- Polymer-wall interaction
- Polymer-NP interaction

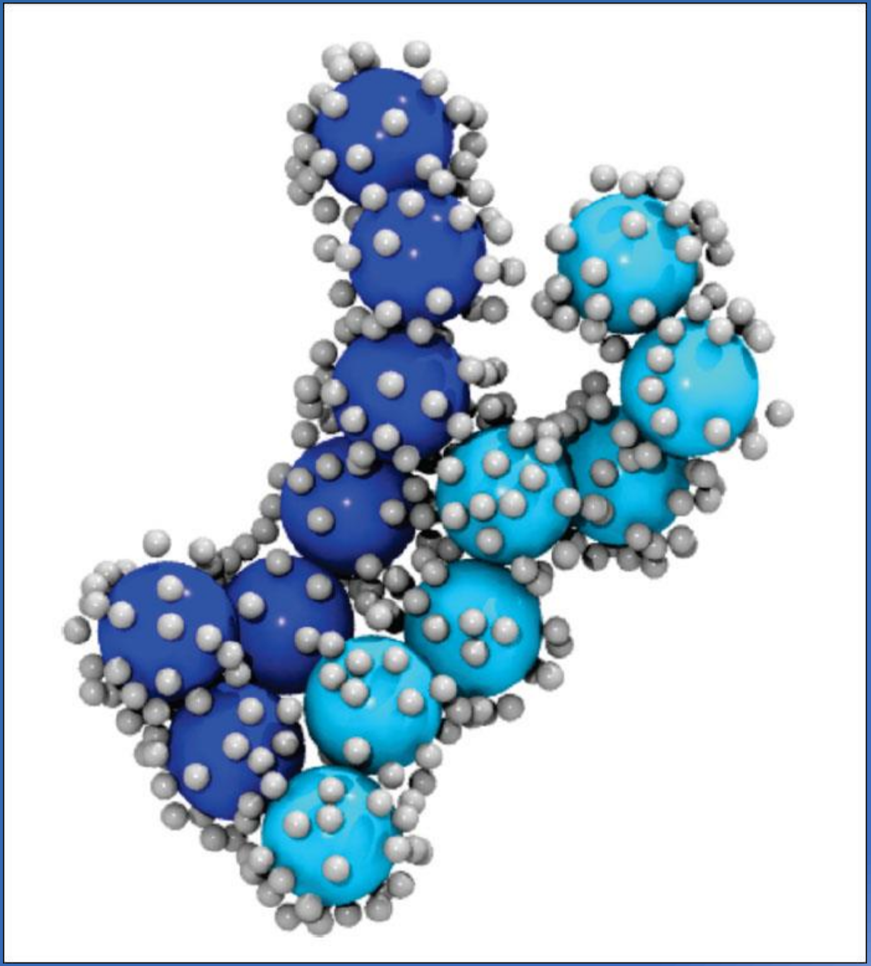
x NP-NP interaction

(depletion potential – entropic attraction)

CPU time saving techniques:

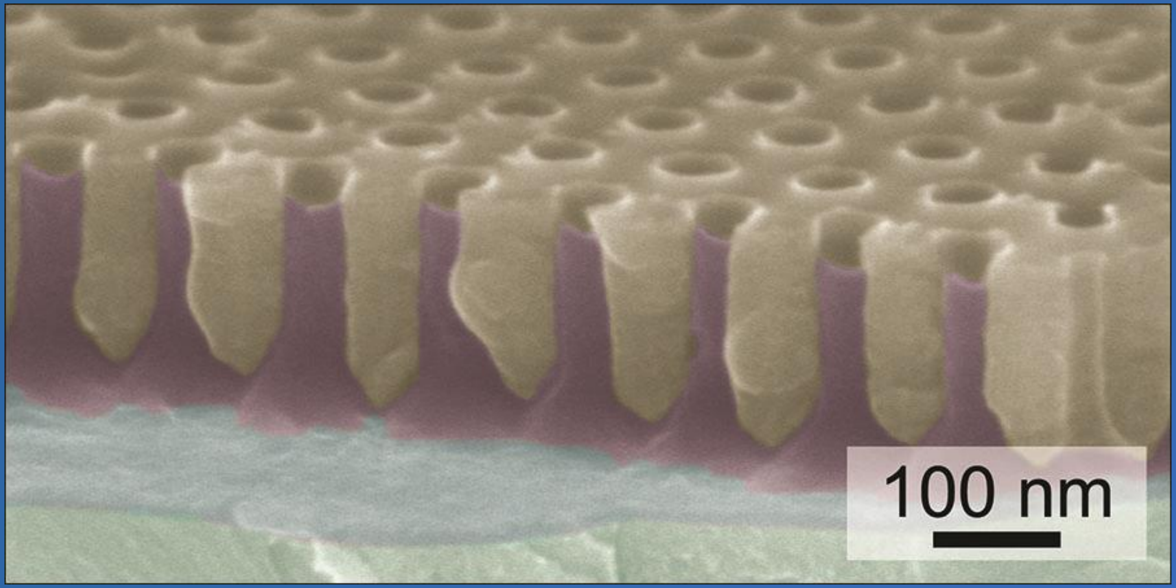
- Verlet list
- Cell list

Computing time scales
from N^2 -> $N^{3/2}$



A snapshot of a simulation system with two polymers of
seven segments and small depleting spheres whose size is one-fifth of
a diameter of polymer segments

Nanoconfinement of Organic Solar Cell Material and Enhanced Conductivity



Aluminum oxide template (gray) with a regular array of 60-nanometer holes filled with an organic semiconductor (purple). This nanoconfined semiconducting polymer produces twice the amount of electricity for a given amount of absorbed sunlight as compared to the same material spread as a thin film.

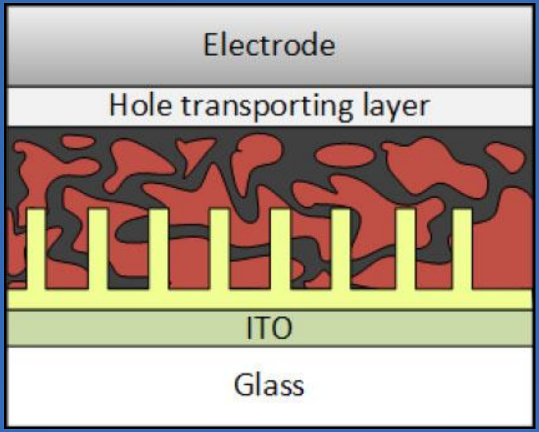
- the out-of-plane conductivity of the material confined to the holes is 500 times better than when it is formed as a thin film
- increased efficiency attributed to the lack of allignement of the molecules which would block electron-hole separation
- doesn't improve overall solar-cell efficiency, because the nano-confined light-absorbing material doesn't cover as much area as in the thin-film format.

http://scitation.aip.org/content/aip/journal/apl/99/16/10.1063/1.3651509

SIMULATION VARIABLES

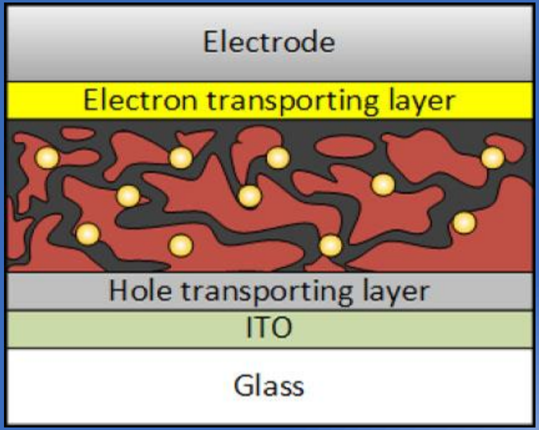
Different conducting polymers

Poly(fluorene)s, poly(pyrrole)s (PPY),
Poly(acetylene)s (PAC), P3HT
poly(3,4-ethylenedioxythiophene) (PEDOT)



Different types of nanoconfinment (silicon):

- Square nanochannels
- Cylindrical nanochannels
- Nanoslit
- Nanorod



Nanoparticles - quantum dots:

- Fraction volume
- Size

Produce prototypes

Organic inorganic hybrid Perovskite Solar Cells

Name: Taame Abraha Berhe

ID No. D10222808

Email:taameabr@gmail.com

NanoElectrochemistry lab, Graduate Inst. Applied Sci. and Tech

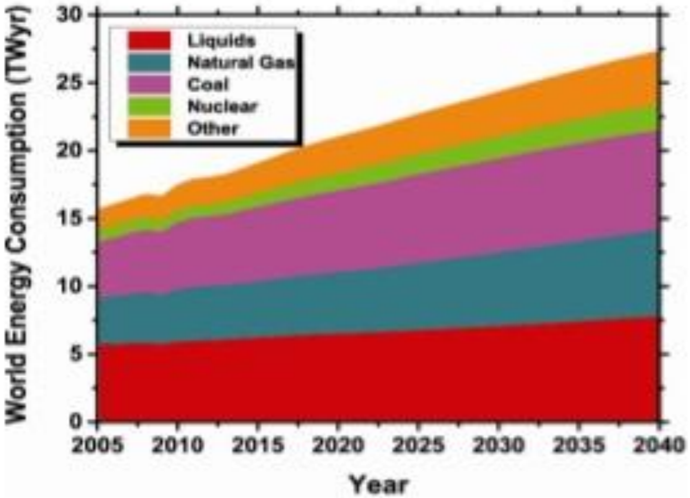
NTUST, Taiwan Tech

Outline

1. Introduction
2. What is solar cell?
3. Perovskite Solar cells
4. Conclusions

The Need for Photovoltaics

- Global energy use is growing at over 1% per year
- This rate will cause energy consumption to nearly double by 2040



Source: EIA, International Energy Outlook (2013)

Renewable Energy Potential	
Hydroelectric	0.5 TW
Tides and Oceans	2 TW
Geothermal	12 TW
Wind Power	2-4 TW
Incident Solar Energy	120,000 TW

Source: DOE, Basic Research Needs for Solar Energy Utilization (2005)

- Solar energy is by far the largest potential source for renewable energy

2

Introduction-Why Solar?

[illegible]

Sun

2. What is a Solar Cell

❖ A solar cell is a semiconductor device which converts electromagnetic radiation (visible light, infrared, ultraviolet, x-rays, and radio waves) into electrical signals.

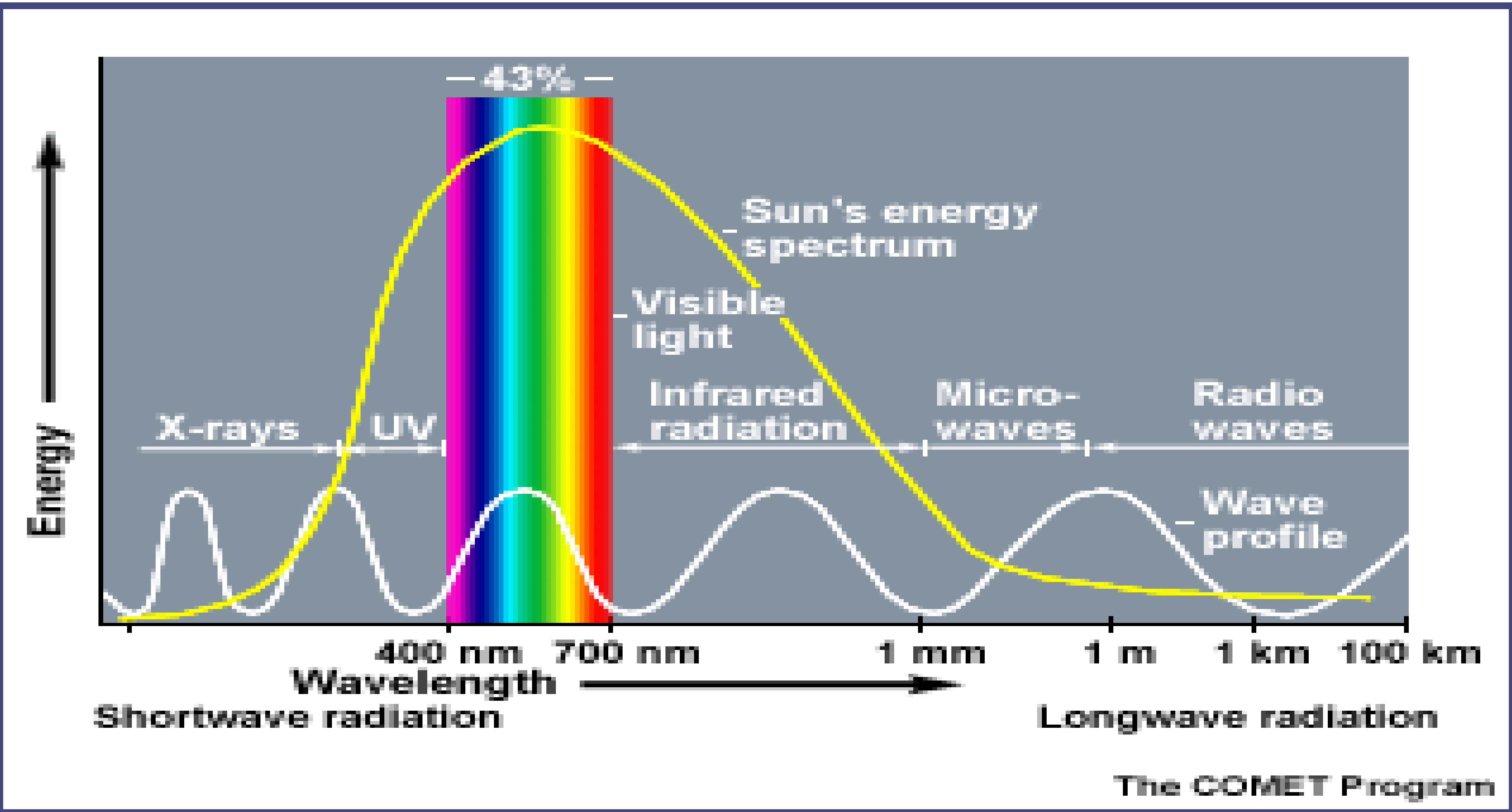
❖ It is a device which generates electricity directly from Sun's radiation by means of the photovoltaic effect so it is also called Photovoltaic cell.

❖ In order to generate useful power, it is necessary to connect a number of cells together to form a solar panel, also known as a photovoltaic module.

❖ What is Solar Energy?

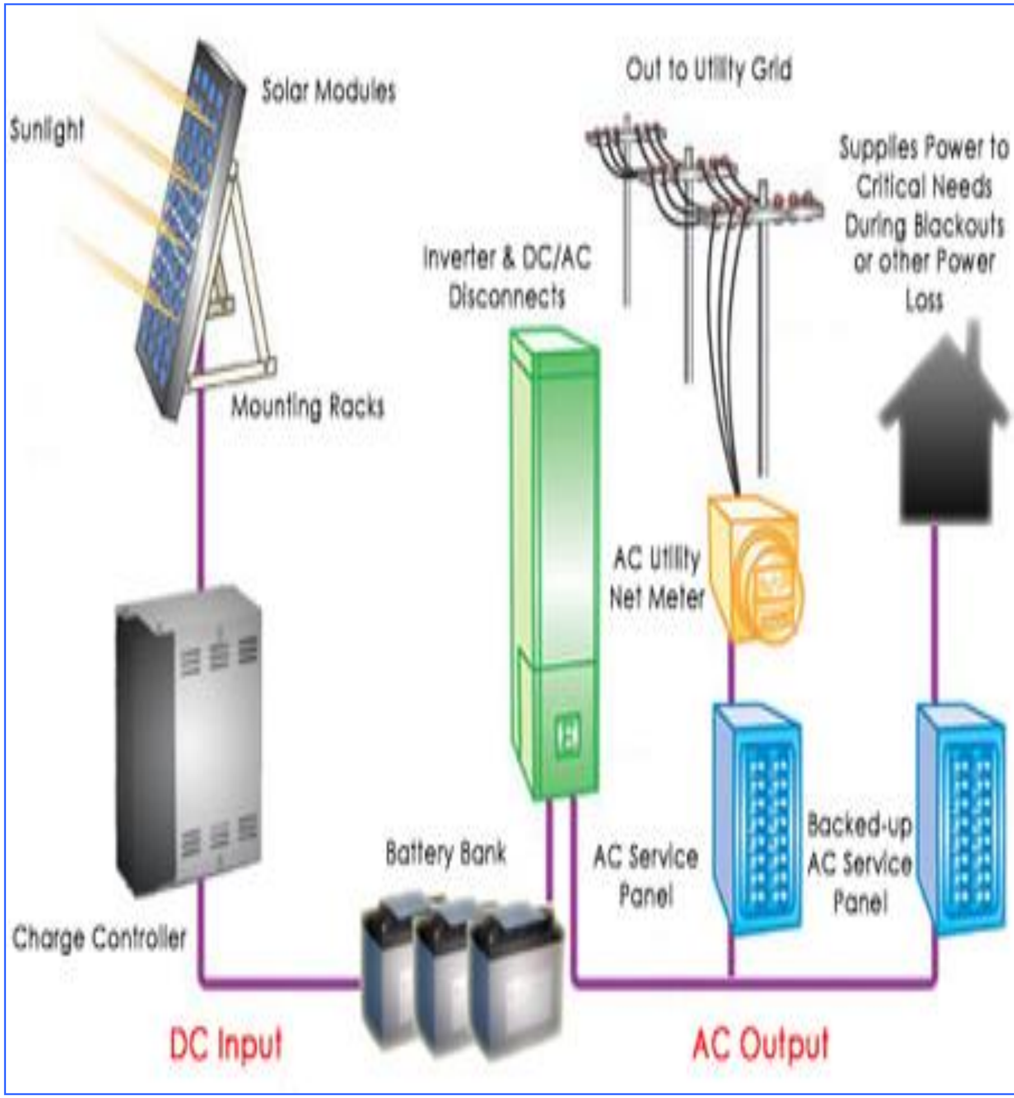
❖ It is the radiation from the sun that is capable of producing heat, causing chemical reactions, and finally generating electricity.

Solar Spectrum

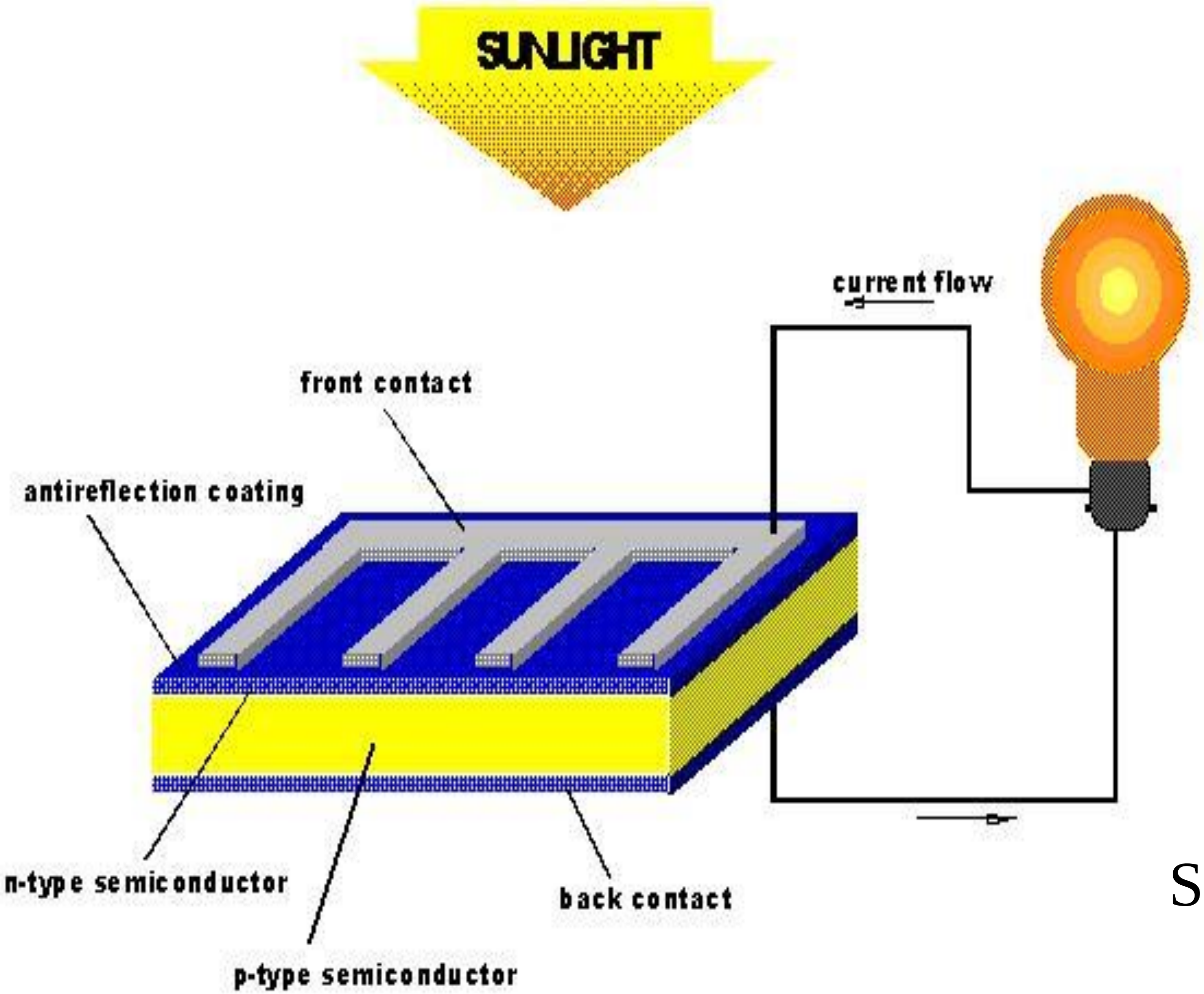


GENERATION OF SOLAR POWER

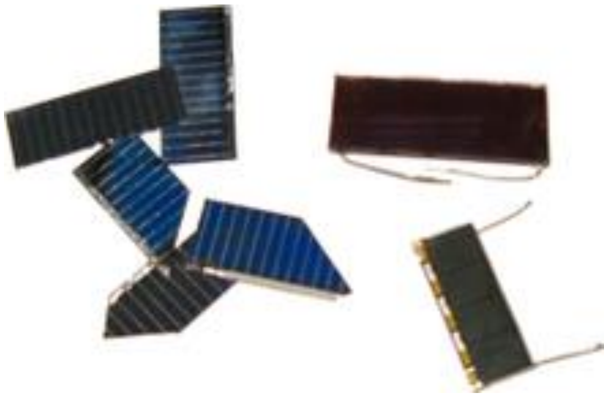
1. Solar power is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP).
2. Photovoltaics converts light into electric current using the photoelectric effect.



Typical Solar CELL device

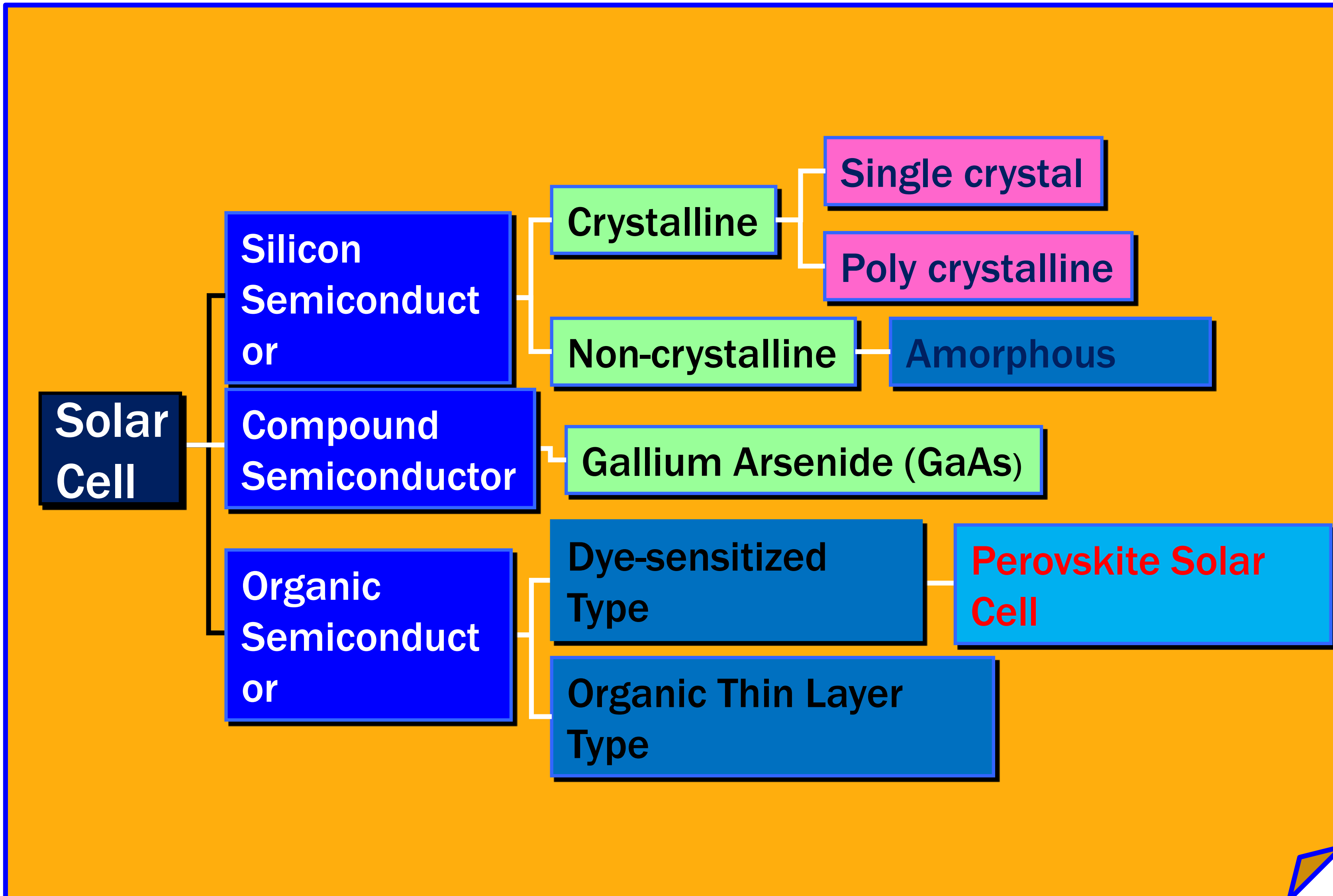


A basic structure of a typical solar cell

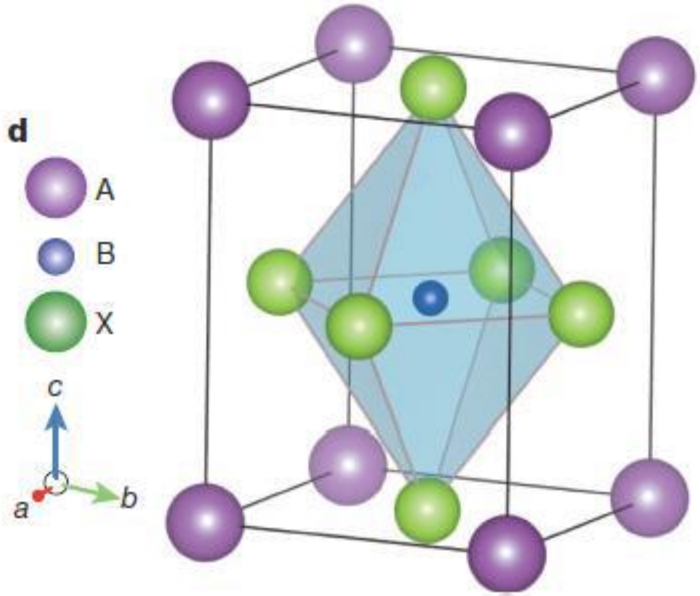


Solar modules/panels

Various type of PV cell



3. So, What is Perovskite Solar Cell?



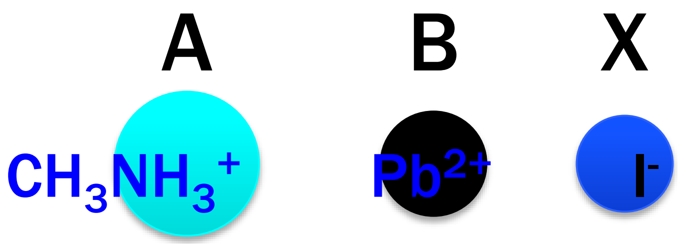
Tetragonal Structure
Parameters: a = 8.825 Å, b = 8.835Å, = 11.24Å
Science. 2012, 338, 643.

- A perovskite structure is any material with the same type of crystal structure as calcium titanium oxide ($CaTiO_3$), known as the perovskite structure ABX_3.
- First discovered by Gustav Rose in 1839 and named after Russian mineralogist L. A. Perovski.

- **"Perovskite solar cells" are hybrid organic-inorganic solar cells** with a perovskite polycrystalline structure, $CH_3NH_3PbX_3$, where X is a halide atom (I, Cl, Br, or a combination of some of them).

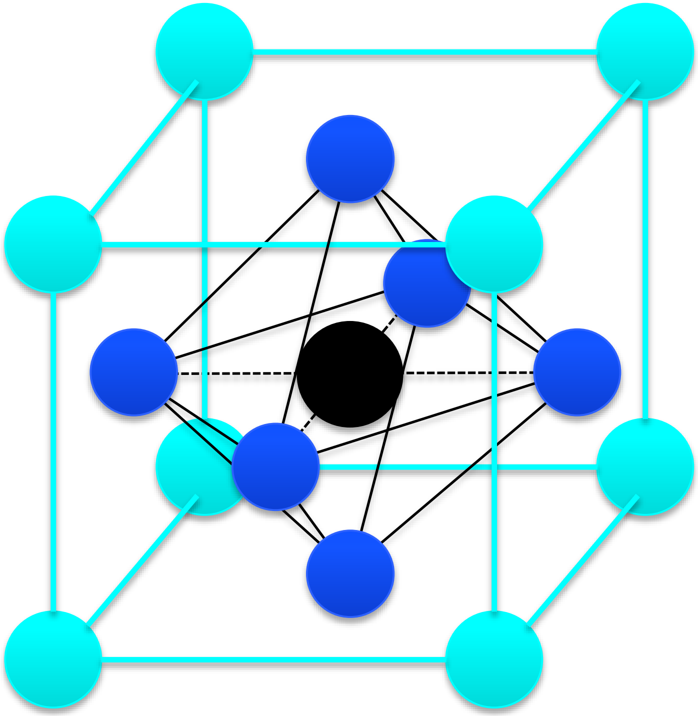
‘Perovskite’ Describes a Crystal Structure Class

Generic formula: ABX_3

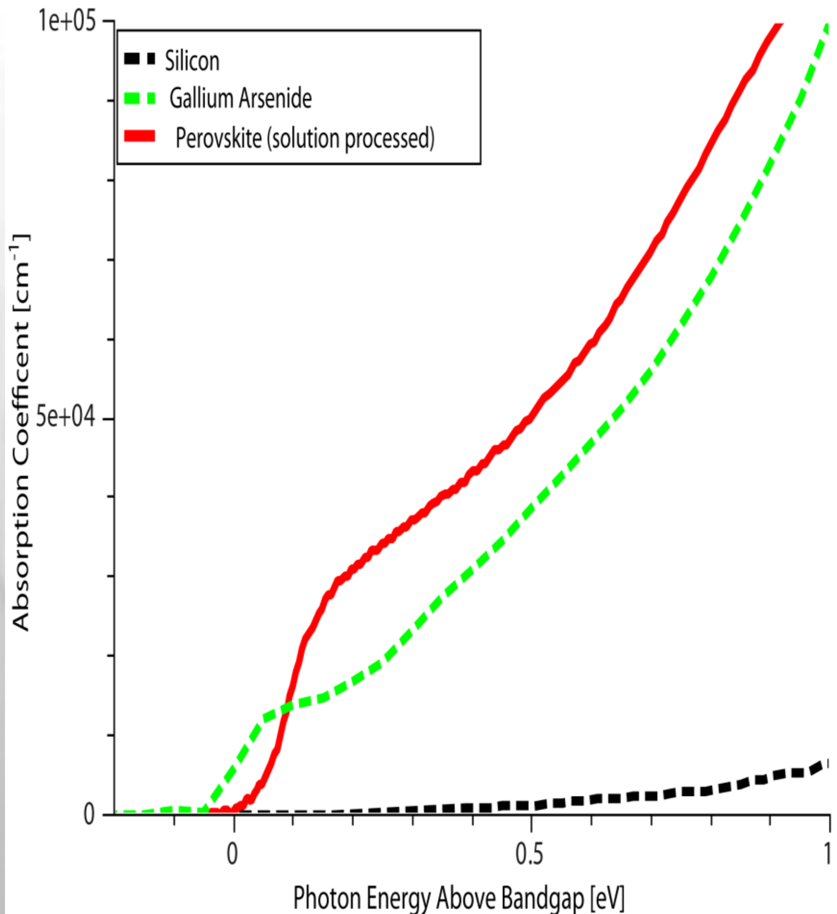


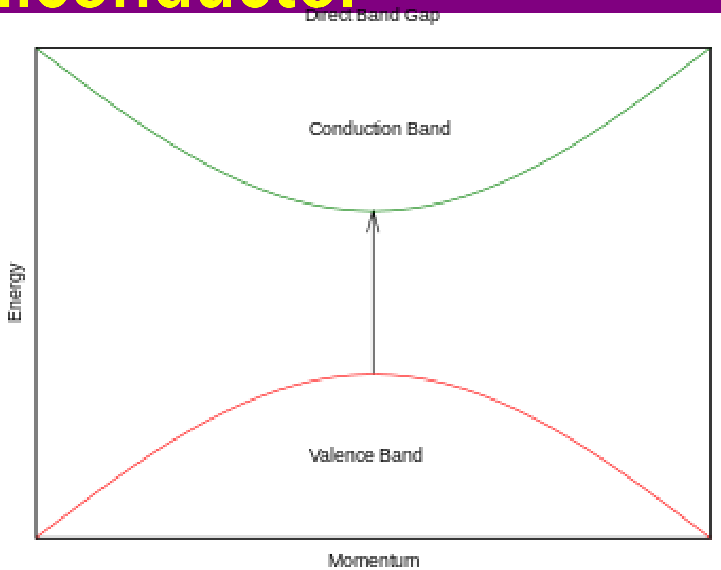
$CH_3NH_3PbI_3$

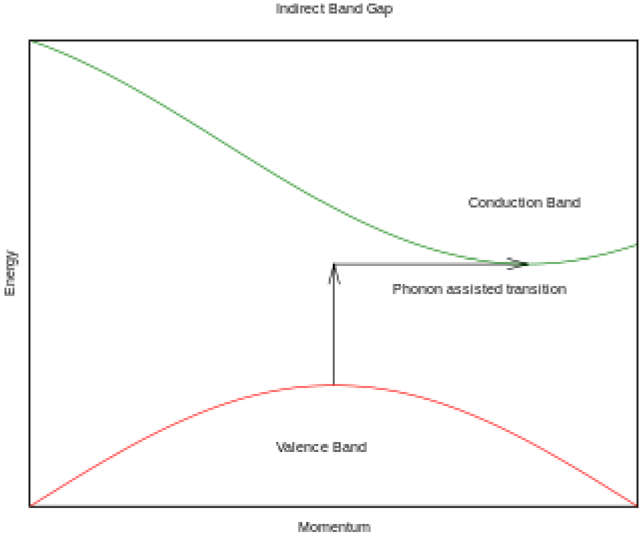
Methylammonium-lead-iodide



The Perovskite is a Strongly-Absorbing Direct Band Gap Semiconductor

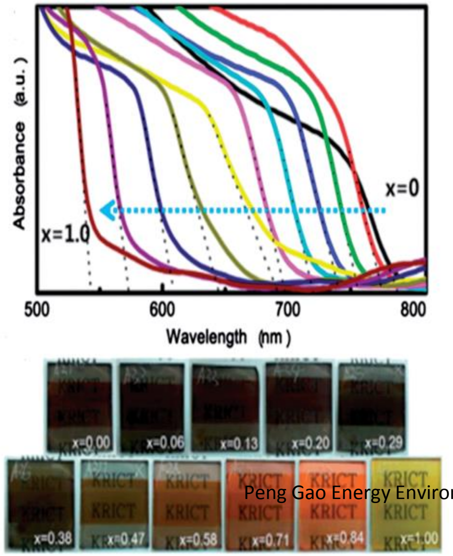




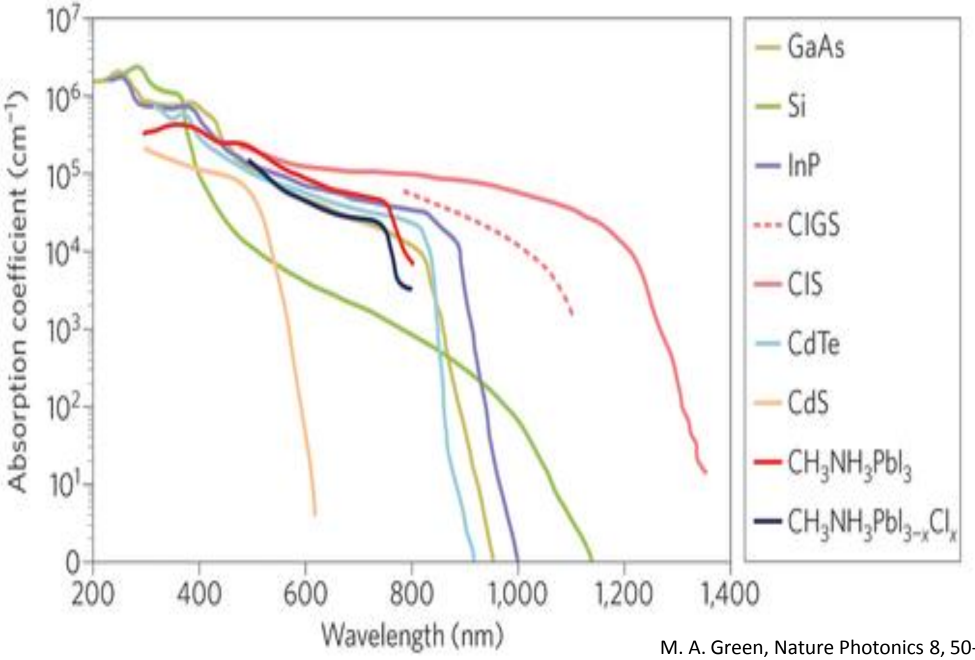


Optical Properties

- High absorption coefficient
- Optical absorption as a function of the metal halide
- Band- tuning



Peng Gao Energy Environ. Sci., 2014, 7,2448



M. A. Green, Nature Photonics 8, 50-514 (2014)

Electronic Properties

- Large Bohr radius Wannier-type excitons
- Low binding energies
- High dielectric constant
- Allow for Charge accumulation
- Ambivalent charge transport
- Very high e- h+ diffusion lengths

$$C = \frac{k\varepsilon_0\varepsilon_r A}{d}$$

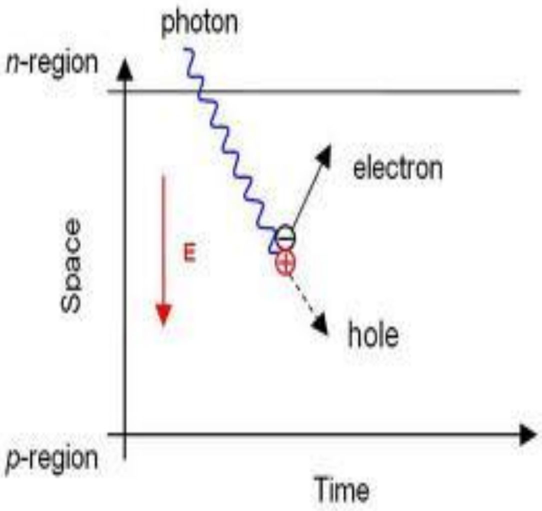
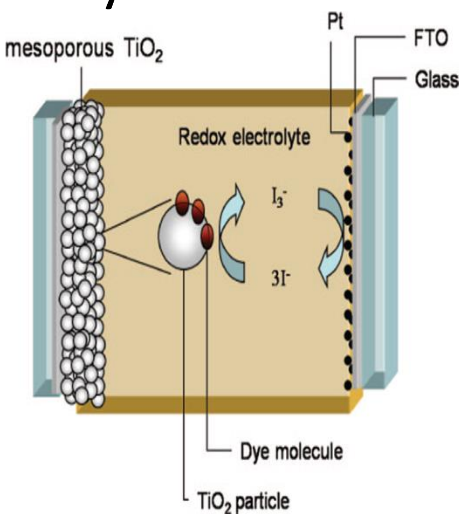


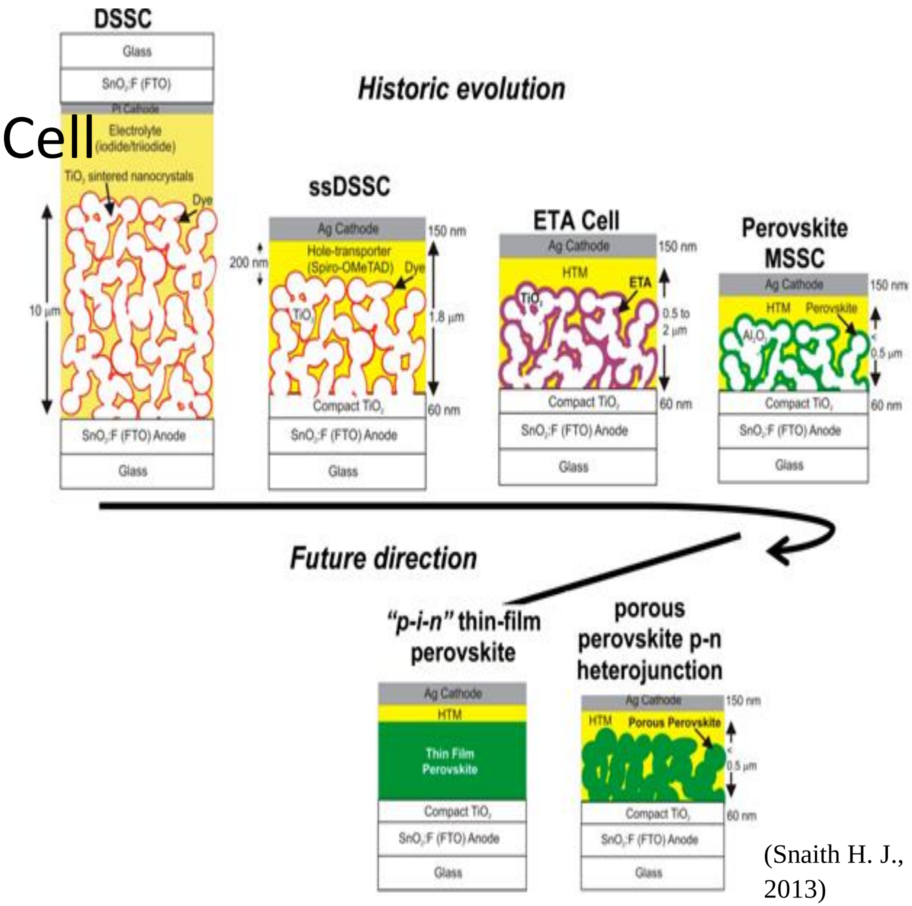
Image Credit: solarwiki.ucdavis.edu

Evolution of Perovskite Solar Cells

Dye-Sensitized Solar Cell



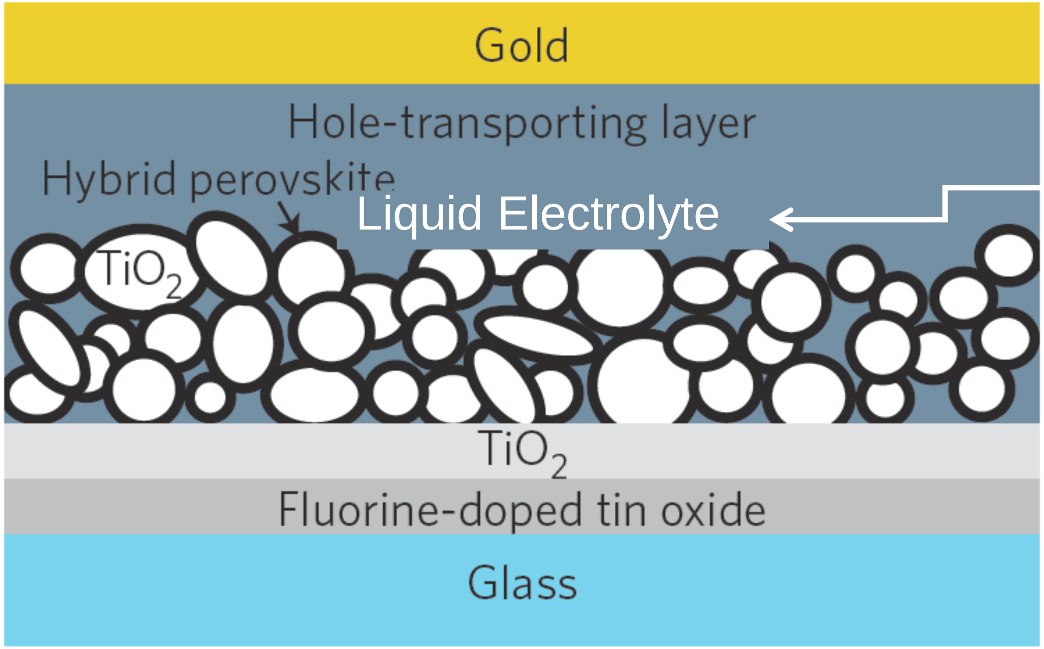
A. Hagfeldt, *Chem. Rev.* ***2010, 110, 6595–6663***



(Snaith H. J., 2013)

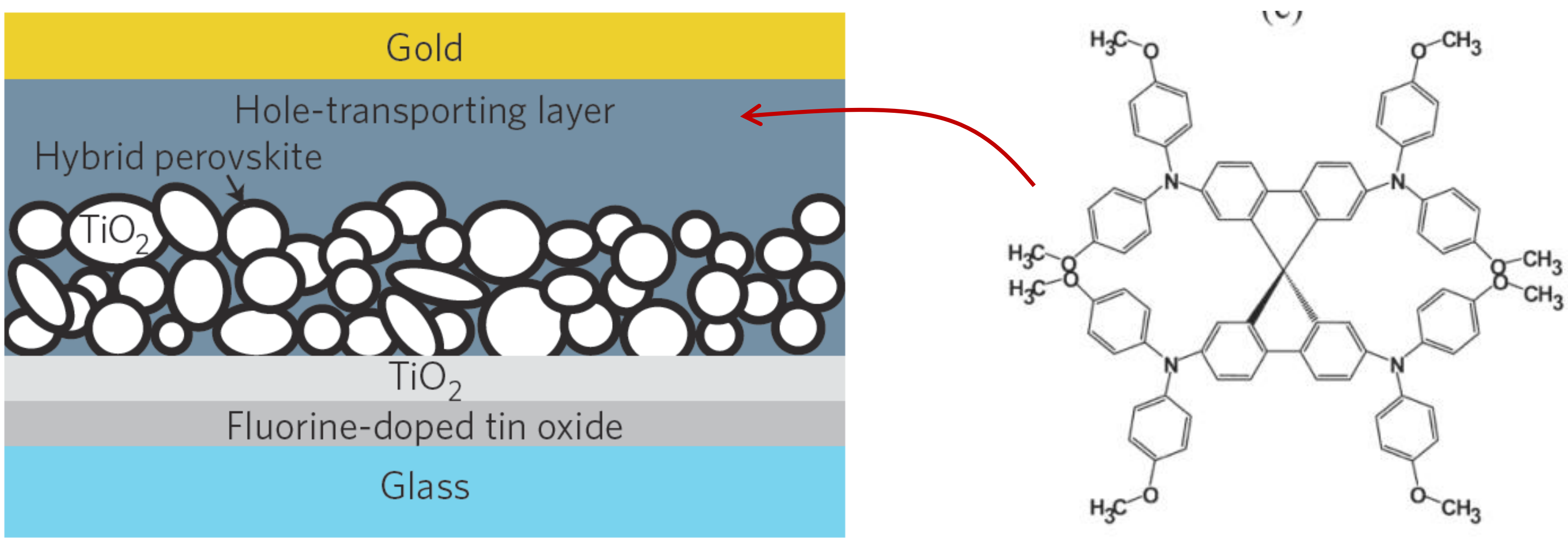
Replacing Dye with Perovskite

- Dyes do not absorb all the incident light, reducing DSSC efficiency.
- In 2009, Miyasaka (Toin U. of Yokohama, Japan) turns to perovskite as possible replacement of the dye and achieved 3.8% efficiency.
- Problem: Liquid electrolyte dissolved away the perovskite within minutes.

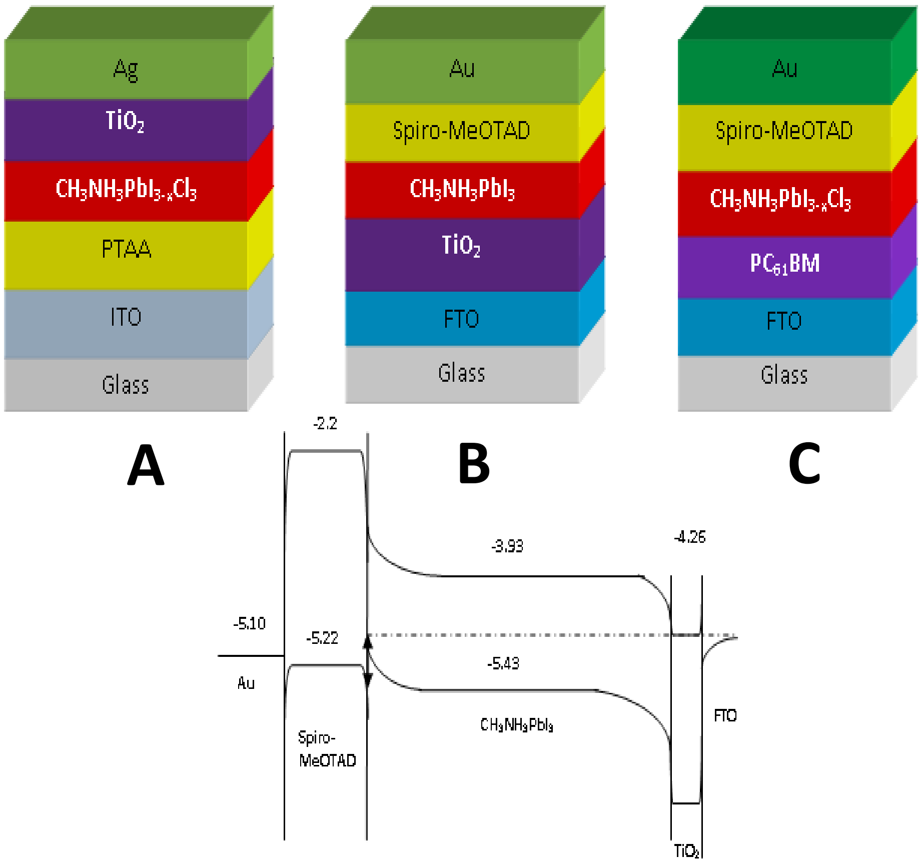


Replace Liquid Electrolyte with a Solid Hole Transporting Layer (HTL)

- 2012, Nam-Gyu Park (Sungkyunkwan U., South Korea) teamed up with Grätzel, over 9% efficiency.



Design Consideration



Solar-Current State-of-the-Art Tech.

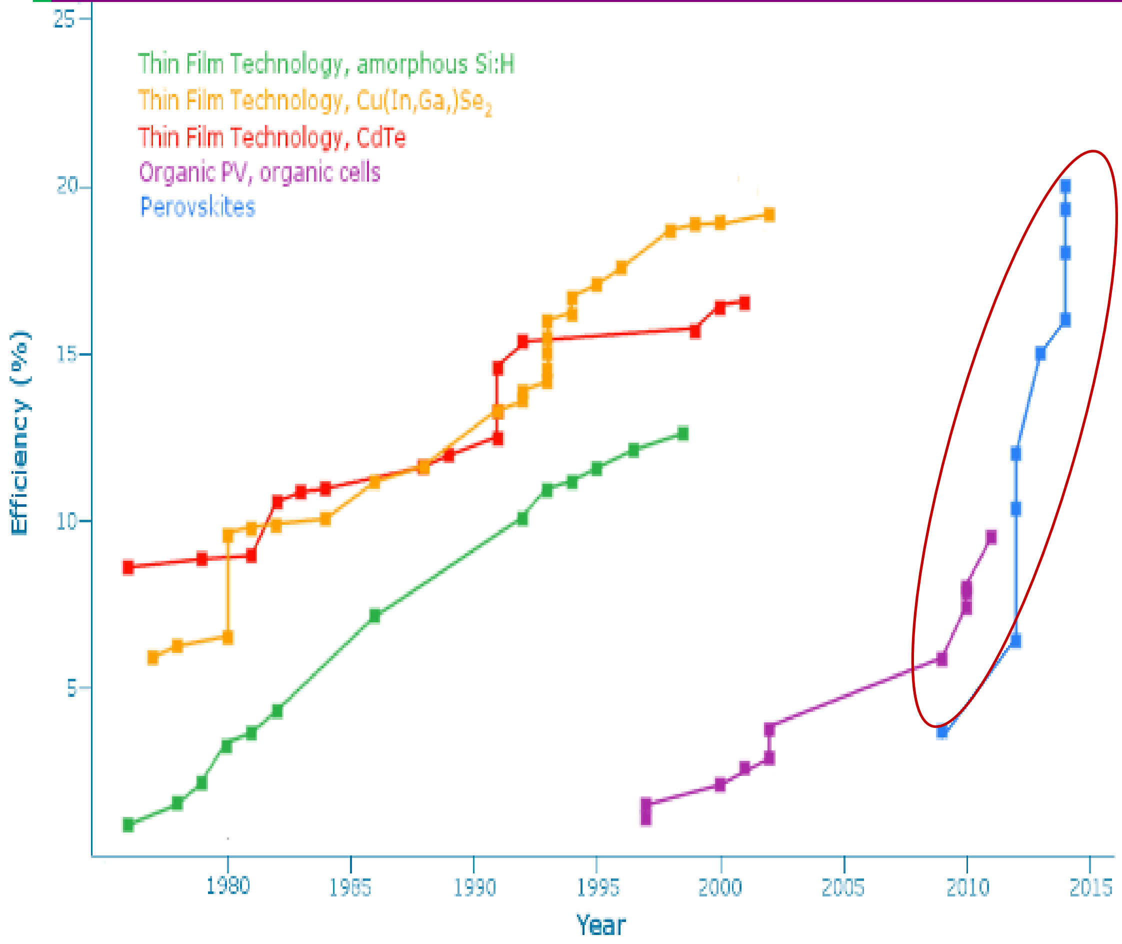


Image Credit: Ossila

What makes perovskite successful?

It has been agreed on that the organic-inorganic hybrid nature is what makes it so successful:

✓The organic component renders good solubility to the perovskite and facilitates self-assembly, effectively enabling its precipitation/deposition from solution.

✓The inorganic component produces an extended network by covalent and/or ionic interactions (instead of weaker forces such as Van der Waals or π-π interactions).

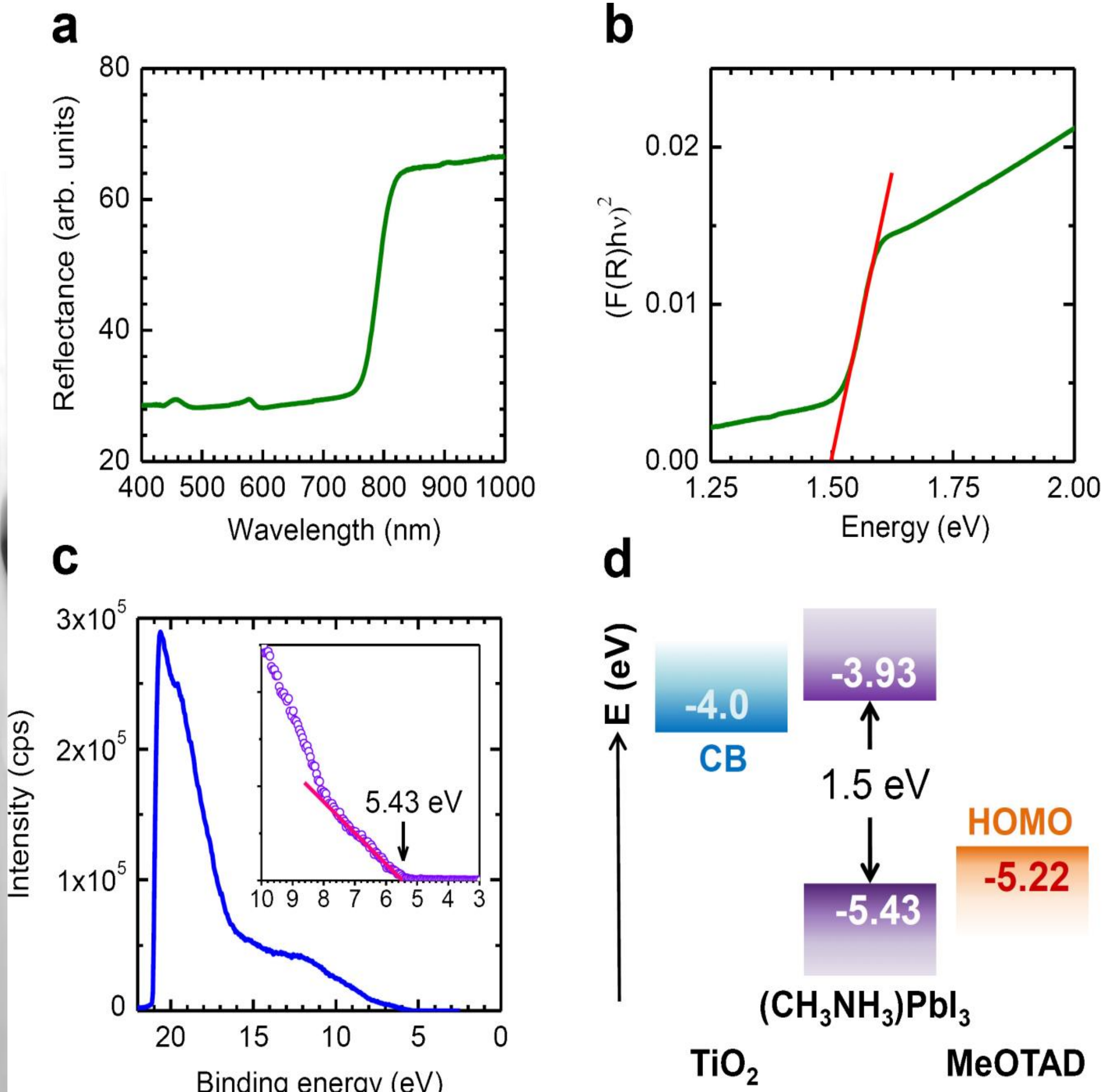
✓Such strong interaction allows for precise crystalline structure in the deposited films."

CH_3NH_3-PbX_3(X=halogens)

Organic part - Inorganic part

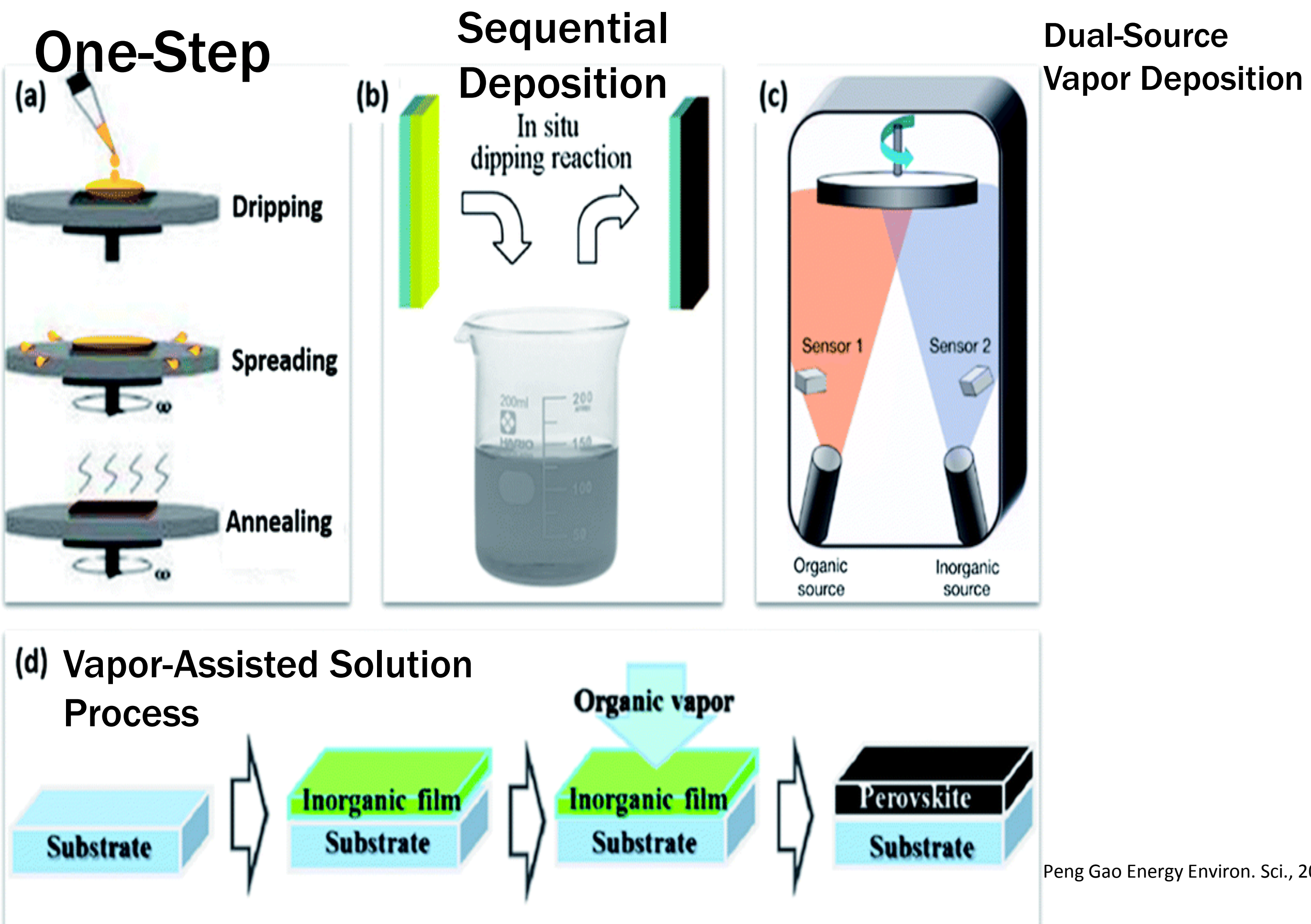
Nature. 2013, 12, 1087

Schematic energy level diagram of TiO_2, $(CH_3NH_3)PbI_3$, and spiro-MeOTAD.



Diffuse reflectance and UPS spectra for $(CH_3NH_3)PbI_3$ perovskite sensitizer. (a) Diffuse reflectance spectrum of the $(CH_3NH_3)PbI_3$-sensitized TiO_2 film. (b) Transformed Kubelka-Munk spectrum of the $(CH_3NH_3)PbI_3$-sensitized TiO_2 film. (c) UPS spectrum of the $(CH_3NH_3)PbI_3$-sensitized TiO_2 film. (d) Schematic energy level diagram of TiO_2, $(CH_3NH_3)PbI_3$, and spiro-MeOTAD.

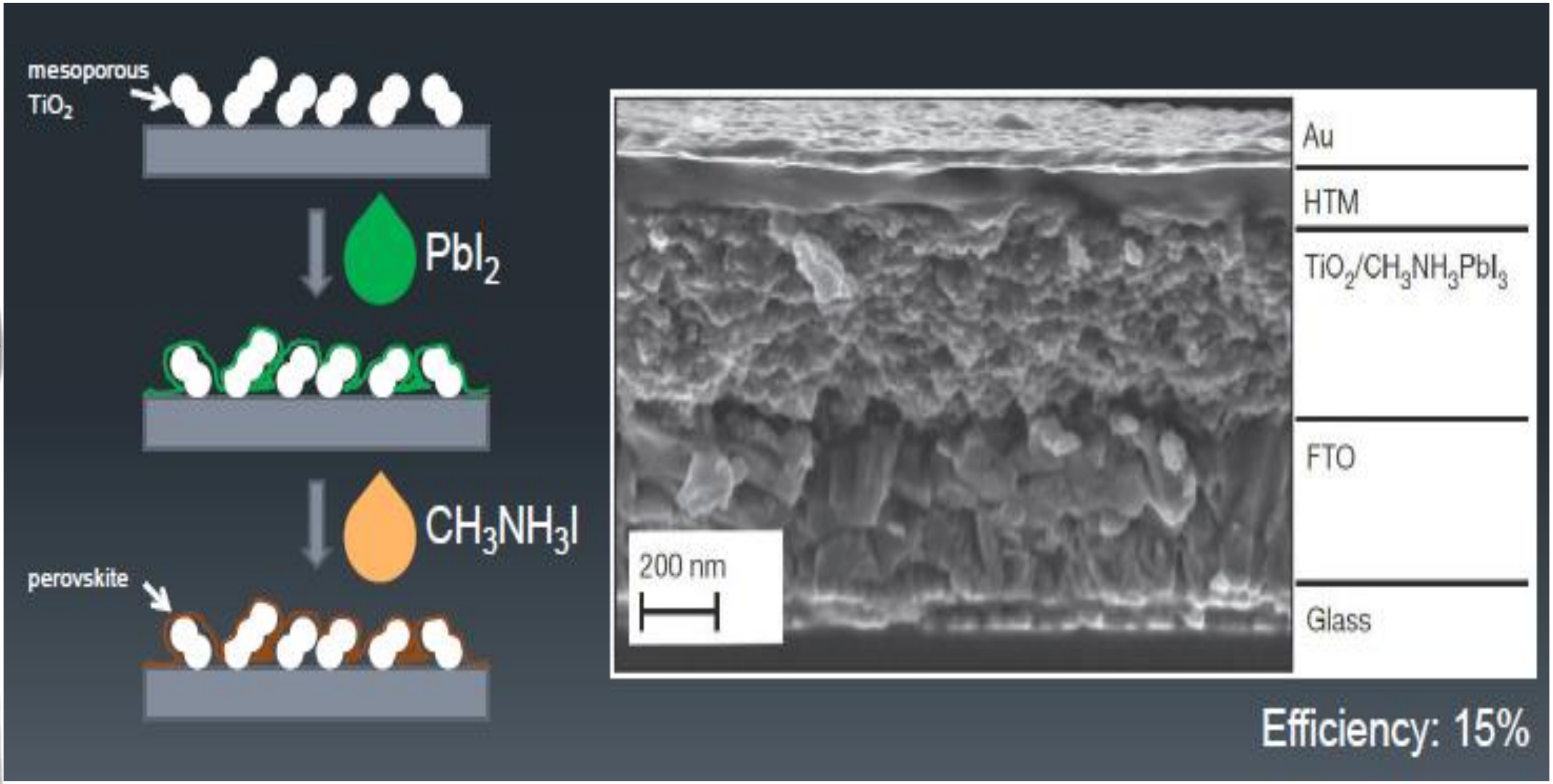
Deposition Methods



Peng Gao Energy Environ. Sci., 2014, 7,2448

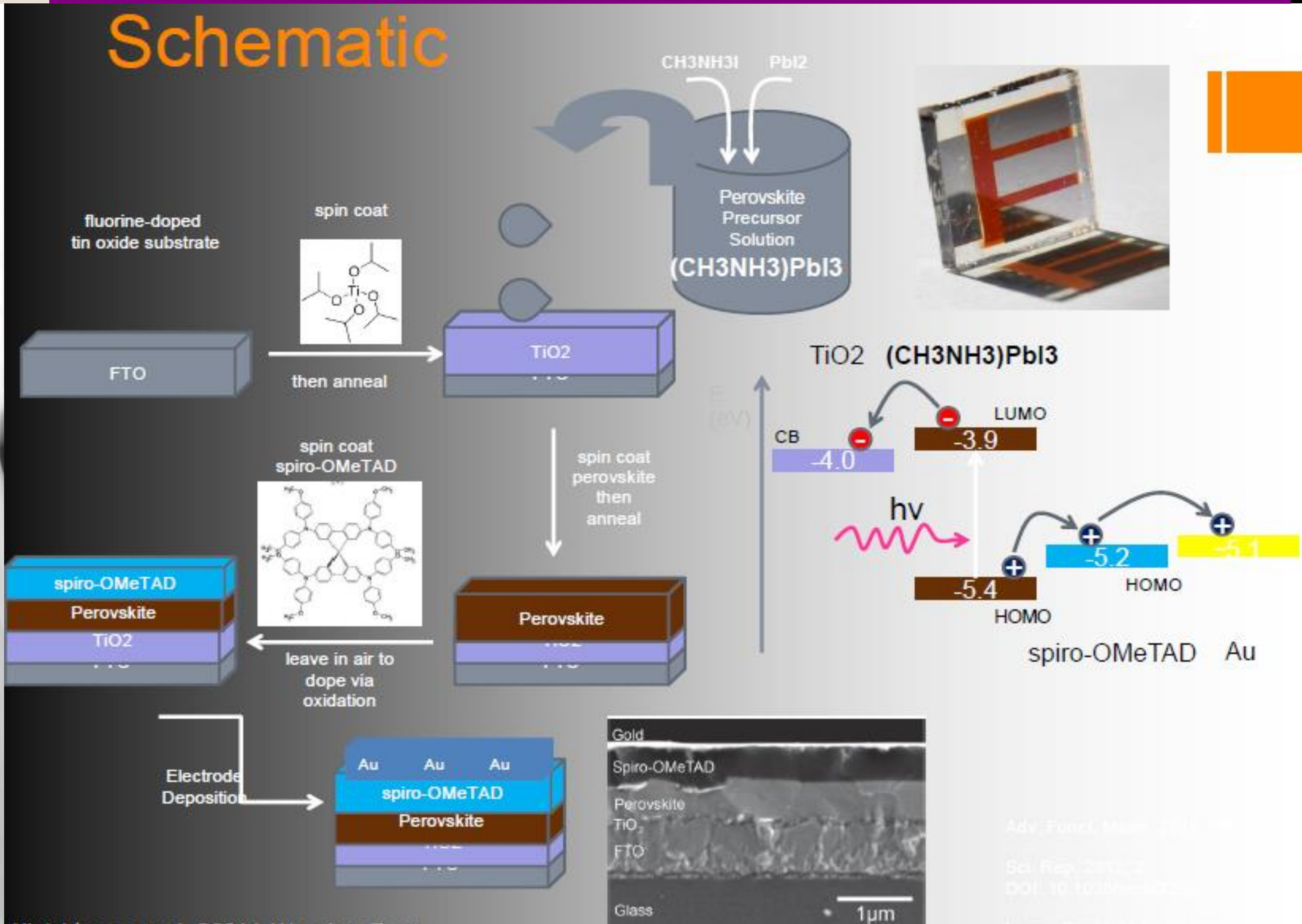
Sequential Deposition

2013, Grätzel sticks with the TiO2 structure and tinkered with the deposition step.



Nature. 2013, 499, 316

One step Method



Comparison between the single-step method and the two-step sequential deposition

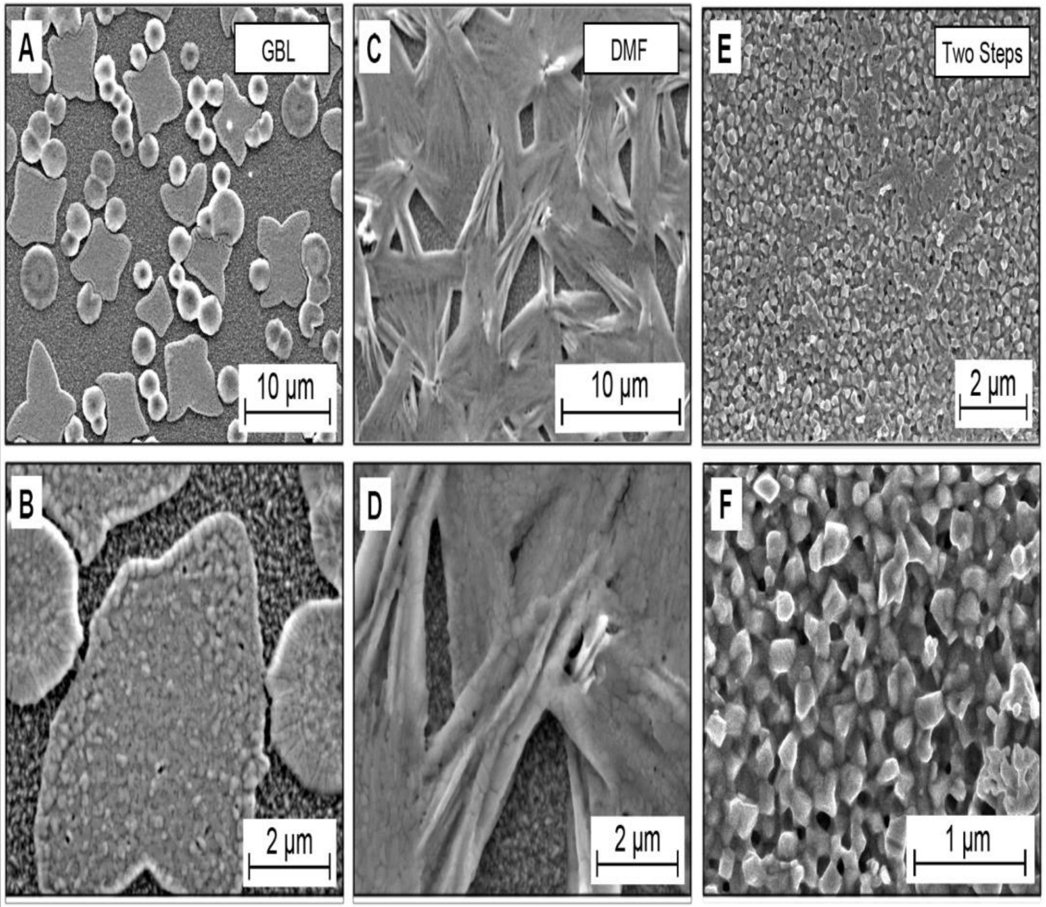


Figure S1.. A-D) $CH_3NH_3PbI_3$ deposited by spin-coating on a fluorine-doped tin oxide glass substrate using a mixed solution of PbI_2 and CH_3NH_3I (1:1, molar ratio) in A, B) y-butyrolactone (GBL) or C, D) N,N-dimethylformamide (DMF) solvent. In both cases the surface coverage is low and bare FTO is exposed. E, F) $CH_3NH_3PbI_3$ obtained using the sequential deposition method. The dipping time of the PbI2 film in the CH_3NH_3I/2-propanol solution was 30 s. Compared to the single-step method, the sequential deposition yields much smaller $CH_3NH_3PbI_3$ crystallites and full coverage of the FTO surface.

Current problems

1. Stability
2. Toxicity due to PB
3. Scale up related problems

Conclusion

- Perovskite absorber: polycrystalline, higher abs coeff., & higher carrier L_D
- Efficiency of > 20% can be achieved
- There is a bright future for perovskites p-i-n solar cells if the problems relating to stability and toxicity can be addressed
- Proposed configurations guarantee better interface layer engineering and charge transport.

H. Zhou, *Science, 345, 542(2014)*

Let the Photovoltaic Battle Begin!!!

Thanks for your attention!

NATIONAL TAIWAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF CHEMICAL ENGINEERING

HYDROPHOBICALLY MODIFIED CHITOSAN FOR SURFACE MODIFICATION OF MAGNETIC NANOPARTICLES: APPLICATIONS IN BACTERIA REMOVAL

Student : Vo Duc Thang

Professor: H. Hosseinkhani

January 12th, 2015

HYDROPHOBICALLY MODIFIED CHITOSAN (HMCS)

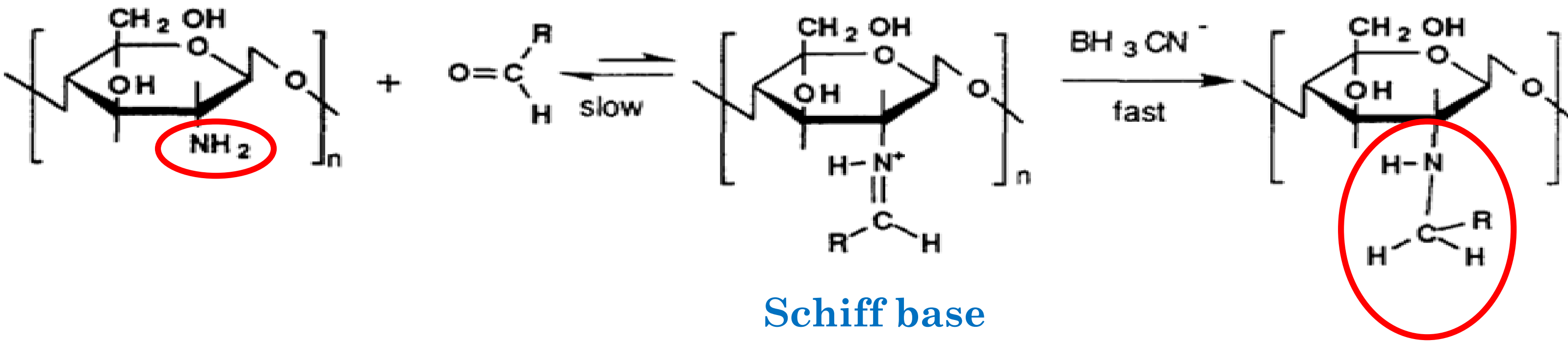
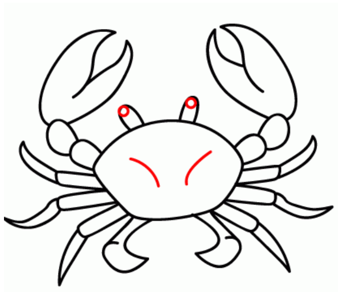
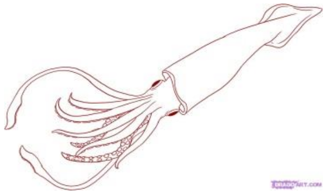
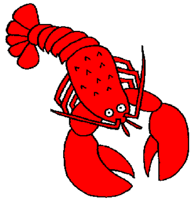


Fig. 1. Reaction mechanism of synthesis of HMCS



- Chitosan :
  - ✓ A linear copolymer.
  - ✓ Composed of glucosamine & N-acetylglucosamine residues.
  - ✓ A derivative of chitin (crab, shrimp, squid …).
  - ✓ Positive charge, low-toxicity biomaterial, …





- Production of chitosan :
  - ✓ Environmentally friendly.
  - ✓ Full biocompatible.

➡ Chitosan can be modified at amino groups to obtain HMCS.

J. E. St. Dennis et al. Soft Matter, 2011, 7, 4170 – 4173.

HYDROPHOBIC PROPERTIES

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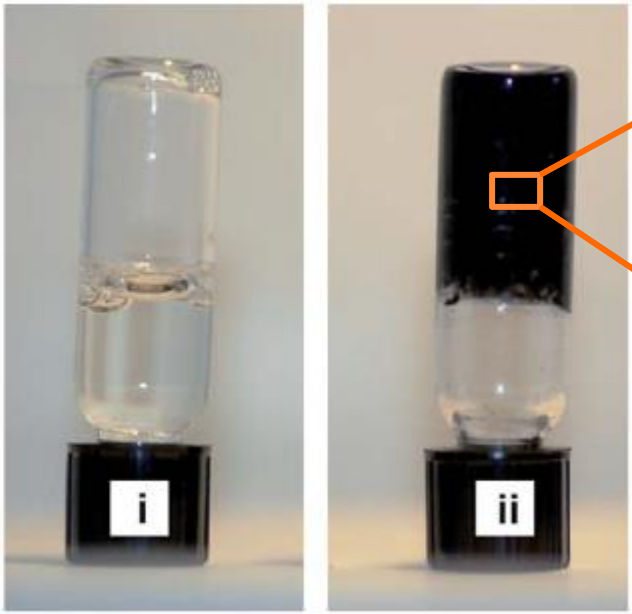
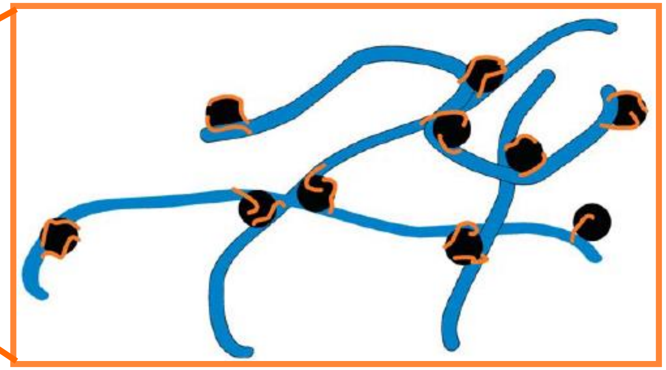
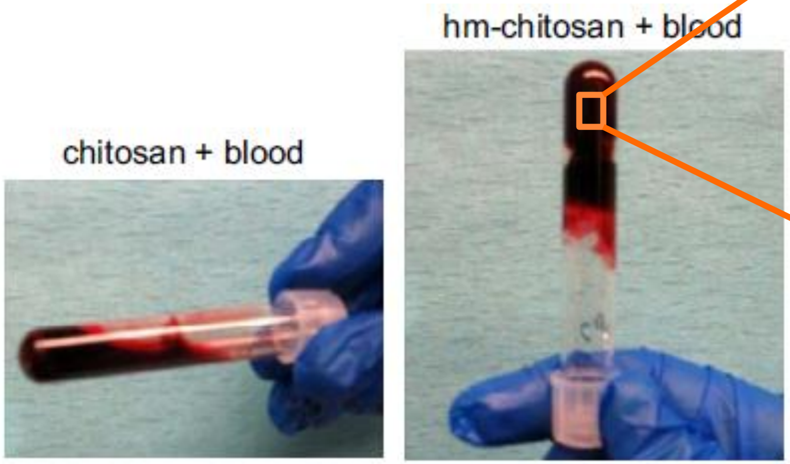
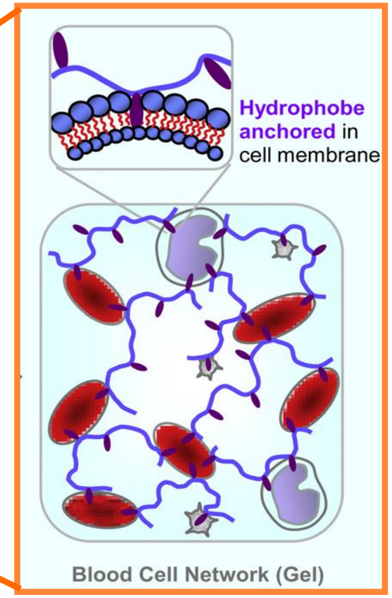




J. E. St. Dennis et al. Soft Matter, 2011, 7, 4170 – 4173





Matthew B. Dowling et al. Biomaterials 32 (2011) 3351-3357

HEMOSTATIC

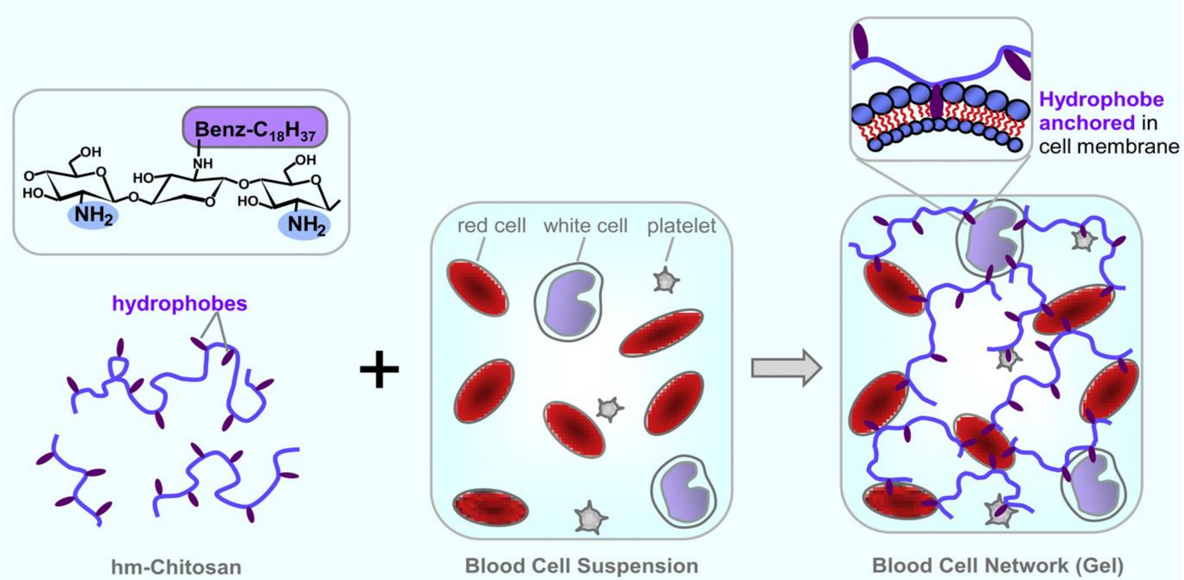
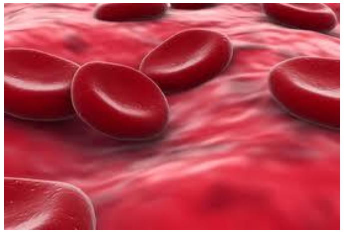


Fig. 3. Mechanism for gelation of blood by HMCS

- The chitosan/blood mixture is a freely flowing liquid.
- The HMCS/blood mixture is a self-supporting gel that holds its weight in the inverted tube.



Red blood cells
6 - 8μm

E. coli
2μm – 0.5μm

Dowling et al. Biomaterials 32 (2011) 3351-3357.

CELLS CAPTURE

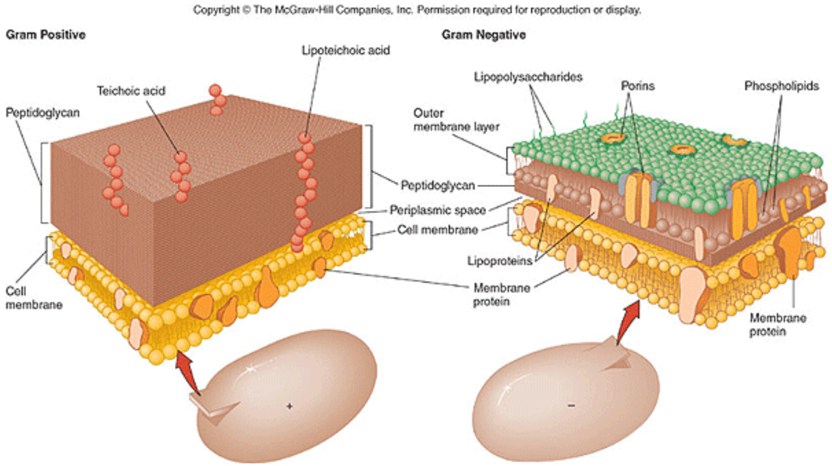


Fig. 4. Cell wall structure of bacteria

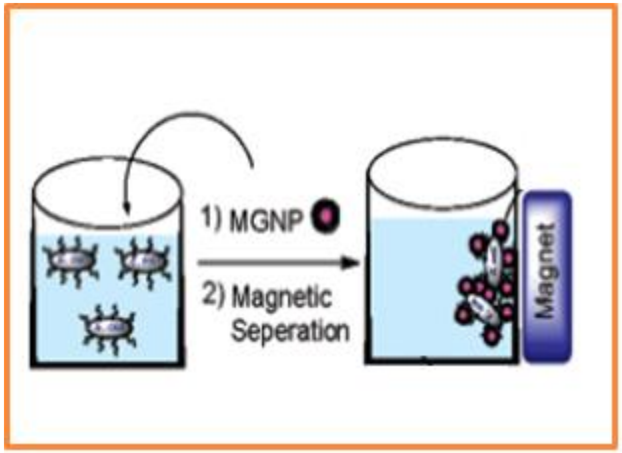


Fig. 5. Cells capture

BACTERIAL GELATION

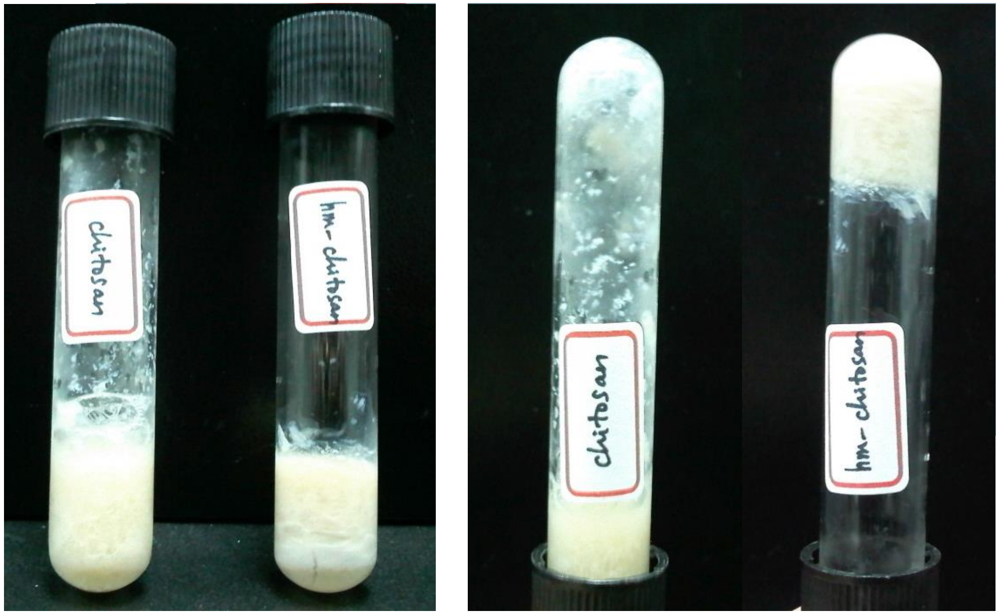


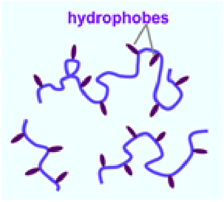
Fig. 6. 0.33% (w/v) chitosan and HMCS in *E. coli* suspension

- The chitosan/*E. coli* mixture is a freely flowing liquid.
- The HMCS/*E. coli* mixture is a self-supporting gel that holds its weight in the inverted tube → HMCS can anchor bacteria.

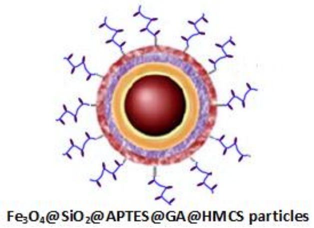
➡ *E. coli* can be recovered by HMCS grafted magnetic particles.

OBJECTIVES

Synthesis of HMCS



HMCS grafted magnetic particles



E. Coli **collection test**

PREPARATION OF HMCS

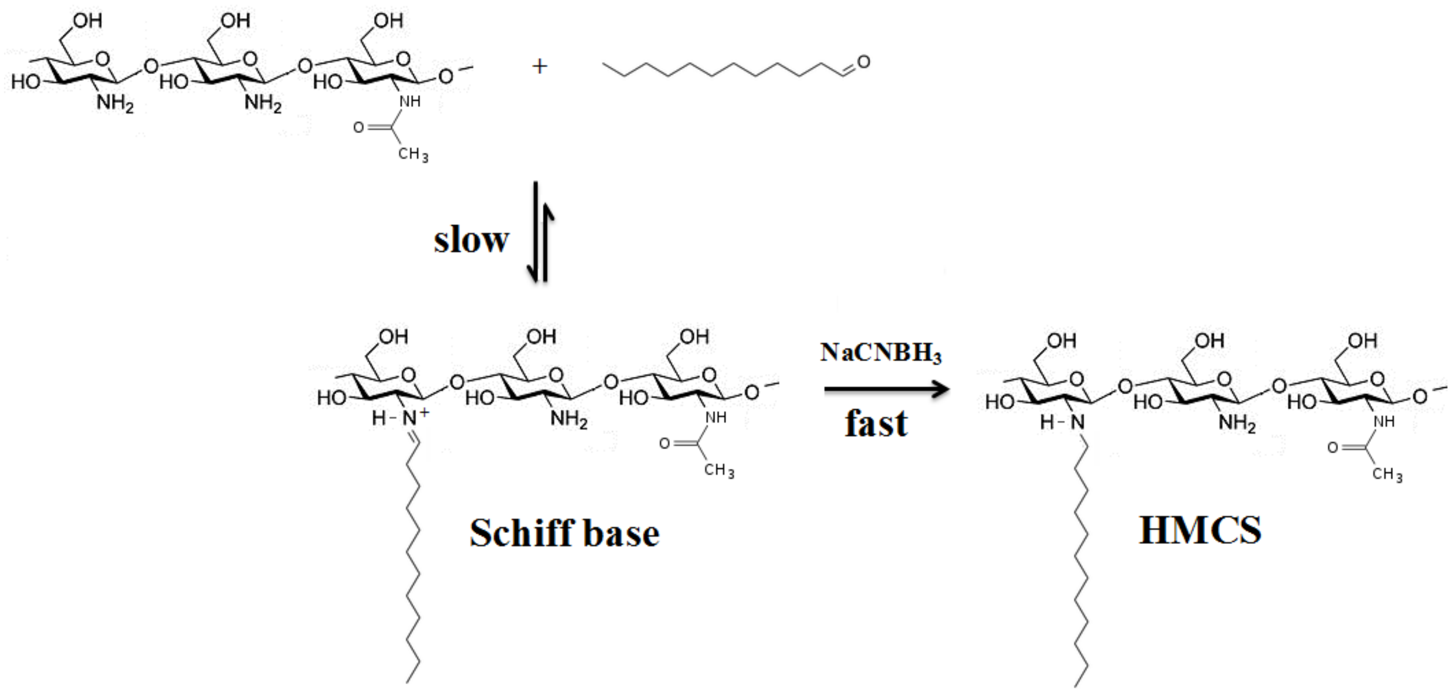


Fig. 7. Preparation of HMCS

HMCS GRAFTED MAGNETIC PARTICLES

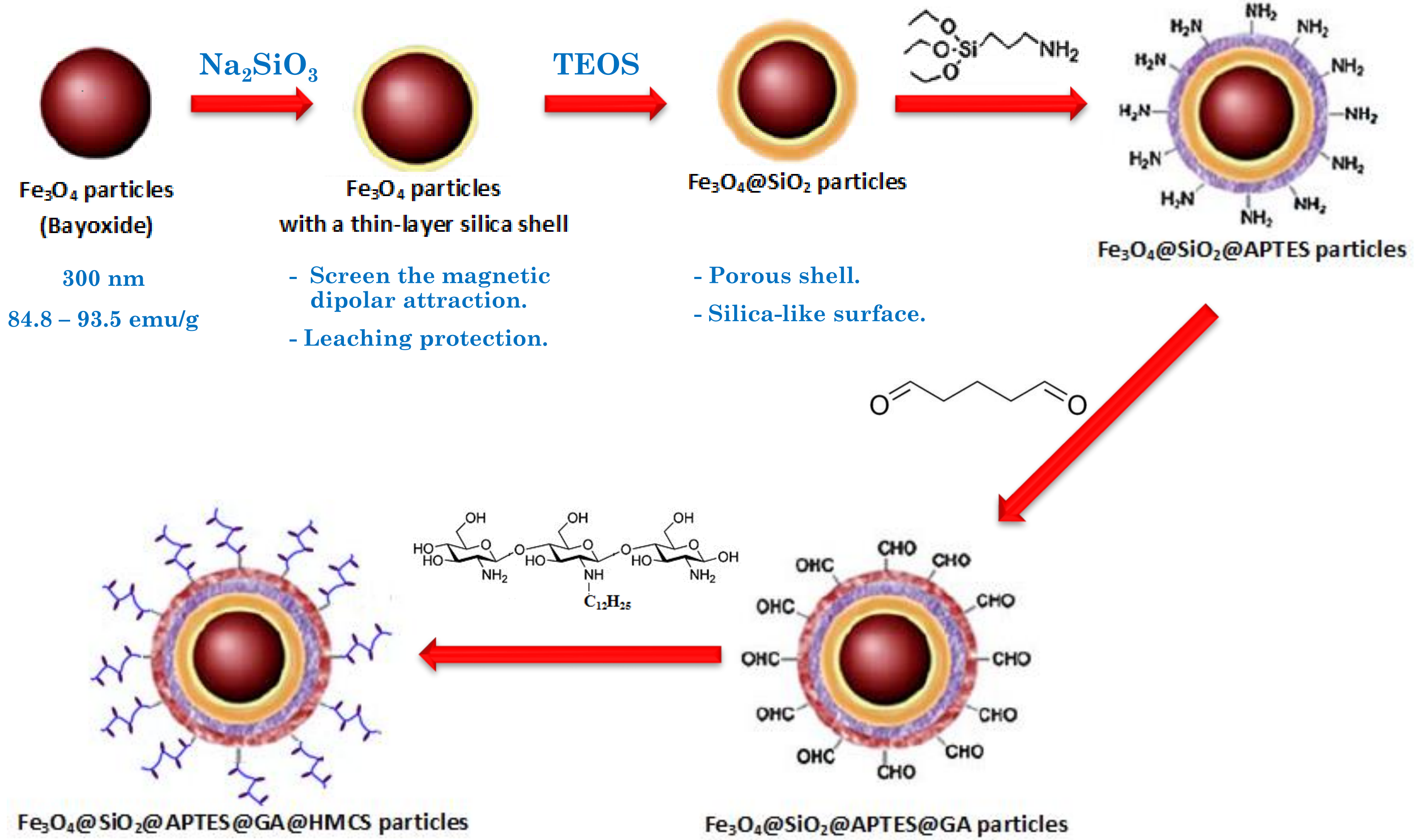


Fig. 8. HMCS grafted magnetic particles procedure

E. coli COLLECTION

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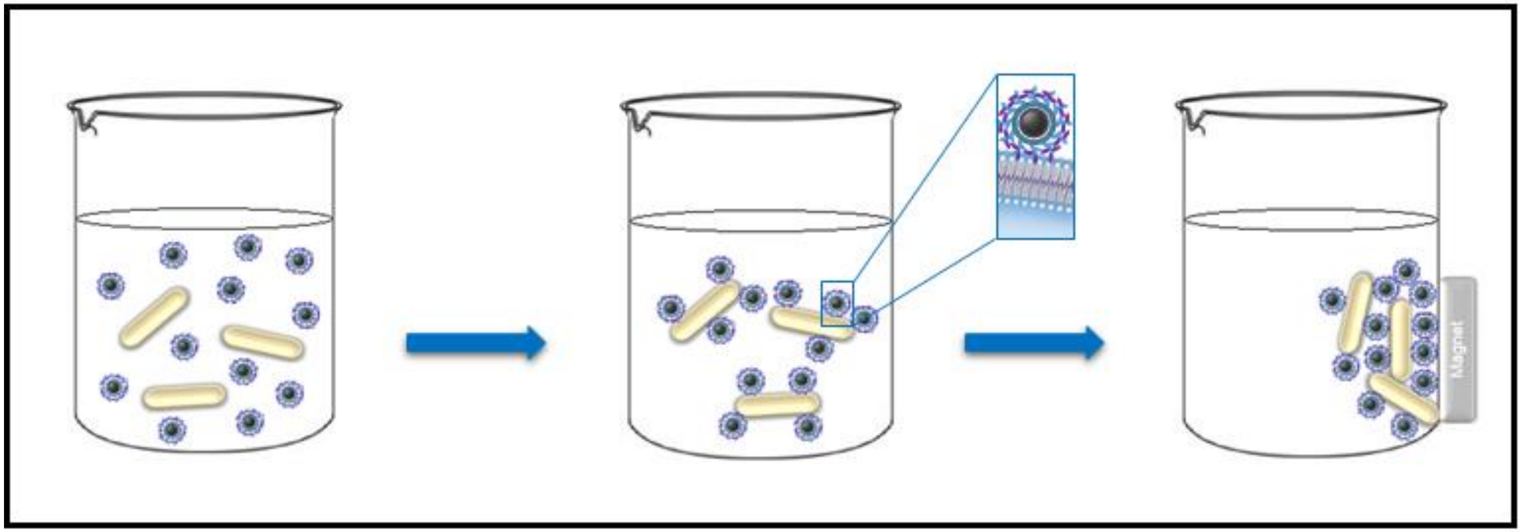


Fig. 9. Schematic diagram of *E. coli* cells removal from contaminated solution by using MNPs@HMCS.

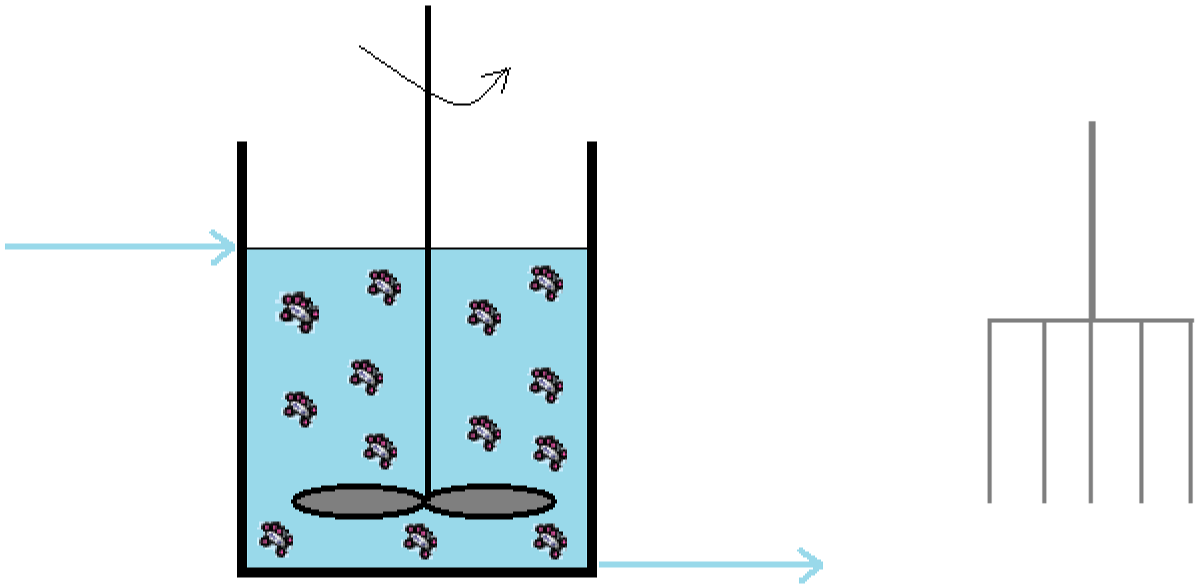
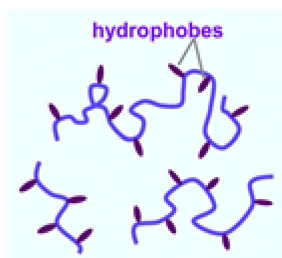
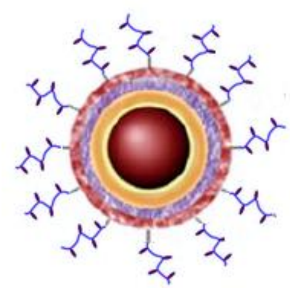


Fig. 2. Reactor and magnetic sticks

THANK YOU FOR YOUR ATTENTION





Fe3O4@SiO2@APTES@GA@HM-CS

E. coli COLLECTION OF @HMCS

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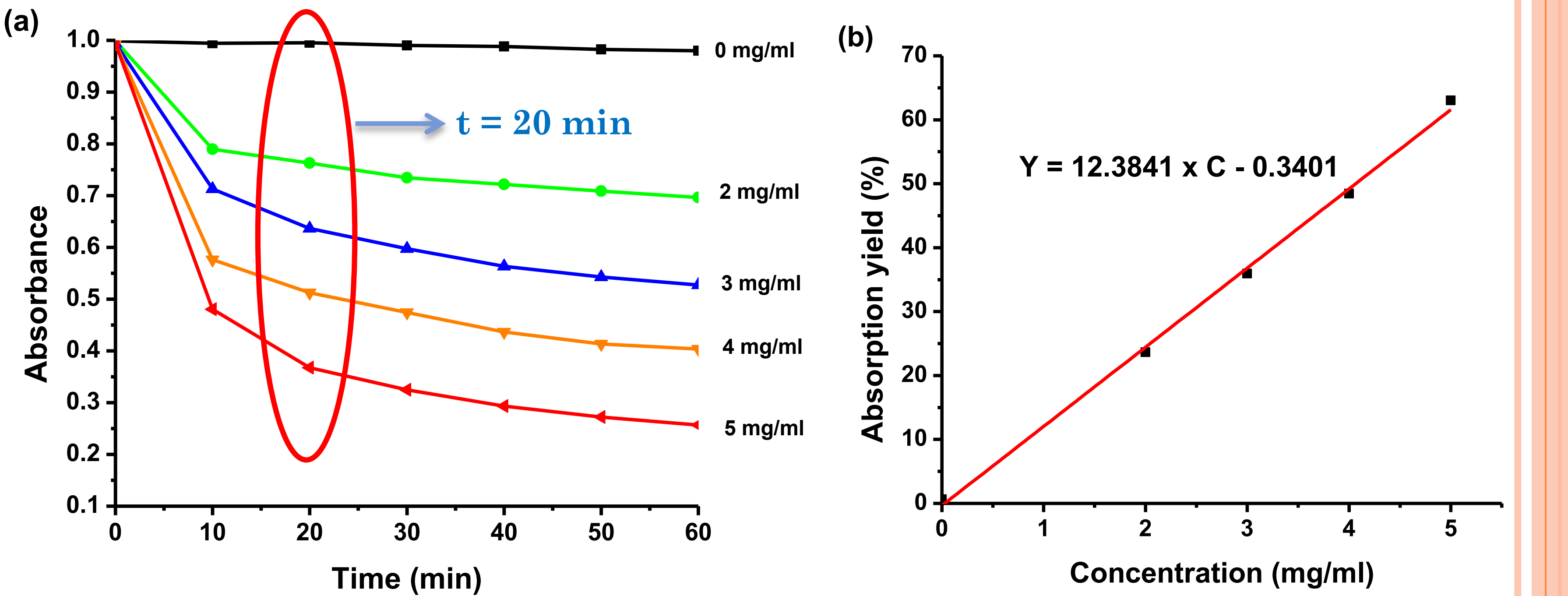


Fig. 7. *E. coli* in PBS with different concentrations of @HMCS particles

- Bayoxide doesn’t have the effect on *E. coli* collection.
- Chitosan has a weak effect on *E. coli* collection.
- HMCS has a stronger effect on *E. coli* collection.

➡ The hydrophobic tail can anchor the membrane of the cells.

UV ABSORPTION KINETIC OF *E. COLI* COLLECTION

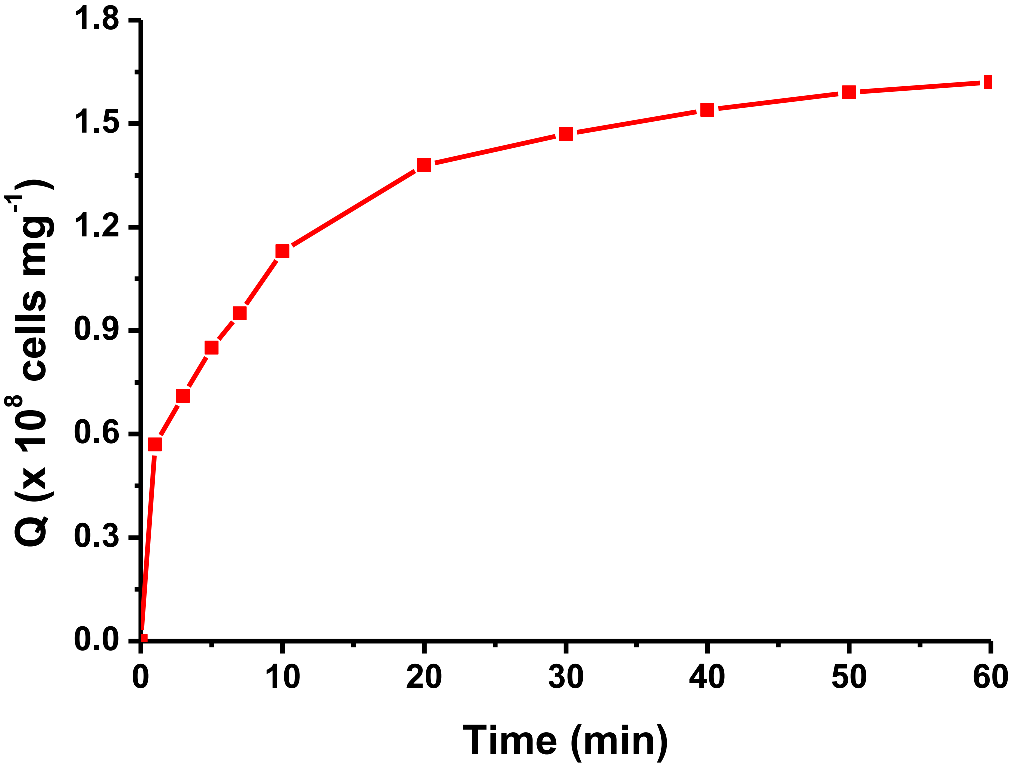


Fig. 8. The UV absorption kinetic of *E. coli* collection (5 mg/ml HMCS particles).

➡ High recovered capacity after 20 min: Q = 1.38 x 10^8 cells mg^{-1}.

S. aureus COLLECTION

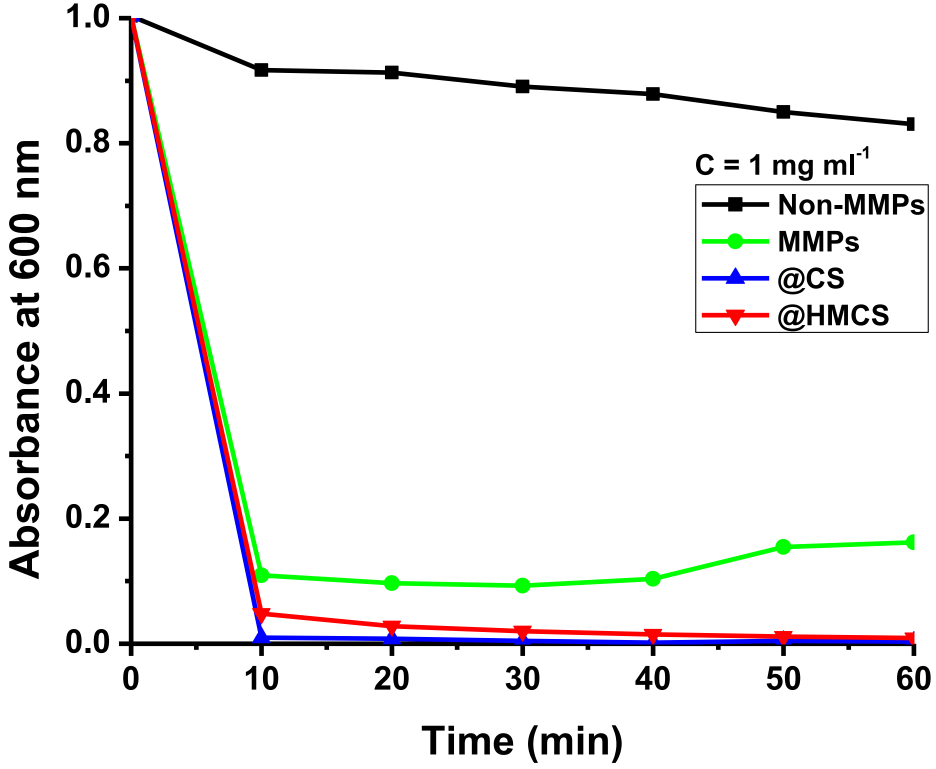
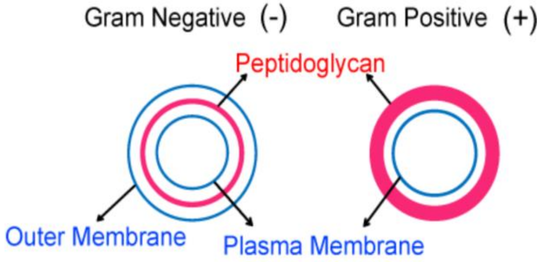
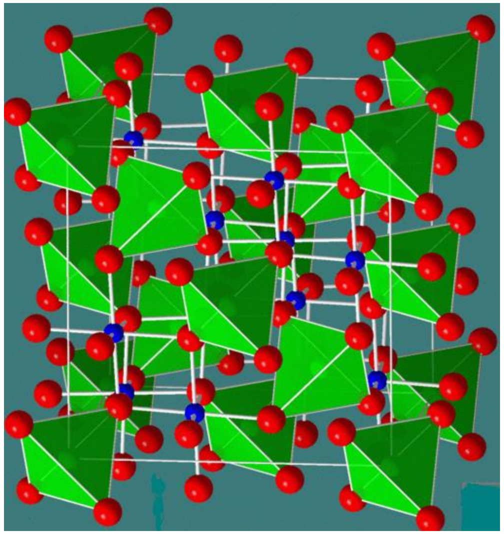


Fig. 9. S. aureus collection of @HMCS particles in PBS (1 mg ml^{-1}).

- Gram negative bacteria : outer membrane.
- Gram positive bacteria : cell wall.



Direct Fabrication of Cobalt Oxide Nano-particles Employing Glycine as a Combustion Fuel



by

Tharwat H.M. Mansoure

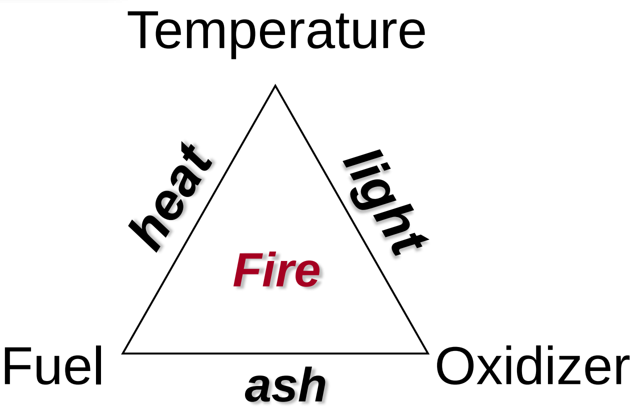
PhD. Student
Nano Science and Technology Program
Institute of Chemistry, Academia Sinica

Introduction

Combustion “or Fire” synthesis

Solid-state combustion

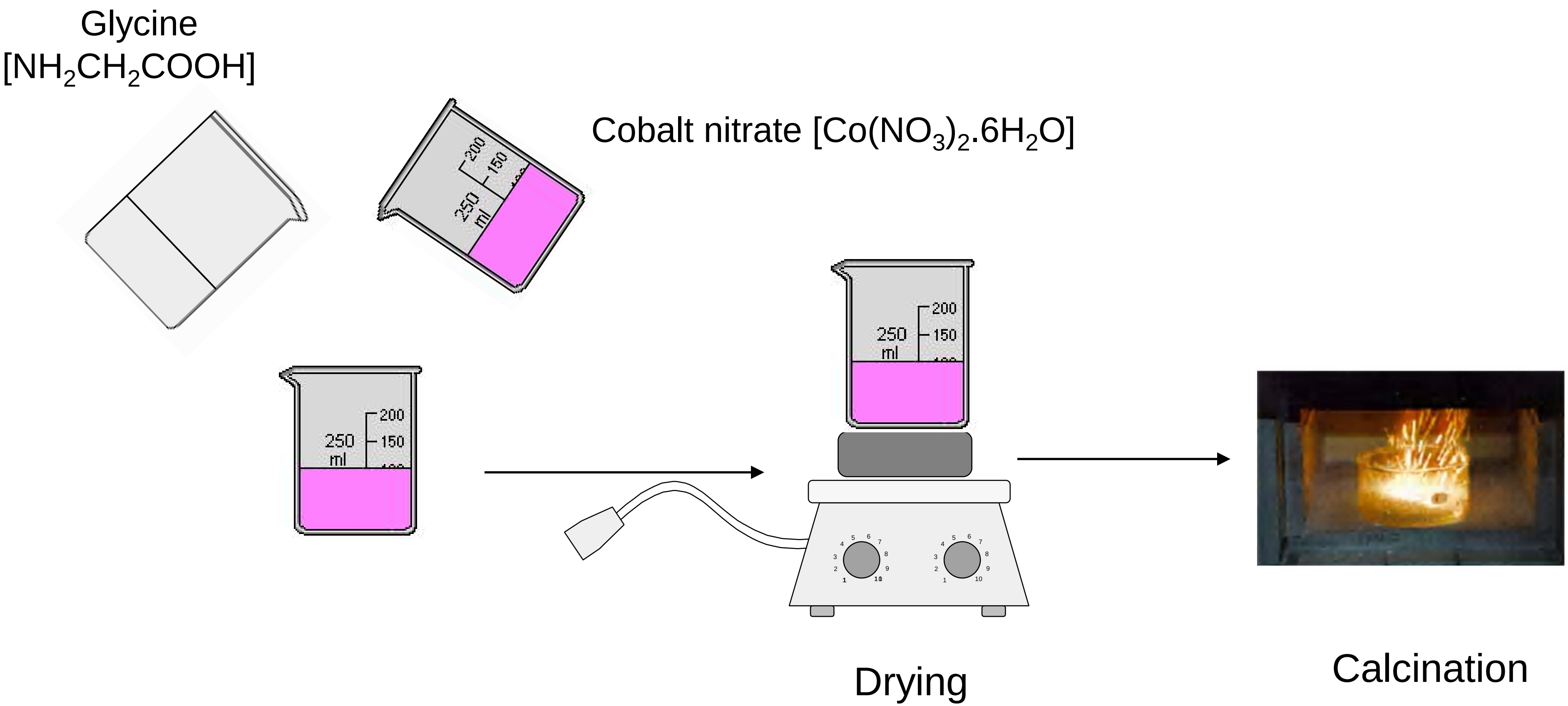
Solution combustion (SCS)



Advantages of SCS:

1. The initial reaction media being in the liquid state.
2. Short process duration.
3. Formation of various gases during combustion.
4. simple and low cost method.
5. It yield homogenous, crystalline, and high-purity product.

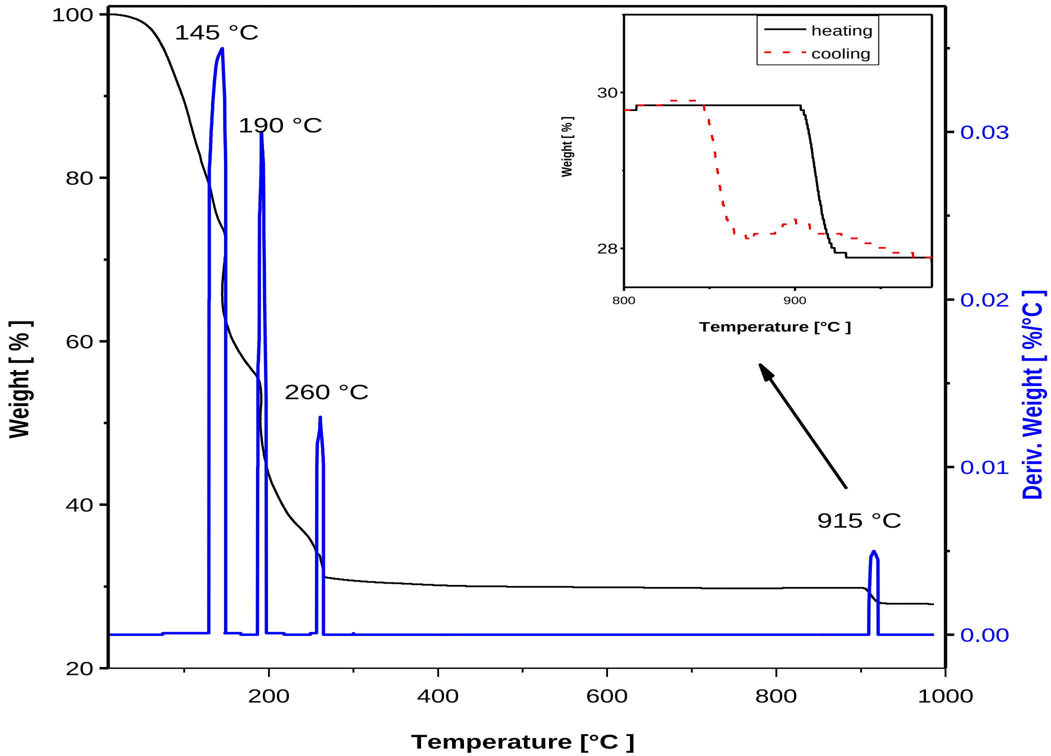
Experimental



Thermal Analyses

TGA

$$Co_3O_4 \longrightarrow 3CoO + 1/2O_2 \;\ldots\ldots\ldots\ldots (1)$$

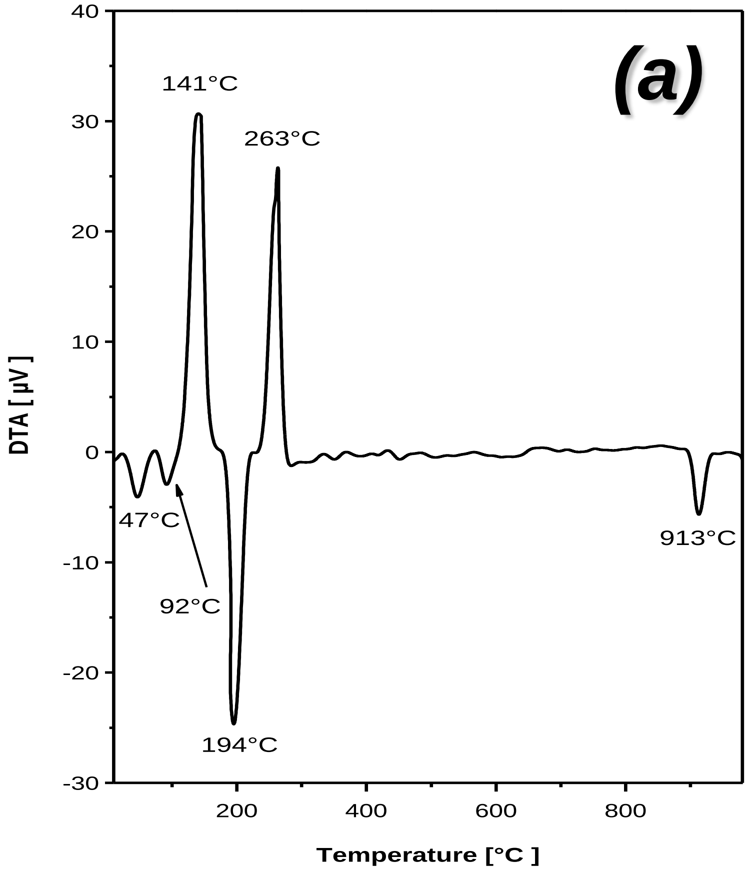


Precursor with F/O 0.5

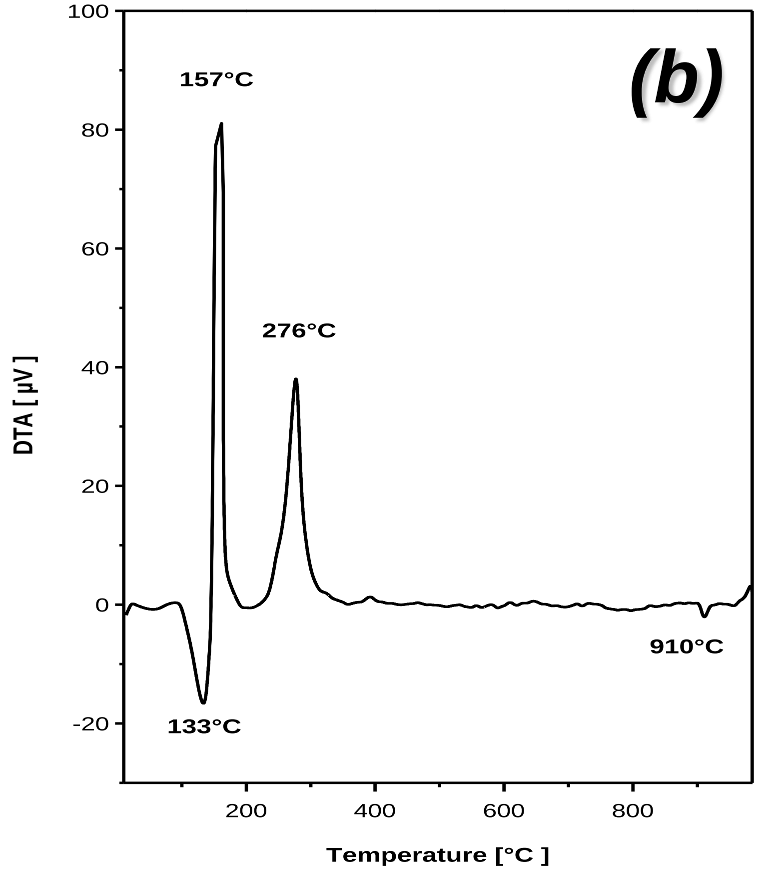
Step	Weight loss (%)
1	27
2	27.4
3	9
4	2.5

Thermal Analyses

DTA



Precursor with F/O 0.5



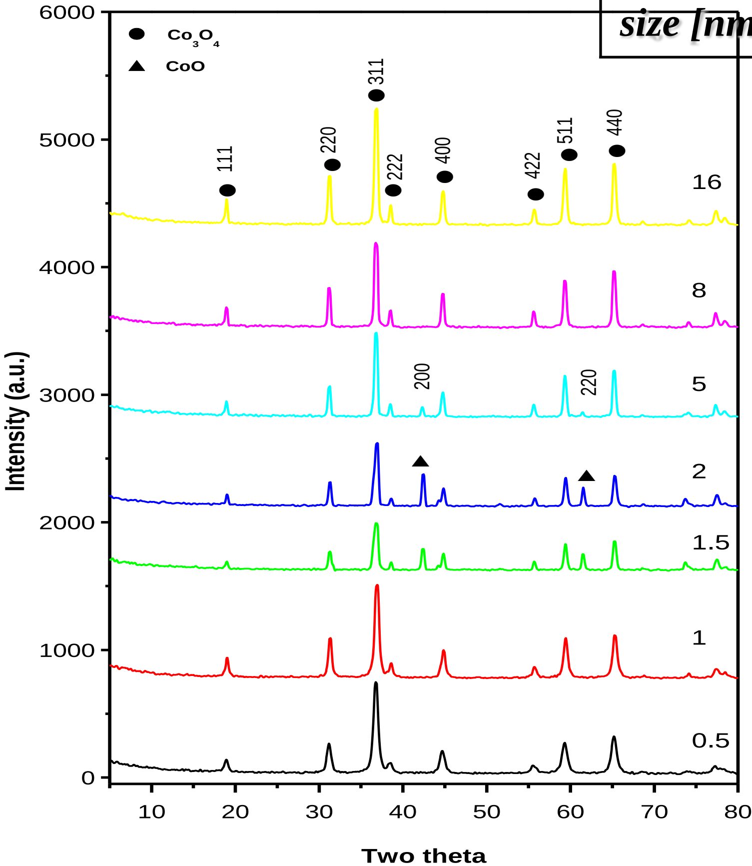
Precursor with F/O 2

X-ray diffraction

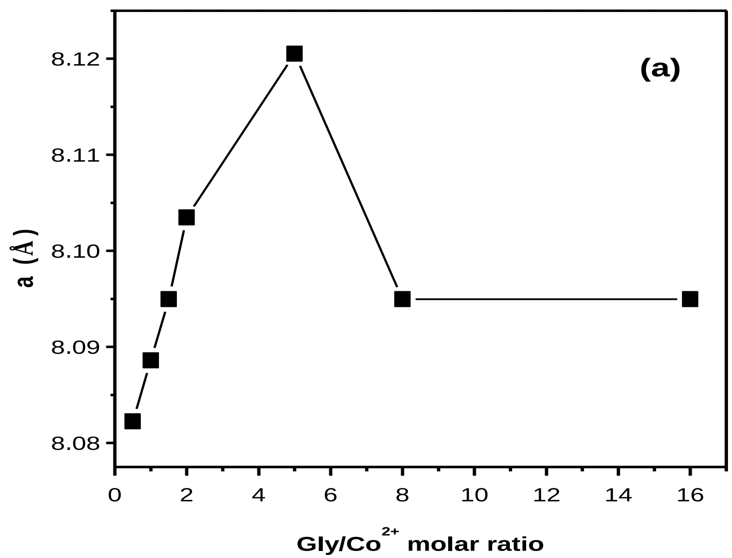
Glycine/Co^{2+} molar ratio	0.5	1	1.5	2	5	8	16
Average Crystallite size [nm]	15.3	16.9	17.9	18.4	23.8	21.9	21.9

$$D = \frac{K\lambda}{\beta \cos\theta}$$

Scherrer equation

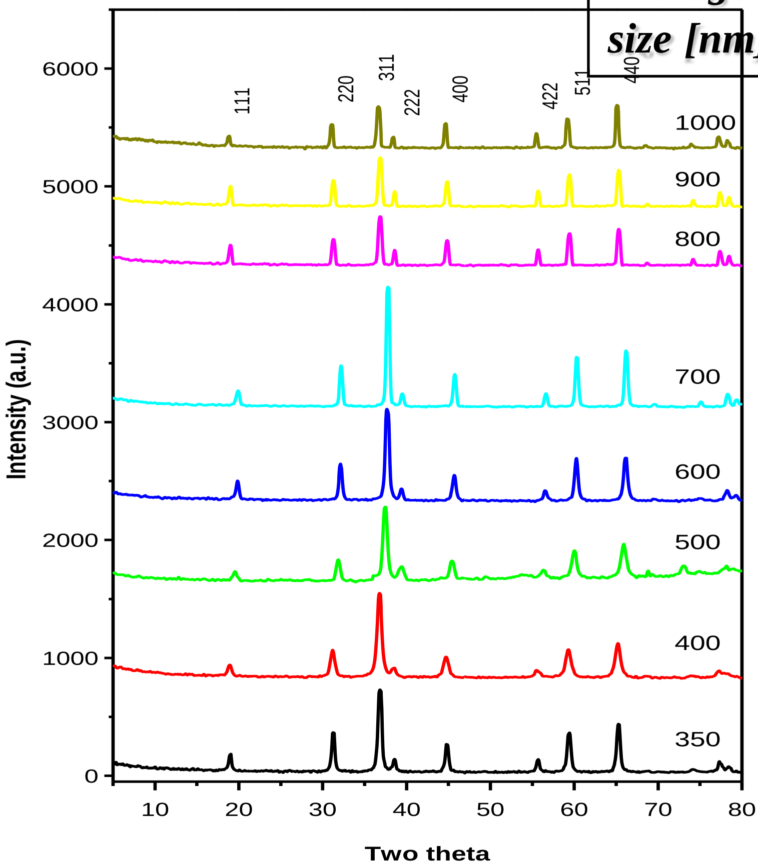


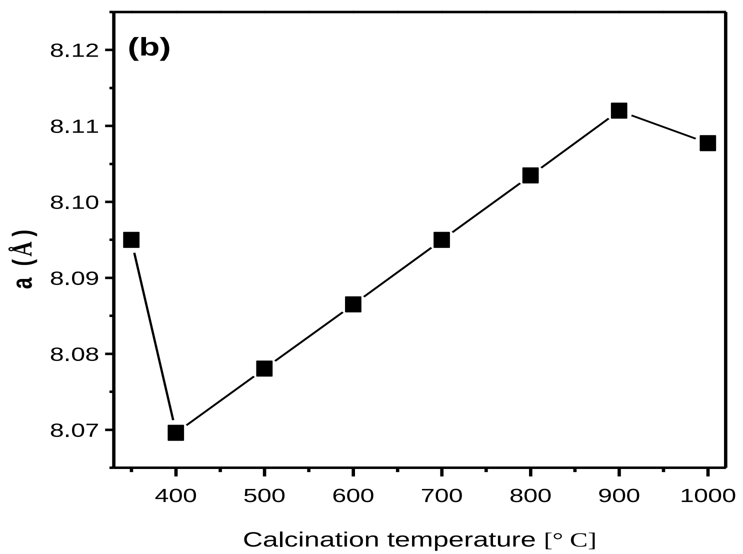
Effect of F/O



X-ray diffraction

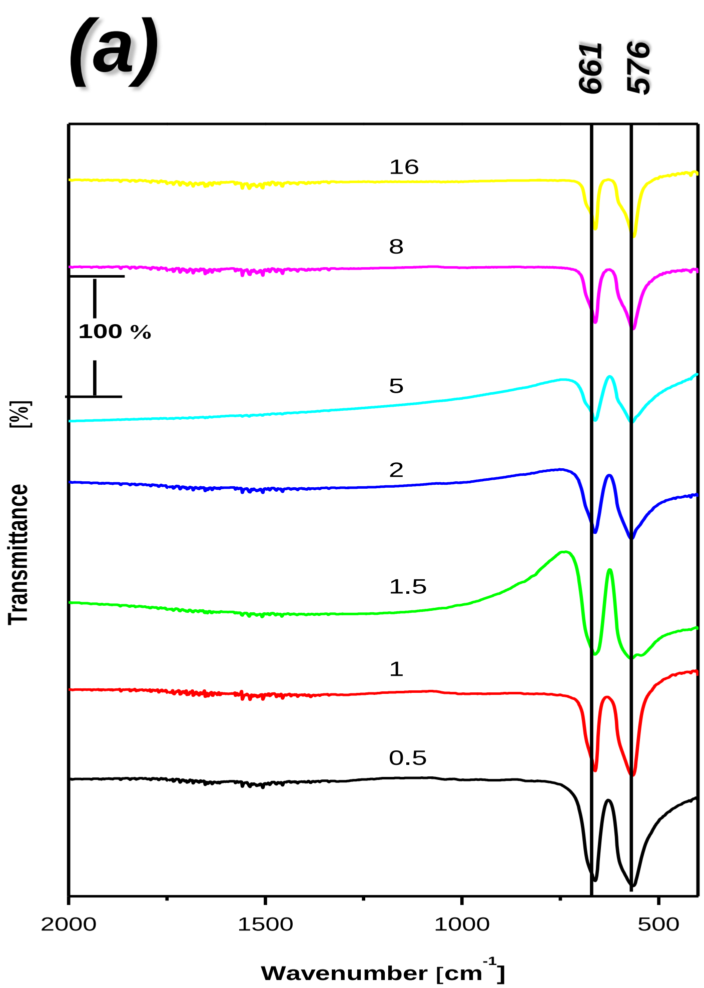
Calcination temperature	350	400	500	600	700	800	900	1000
Average Crystallite size [nm]	21.6	15.3	15.5	20.7	24	28.2	29.5	28



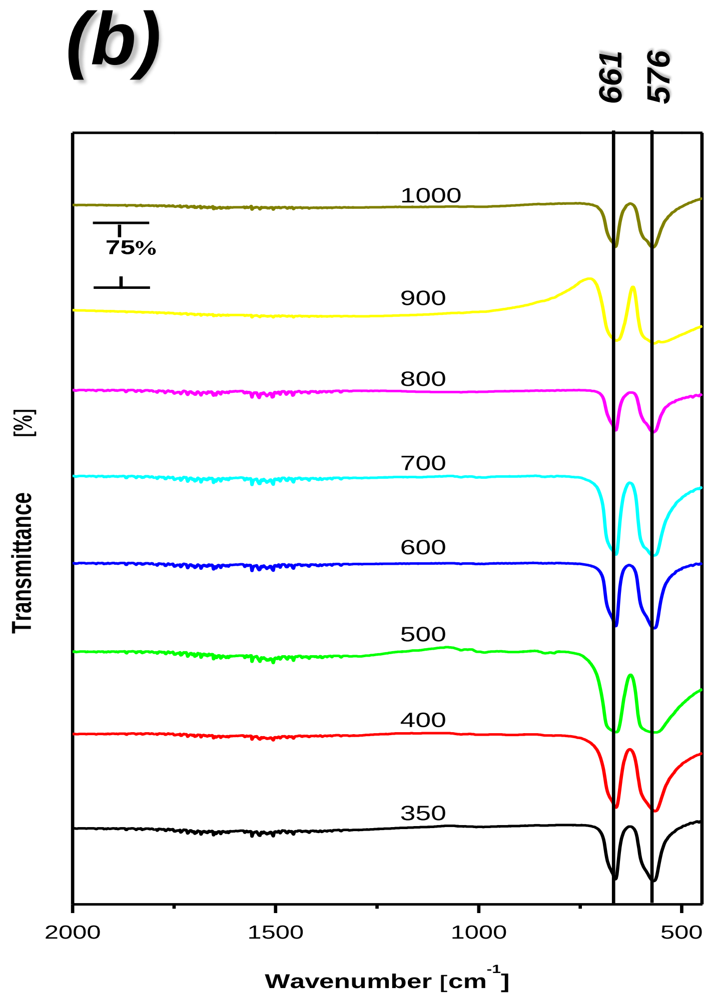


Effect of calcination temperature

Infrared Spectra

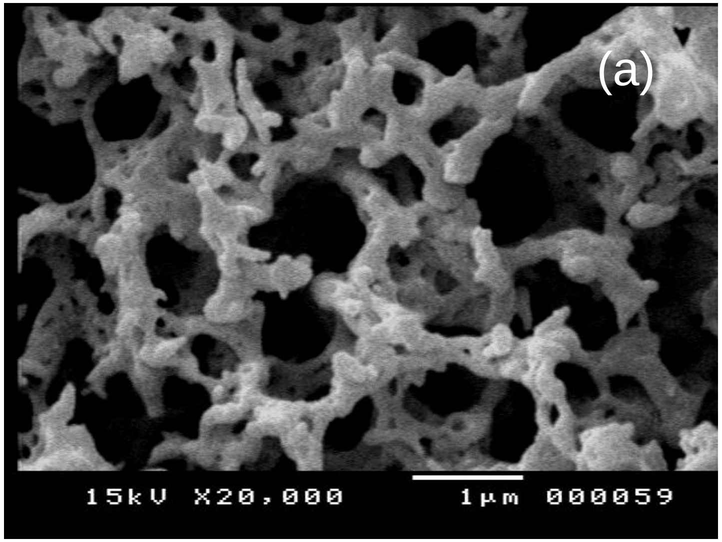


Effect of F/O

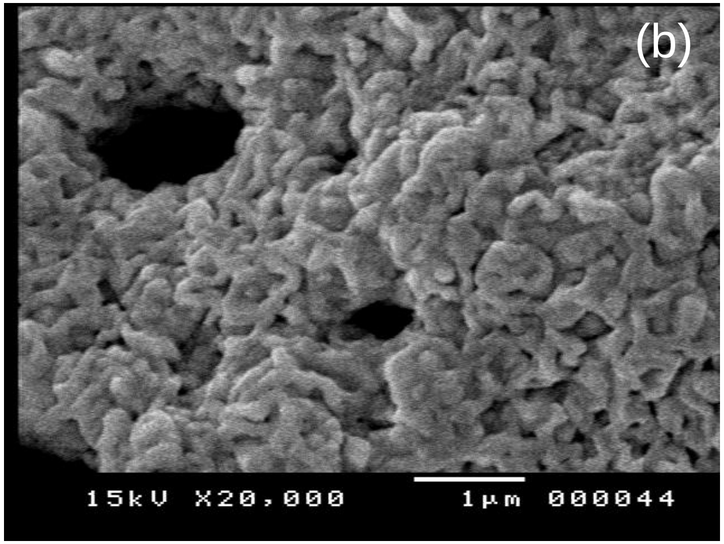


Effect of calcination temperature

Scanning Electron Microscope

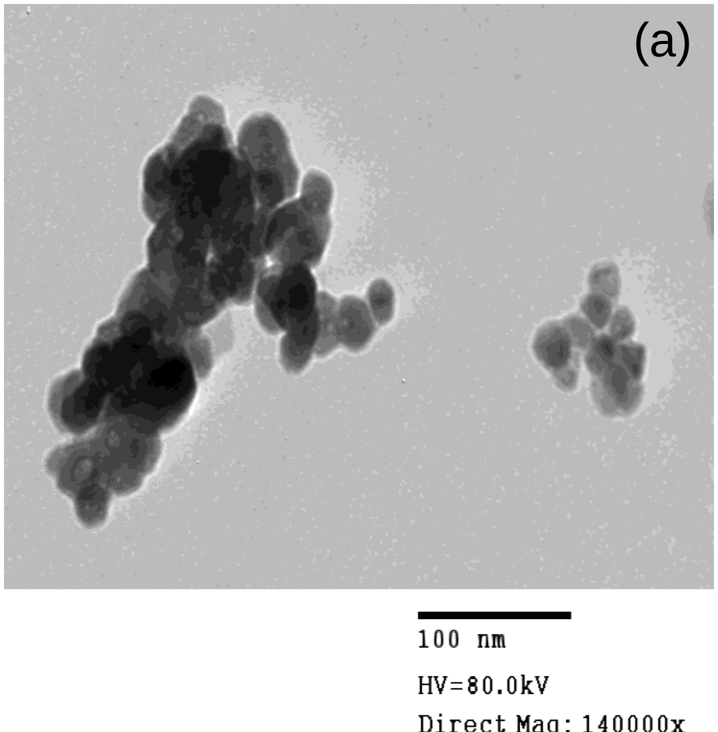


F/O = 1

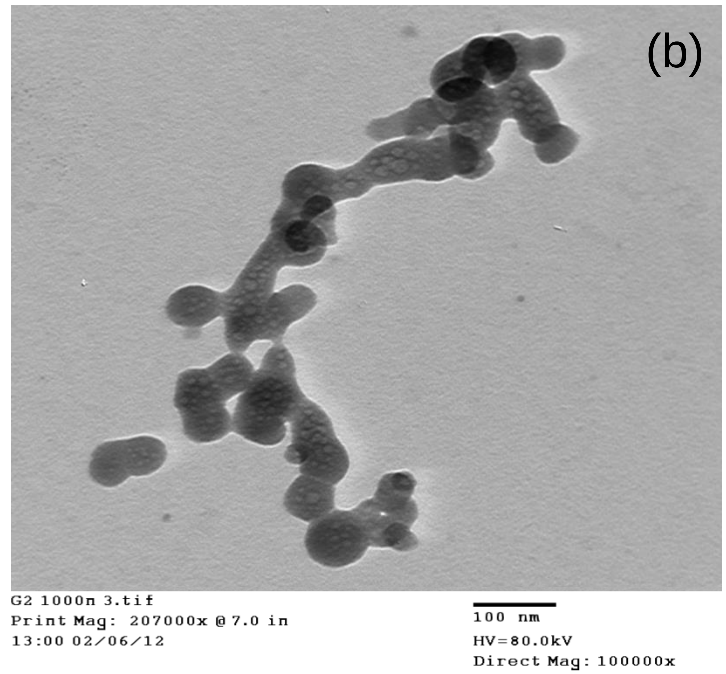


F/O = 5

Transmission Electron Microscope



400 °C



1000 °C

Conclusion

With the already presented results in mind, the following conclusion could be drawn :

1. Combustion process consists of three important elements, namely oxidizer, fuel and ignition temperature.

2. By this method, ultra-fine powders could be produced due to the prevention from both the over-growth of crystallites and the agglomeration of particles.

3. In addition, this methodology can lead the system to a good chemical homogeneity as the reagents were mixed in an aqueous solution. The other advantages include inexpensive raw materials, a relatively simple preparation process, and a fast production rate.

4. The calcined powders showed the presence of regular particles, with narrow particle size distribution.


Thank You!

High Performance Li-S Battery using NanostructuredLi_2S as a Cathode Material

Nanotechnology Student Project Part-1

Presenter : Tilahun Awoke Zegeye (D10204809)

NanoElectrochemistry, Department of Chemical Engineering, Taiwan Tech

Outlines

1. **Introduction**
2. **Innovated works**
3. **Summary**
4. **Future work**

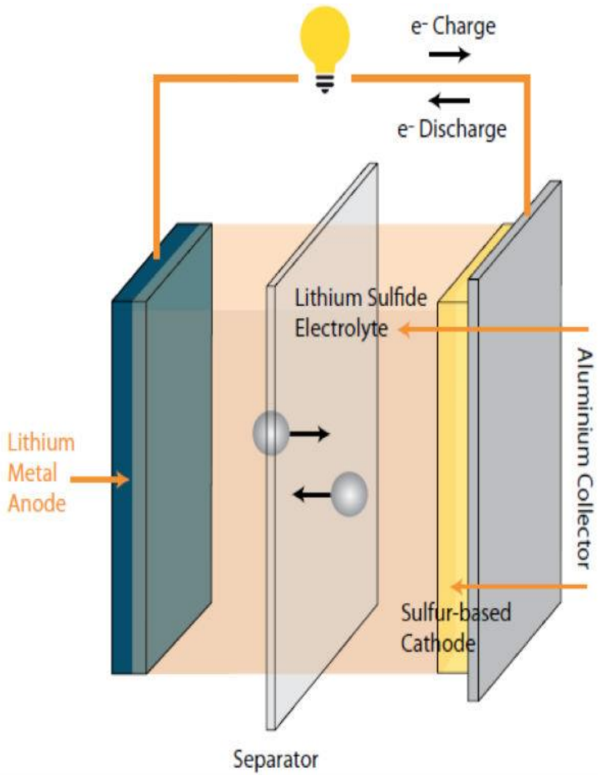
Introduction

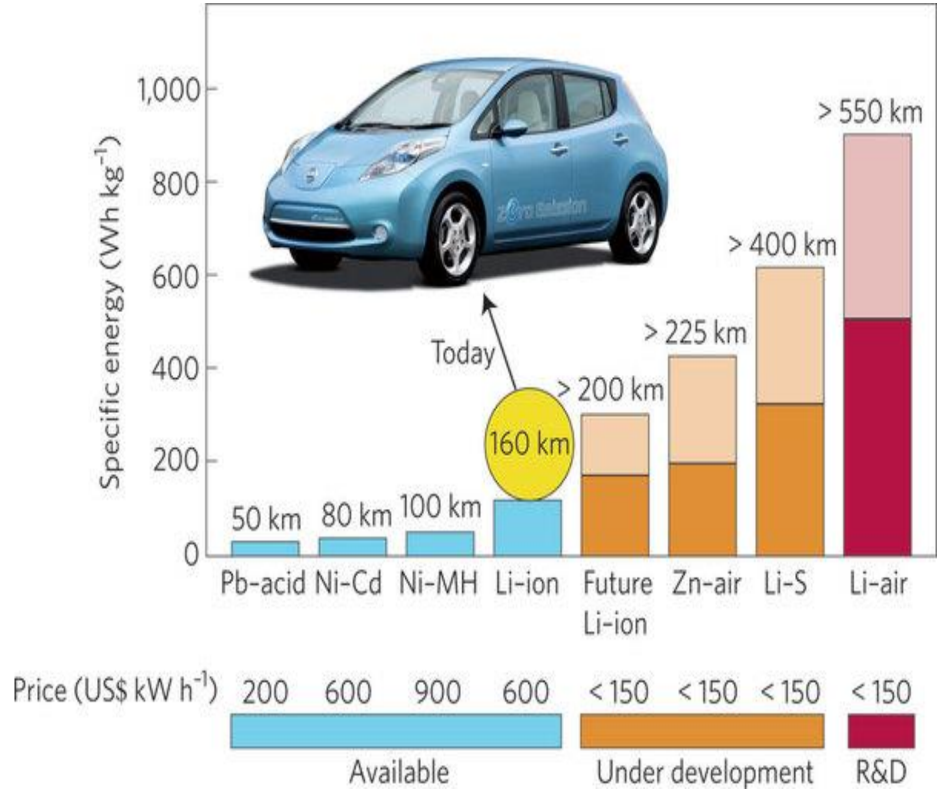
- Lithium-Sulfur batteries have attracted great interest in recent years.

Why Li/S??

- **High specific capacity**≈1675mAh/g
- High energy density ≈2600Wh/kg
- Utilize S as cathode materials to react with Li reversibly.
- Sulfur is abundant, low-cost & environmental friendly.

Con't…..





Discharging: $S_8 \rightarrow Li_2S_8 \rightarrow Li_2S_6 \rightarrow Li_2S_4 \rightarrow Li_2S_3$

Charging: $Li_2S \rightarrow Li_2S_2 \rightarrow Li_2S_3 \rightarrow Li_2S_4 \rightarrow Li_2S_6 \rightarrow Li_2S_8 \rightarrow S_8$

Li/S can't be used commercially

- ✓ Low active material utilization
- ✓ Poor cycle life & low columbic efficiency
- ✓ The use of Li metal anode creates short circuit & Safety issues.

- insulating nature of S & solubility of Li_2S_x in liquid electrolytes
- arising from dissolved Li_2S_x shuttle & large volume change
- Due to formation of Li-dendrite

To prevent this safety issue

⇩

✓Lithium free anode materials should be used

✓ Use fully lithiated S cathode materials should be used as Li_2S.

Energy & Environmental Science

ROYAL SOCIETY OF CHEMISTRY

COMMUNICATION

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Facile synthesis of Li_2S–polypyrrole composite structures for high-performance Li_2S cathodes†

Cite this: *Energy Environ. Sci.*, 2014, 7, 672

Received 12th October 2013
Accepted 29th November 2013

DOI: 10.1039/c3ee43395a

www.rsc.org/ees

Zhi Wei Seh,[a] Haotian Wang,[b] Po-Chun Hsu,[a] Qianfan Zhang,[c] Weiyang Li,[a] Guangyuan Zheng,[d] Hongbin Yao[a] and Yi Cui*[ae]

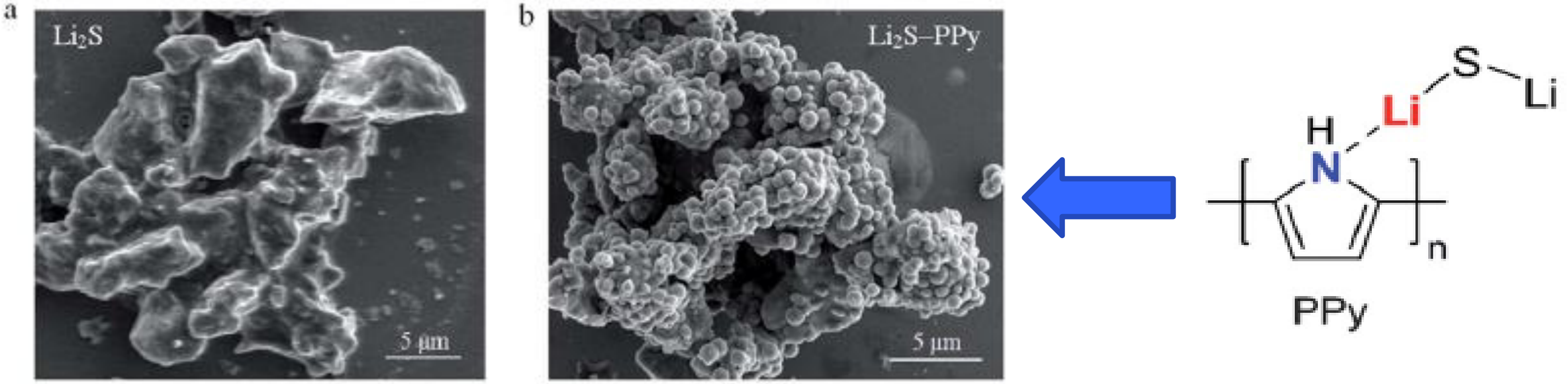
✓ **Li_2S- suffer from:**

1. **Low electronic and ionic conductivity**
2. **Dissolution of polysulfide's**

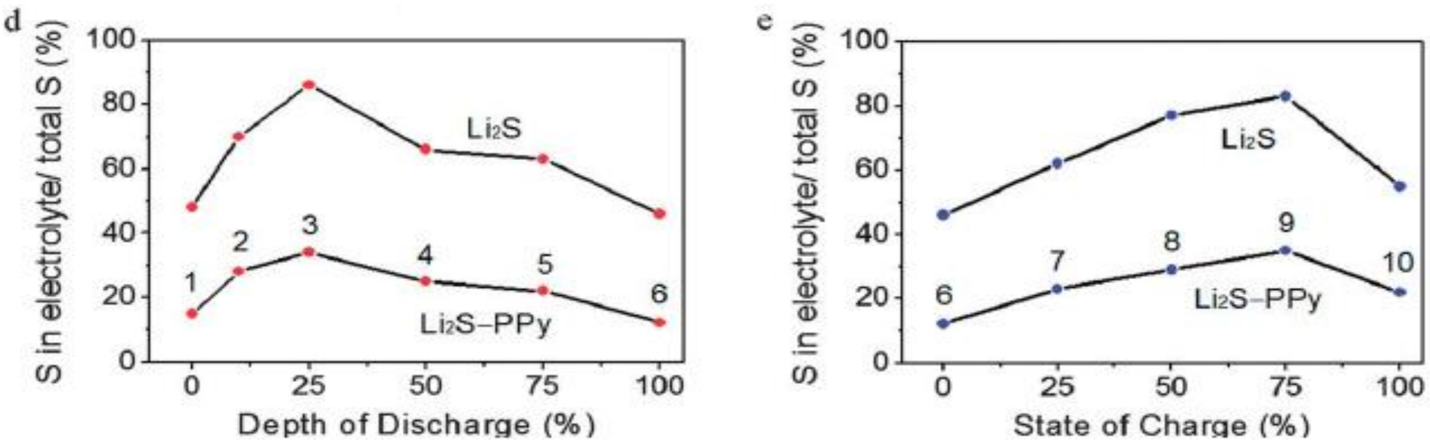
- Fast capacity fading and
- Low coulomb efficiency

Methods

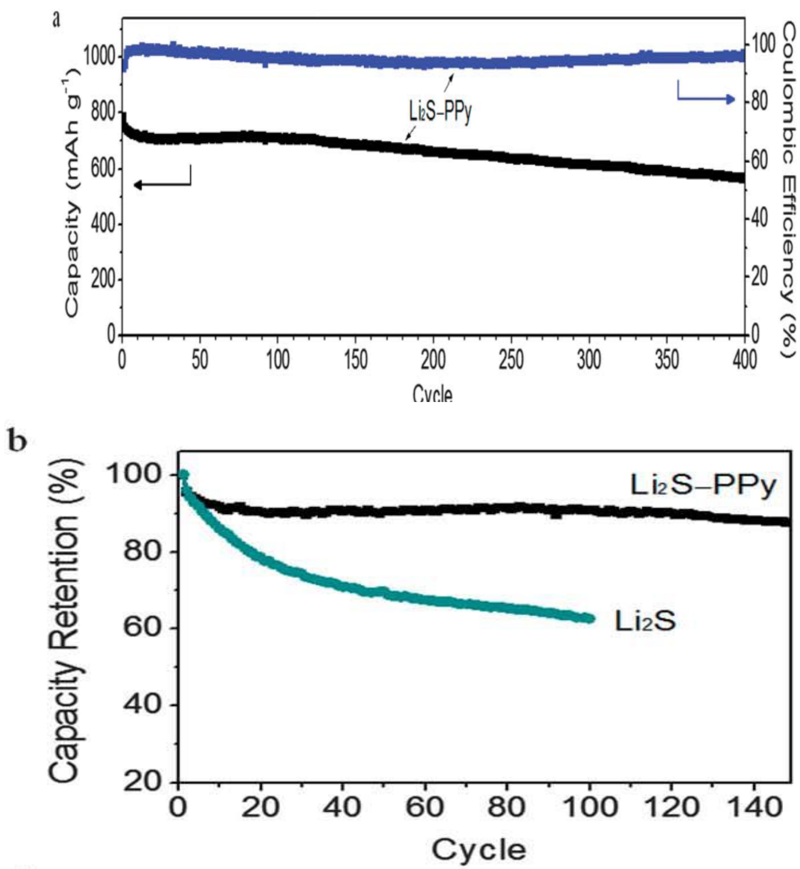
- **Li_2S-Ppy/C**
- N-methyl-2-pyrolidin(Binder)
- Li-bis(trifluormethane sulfonyl)-imide(Elec.)
- 1,2-dimethoxyethane&1,3-dioxalane(1:1)
- $LiNO_3$ additives to the electrolyte

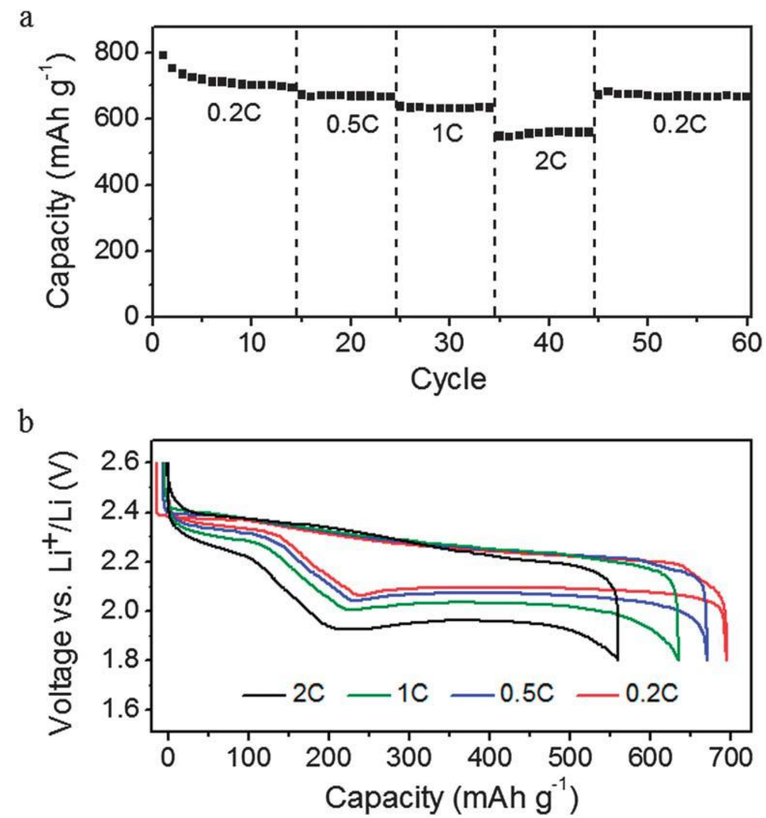


✓ **Comparison of dissolution of S in electrolyte at** various stage of cycling for Li_2S & Li_2S-PPy



Con’t........





a. Specific capacity and columbic efficiency of Li_2S-Ppy Composite cathode upon prolonged cycling over 400cycles at 0.2C rate

b. Capacity retention of Li_2S-Ppy cycled at 0.2C compared with pristine Li_2S cathode.

C-rate increases from 0.2C to 0.5C to 1C to 2C,

- Stability increases at capacity 695,670, 635&560mAh/g
- Capacity achieved 0.5, 1 and 2C.
- All capacities> 80% of 0.2C, indicate good reaction kinetics in the cathodes.

JACS
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Article
pubs.acs.org/JACS

Durable Carbon-Coated Li_2S Core–Shell Spheres for High Performance Lithium/Sulfur Cells

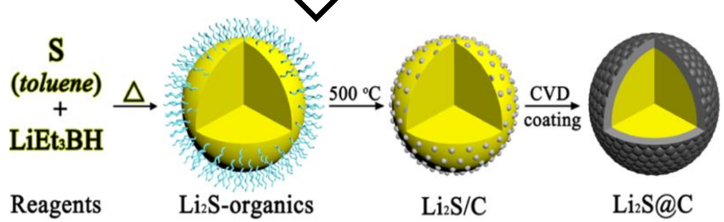
Caiyun Nan,[†,‡,§] Zhan Lin,[†,‡] Honggang Liao,[∥] Min-Kyu Song,[⊥] Yadong Li,[§] and Elton J. Cairns[*,†,‡]

Challenges:

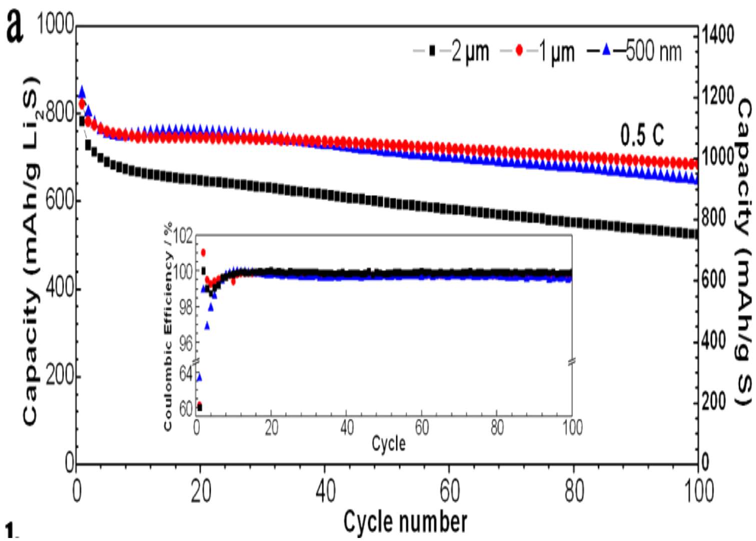
- Poor cycle life
- Rate capability

Methods → **Synthesis of Li_2S Sphere with size control** → **CVD to convert Li_2S to $Li_2S@C$** → **✓Different sizes ✓2μm,1μm and0.5μm**

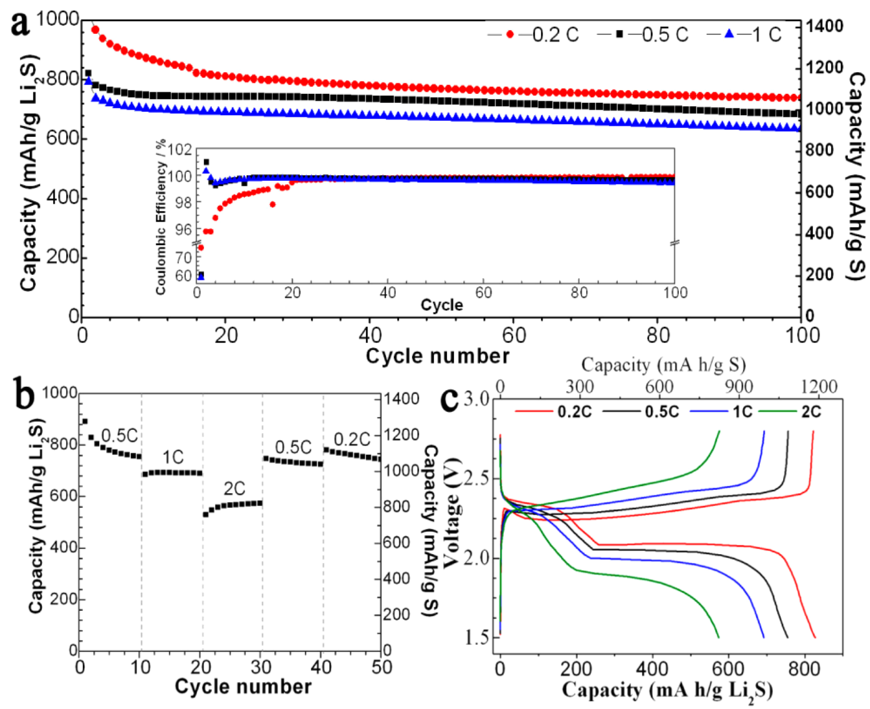
Synthesis methods



Achievements



1.



✓**Discharge capacity= 972mAh/g at 0.2C**

✓Coulombic efficiency=99% at 0.2C after 100cycles

✓ capacity retention= 76% at 0.2C after 100cycles

✓500nm size low performance is due to Long Li diffusion

Chemical Science

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NanoElectroChem. Lab. Chemical Engineering

EDGE ARTICLE

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High-capacity Li_2S–graphene oxide composite cathodes with stable cycling performance†

Cite this: DOI: 10.1039/c3sc52789a

Zhi Wei Seh,[a] Haotian Wang,[b] Nian Liu,[c] Guangyuan Zheng,[d] Weiyang Li,[a] Hongbin Yao[a] and Yi Cui*[ae]

Challenges:
- Low cycle life
- Low stability

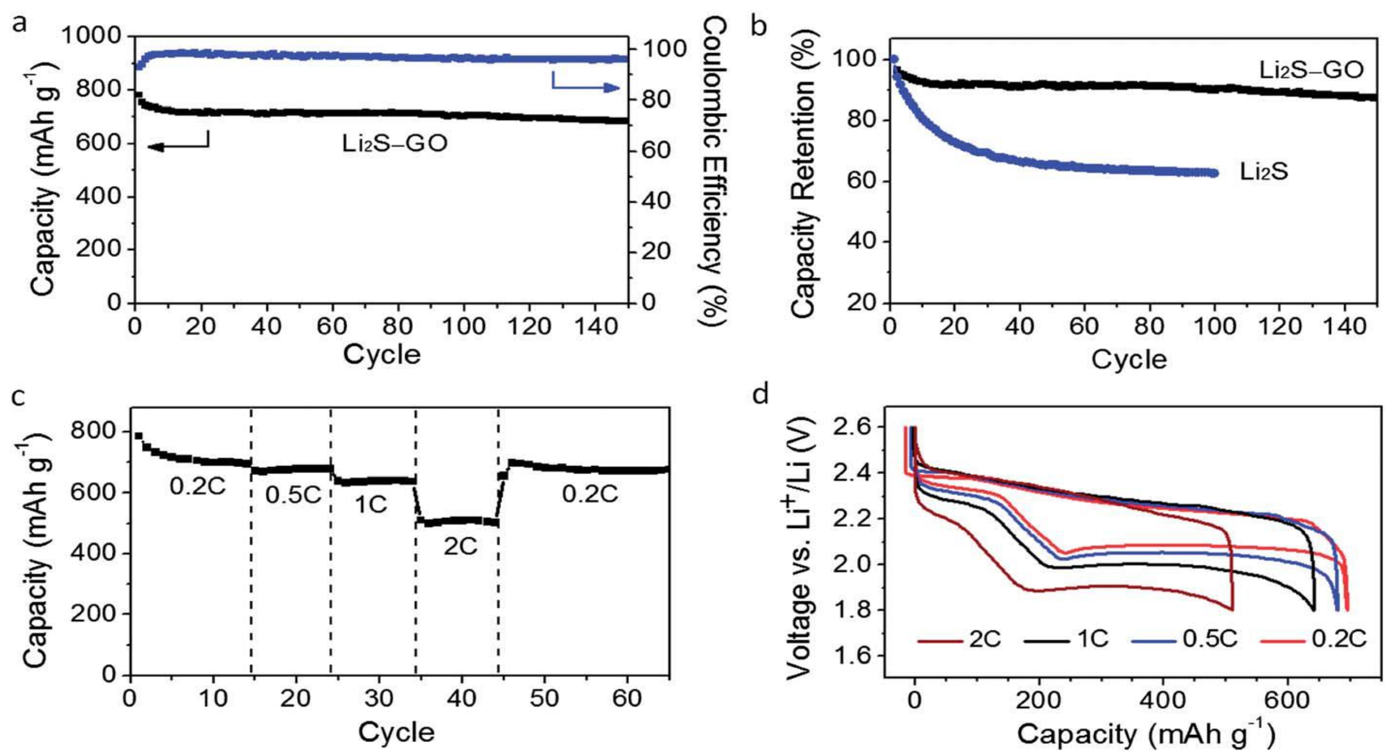
Methods: Using Go nano-composite as Encapsulated material for Li_2S Cathodes

Materials

- ✓ Li_2S-Go/=70%
- ✓ Carbon black=25%
- ✓ Binder=5%

→ in N-methyl-2-pyrrolidinone

- ✓ Discharge capacity is 782mAh/g at 0.2C
- ✓ Capacity retention is 90% after 100 cycles at 0.2C
- ✓ Columbic efficiency is 97% after 150 cycles



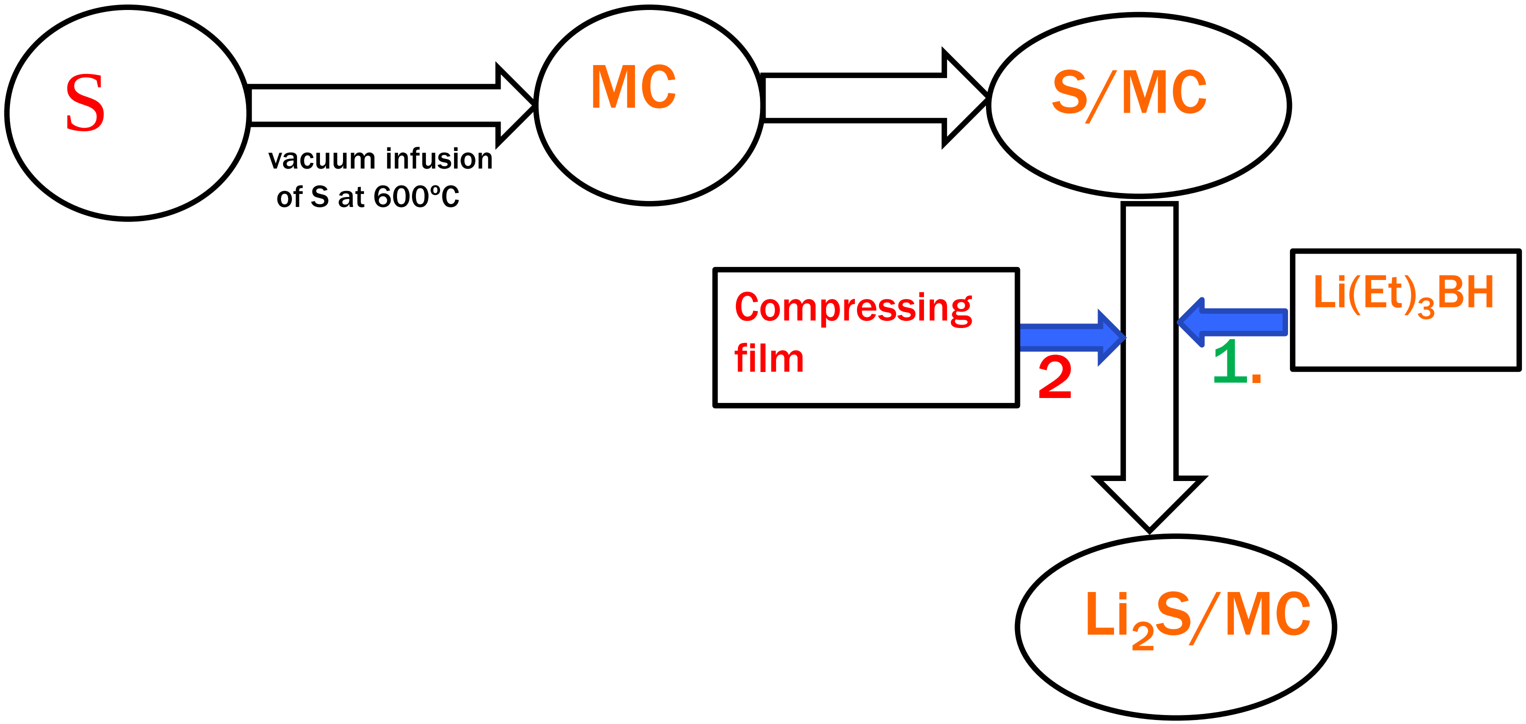
Chem.Sci. 2014

Summery

- **Synthesis of Li_2S is better than commercial Li_2S even coating is takes place.**
- **Size control synthesis produces homogeneous structure even after prolonged cycling**
- **Li_2S is good cathode material than pure S due to fully lithiated and paired with Li-free anode so that it prevents dendrite formation**
- **This also prevents short circuits and safety issues.**

Future work

1. Synthesis of synthesis of Li_2S/MC-composite



Thanks!!!

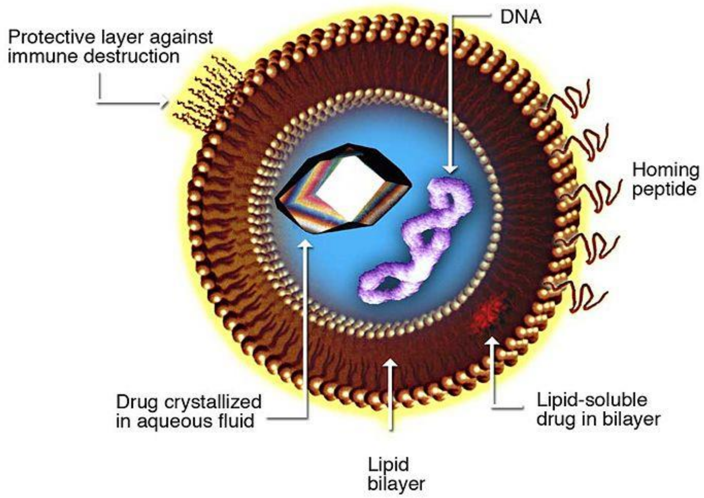
National Taiwan University of Science and Technology

Department of Graduate Institute of Applied Science and Technology

Final project reports on

Potential application of Nanoparticles in Medicine: Drug delivery

Liposome for Drug Delivery



BY: - TILAHUN AYANE

ID: - D10322803

OUTLINE

- Nanomedicine overview
- Potential application of Nanotechnology in drug delivery
- Some example of polymer used to deliver drugs
- Challenge

Nanomedicine

Nanometer-sized particles have optical, magnetic, chemical and structural properties that set them apart from bulk solids, with potential applications in medicine.

Nanomedicine is the medical application of nanotechnology

- <u>Potential applications</u>

DRUG DELIVERY

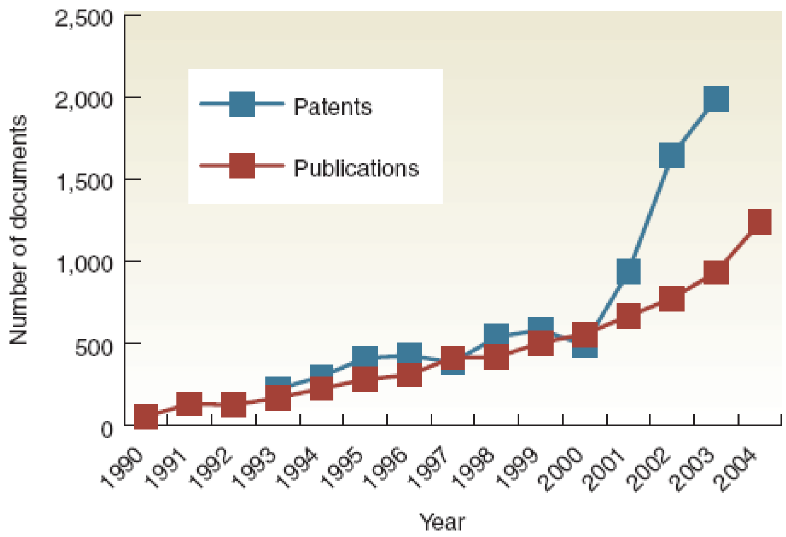
MEDICAL IMAGING

DIAGNOSIS & SENSING

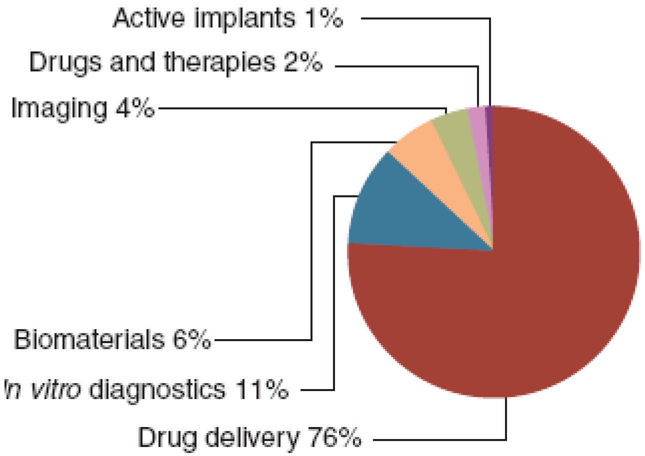
THERAPY

Interesting facts about Nanomedicine

A. Interest in the area has grown exponentially

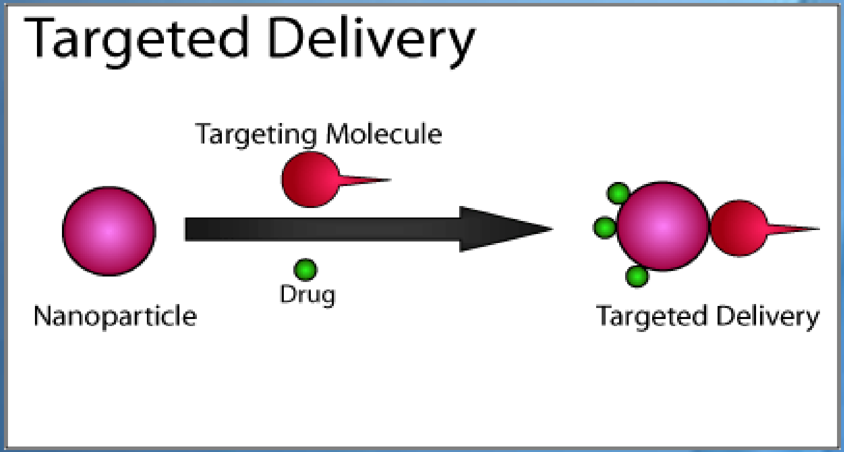


B. Drug delivery is the most productive area



Nature Biotechnology 2006, Vol. 4, pp.1212-1217

Drug Delivery



Drug delivery refers to approaches, formulations, technologies, and systems for transporting a pharmaceutical compound in the body as needed to safely achieve its desired therapeutic effect.

- ✓ For example protein and peptide drugs have to be delivered by injection(daily life) or a nanoneedle

Why nanotechnology in drug delivery?

(i)Targeting, to increase the drug concentration at desired sites of action and reduce systemic levels of the drug and its toxic effects in healthy tissues.

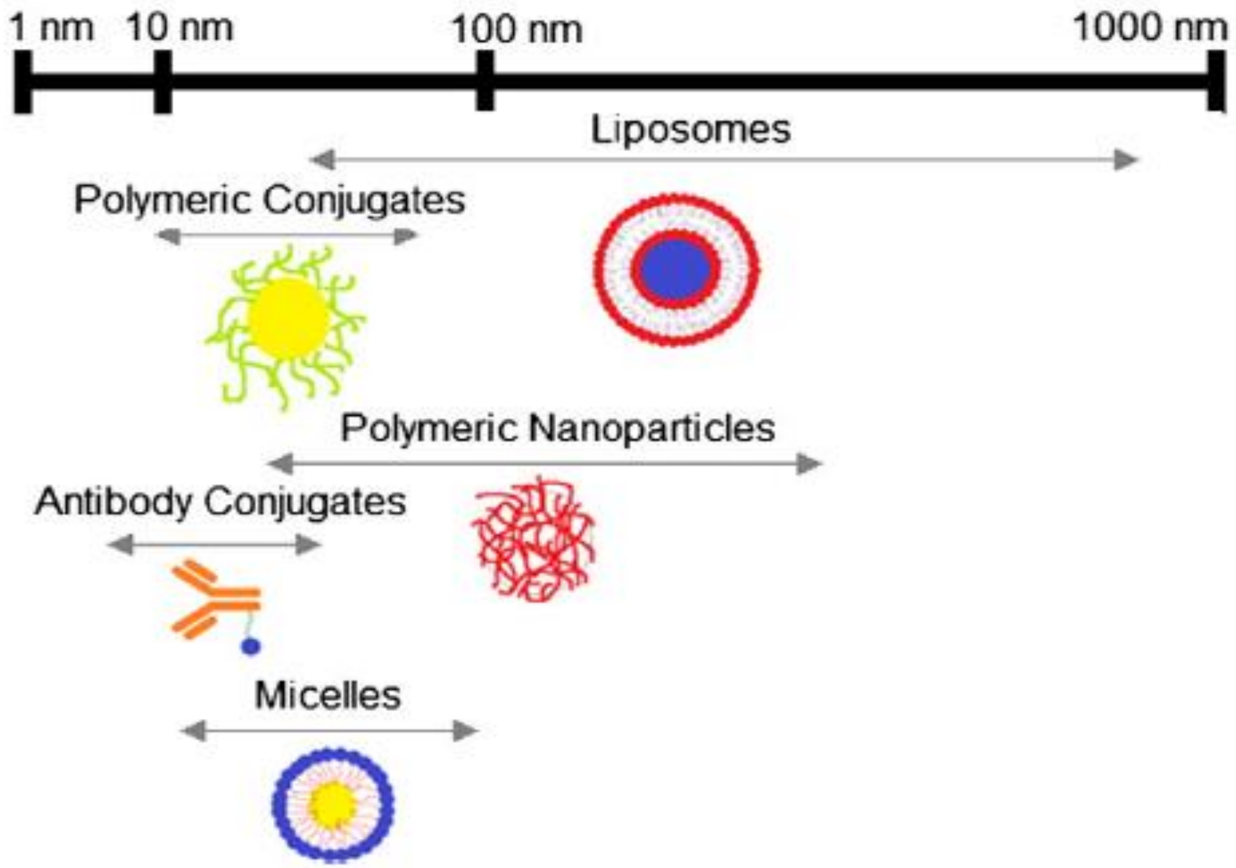
(ii)Improved solubility

(iii)Constant rate of drug delivery, resulting in zero-order release kinetics to maintain a constant therapeutic dose at the site of action .

(iv)Increased drug stability, to reduce degradation and maximize drug action.

(vi)Drug delivery across the blood–brain barrier (BBB).

➢ Nowadays there are multiple nDDS being studied (i.e. liposomes, nanoparticles, dendrimers, micelles and nanorods) and available commercially to treat different diseases including cancer, infections and hormonal disorders.

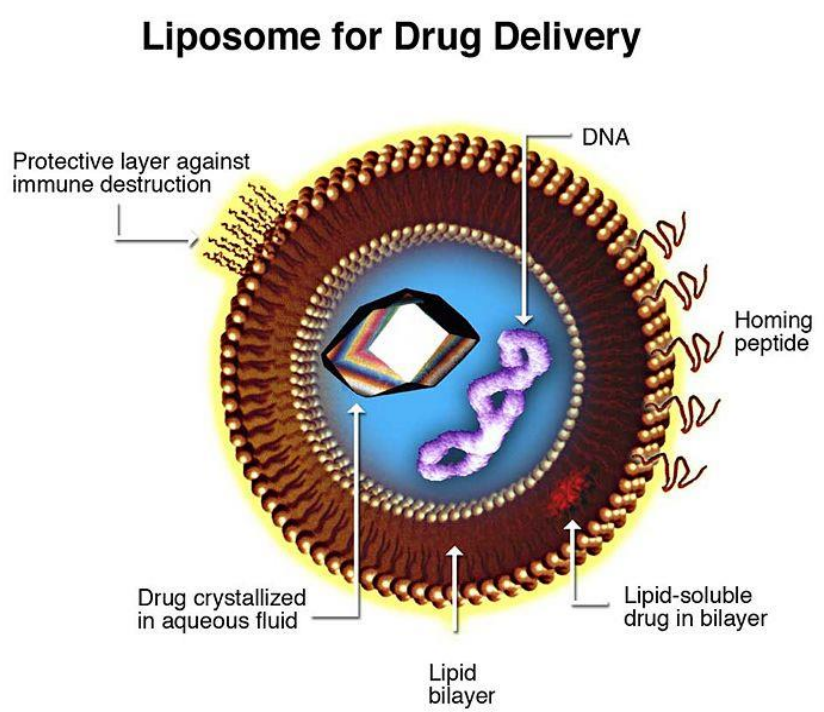


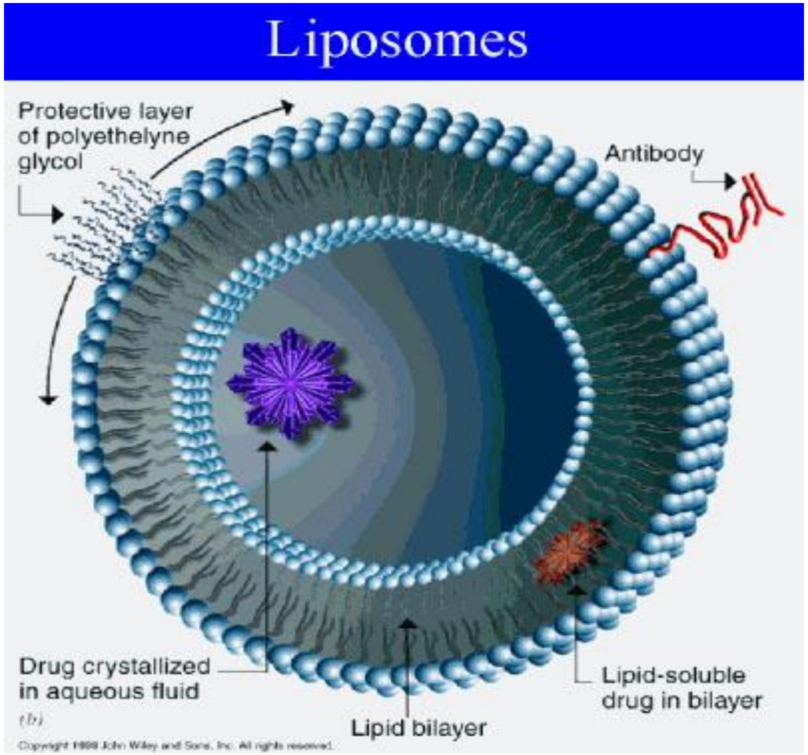
Representative nanoengineered drug delivery systems and their sizes.

Source:- B. Felice et al. / Materials Science and Engineering C 41 (2014) 178–195

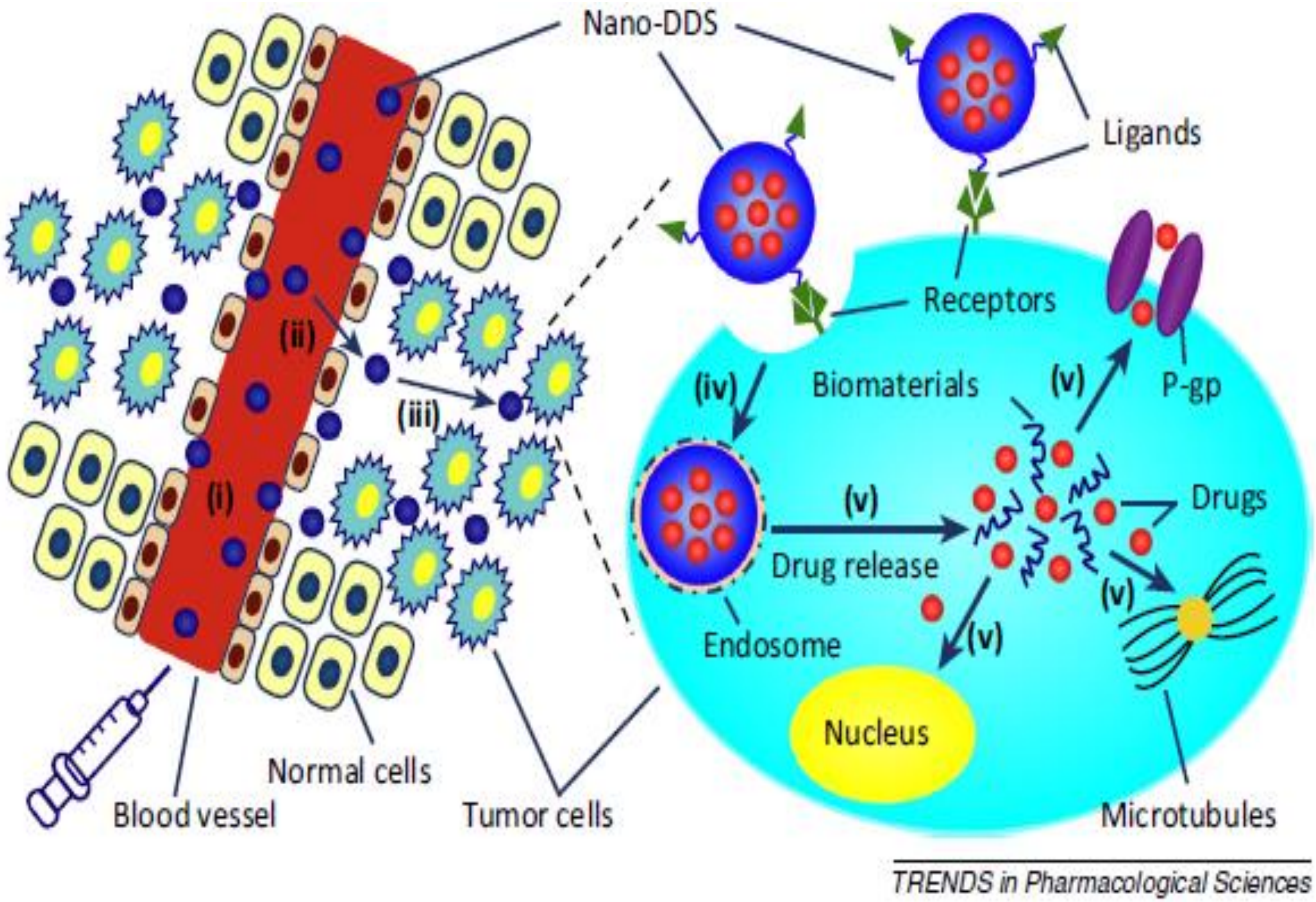
Liposomes

- ➢Liposomes are spherical self-closed structures , composed of lipid bilayers, which enclose part of the surrounding solvent into their interior
- ➢The lipid most widely used is PC, PI and PS



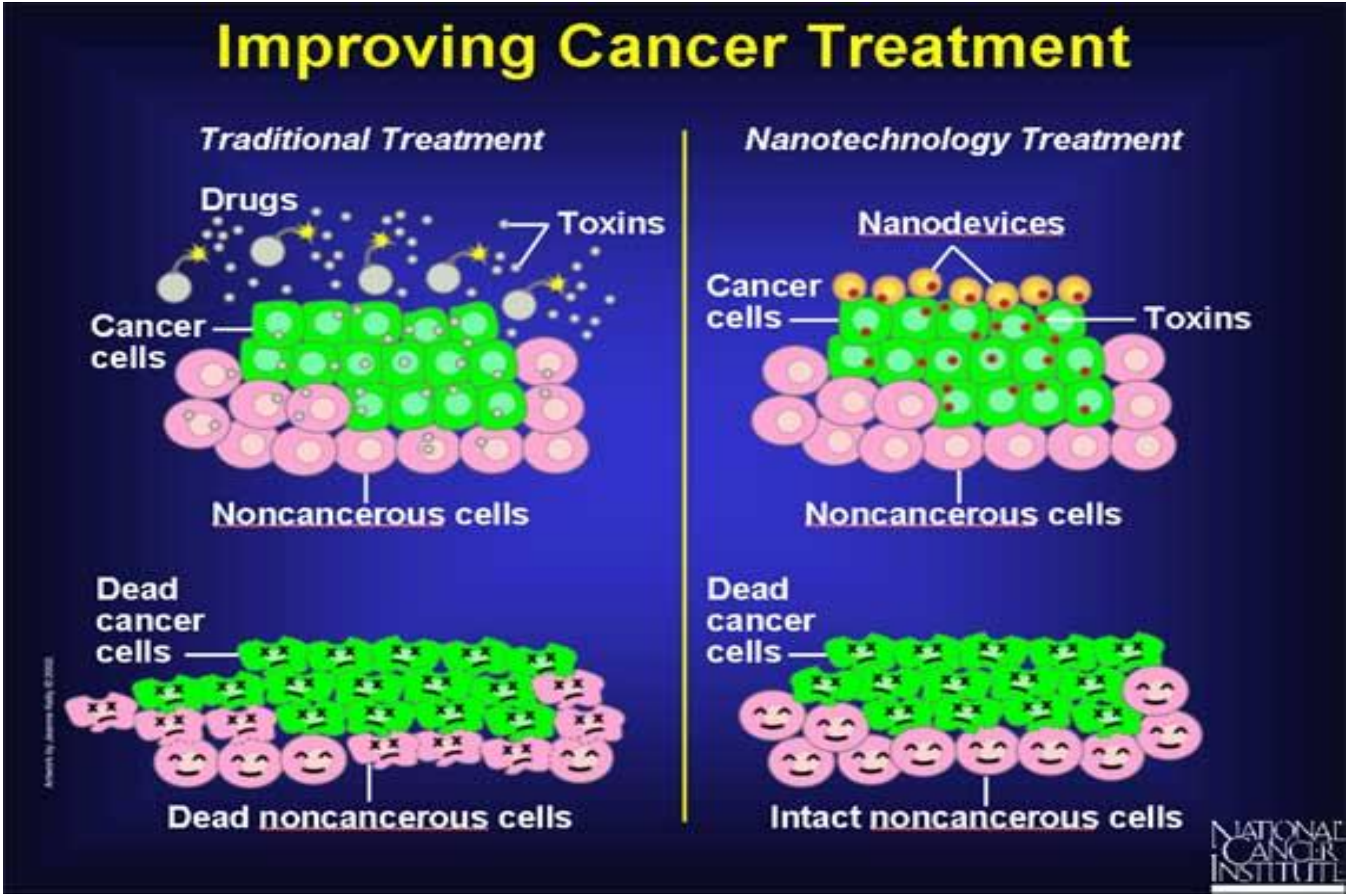


Source:- Kosi Gramatikoffen, Liposome (1999) bywikipedia.org/wiki/File:**Liposome**.jpg



General schematics of the delivery process of nanoparticles (NPs) after intravenous administration: (i) circulation in blood; (ii) permeation through the blood vessel wall; (iii) deep tumor penetration; (iv) internalization into tumor cells; and (v) disposition of drugs or nanocarriers within tumor cells. Abbreviations: Nano-DDS, nanoparticulate drug delivery systems; P-gp, P-glycoprotein.

Source:- Trends in Pharmacological Sciences November 2014, Vol. 35, No. 11



http://www.cancer.gov/PublishedContent/Images/images/documents/59f950a6-9b9d-43ad-80a4-776cefdd17ce/cancer17.jpg

Some List of polymer used to deliver drugs

Drug used	Polymer used	Form of the drug delivery systems suggested	Therapeutic indication (references)
Doxorubicin	Poly(butyl cyanoacrylate)	Drug-loaded nanoparticles	Brain cancer
Clarithromycin	Gliadin/pluronic F 68	Mucoadhesive nanoparticles	Broad-spectrum antibiotics
Celecoxib	Lipid system	Nanostructured carriers	Inflammation and other allied conditions
Acyclovir	Cholesteryl acyl didanosine and cholesteryl adipoyl didanosins	Self-assembled drug delivery systems	Anti-HIV drug
Vaccine	Poly(γ-glutamic acid)	Nanoparticles	Vaccines against cancer
Vaccine	Hydroxyapatite/ bovine serum albumin	Nanoparticles	Vaccine/antigen carrier
Camptothecin	PLGA	Nanoparticles	Cancer
Rifampicin, isoniazid	Alginates	Nanoparticles	Anti-TB drugs
Psoralen	Solid lipid system	Lipid nanostructure	Topical treatment of psoriasis
Docetaxel	Poly(D,L-lactide-co-glycolide)	Long-acting nanoparticles	Cancer tumors
Antimycobacterial agents	Various polymers	Liposomes and nanoparticles	Anti-TB
Rivastigmine	PEGylated acryloylated polyaspartamide	Nanoparticles	Dementia in Alzheimer's disease and Parkinson's disease
Plasmid IGF-1	Cationized gelatin	Nanoparticles	Gene delivery
γ-Interferon	Albumin	Nano particles	Antibacterial against *Brucella abortus*
Protein drugs	Poly(lactide)-tocopheryl polyethylene glycol succinate copolymers	Nano particles	Protein drug delivery
Paclitaxel	PEO-PPO-PEO/PEG cross-linked polymer	Nano capsules	Anticancer
	PLGA polymer	Nano capsules	Anticancer

Source:-M S Ramaiah Institute of Technology, Bangalore

Con't

Drug used	Polymer used	Form of the drug delivery systems suggested	Therapeutic indication (references)
Oridonin	Poly(D,L-lactic acid)	Nanocapsules	Multiple myeloma
Cisplatin	Phosphatidylethanolamine	Liposomes	Melanomas
Aclarubicin	Albumin-conjugated PEGylated drug	Nanoparticles	Glioma
Amphotericin B	Lipoproteins	Nanodisks	Antibiotic
Docetaxel	PEG derivatives	Nanosized PEG drug assembly	Cancer
Ceramide and paclitaxel	Lipid carriers	Nanoemulsions	Cancer
Cisplatin	Hyaluronic acid–drug conjugate	Nanoparticles	Cancer
Fludarabine and mitoxantrone	Lipid carriers	Liposomes	Lymphoproliferative disorder
Estradiol	PLGA	Nanoparticles	Hormone
Cyclosporine	Polymeric micelles delivery	Colloidal	Antibiotics
Flurbiprofen	PLGA	Nanospheres	Ocular delivery
Insulin	Sodium alginate and chitosan	Nanospheres	Diabetes mellitus
Thymopentin	Poly(butyl cyanoacrylate) polymer	Nanoparticles	Protein peptide drug for cancer treatment
Indinavir	Lipids	Lipid–drug conjugates	AIDS treatment
Cyclosporin	Polysorbate 80	Nanodispersion	Pulmonary infections
Ketoprofen and diflunisal	Polyamidoamine dendrimers	Drug–polymer complex suspension	Anti-inflammatory
Halofantrine and procubol	Cremaphore RH 40	Self-emulsifying nanoemulsion system	Lipophilic drug models
Etoposide	Poly(D,L-lactide) block copolymers	Nanoparticles	Cancer

Source:-M S Ramaiah Institute of Technology, Bangalore

CHALLENGES

- ✓ Prevention of drug from biological degradation
- ✓ Effective targeting
- ✓ Patient compliance
- ✓ Cost effectiveness
- ✓ Product life extension

Conclusion

- Nanoparticles can be used in targeted drug delivery at the site of disease to improve the uptake of poorly soluble drugs, the targeting of drugs to a specific site, and drug bioavailability

- The effectiveness of drug delivery systems can be attributed to their small size, reduced drug toxicity, controlled time release of the drug and modification of drug pharmacokinetics and biological distribution

REFERENCE

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Thank You
nanoschematic

Desalination of Ocean Water

Ziba Roveimiab

Prof. Hosseinkhani

About 1 of every 6 people around the world has no adequate access to clean water

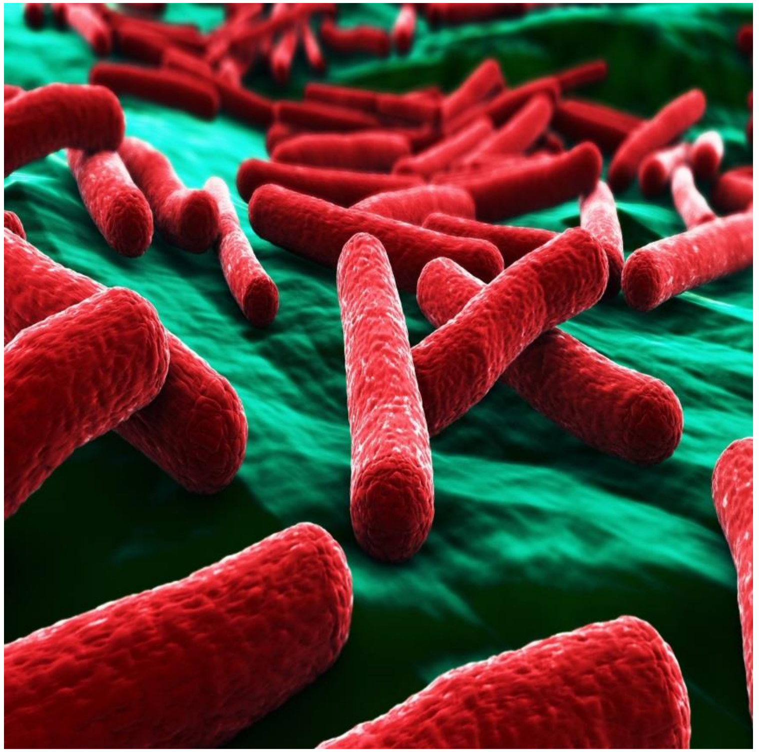
- It’s not that the world doesn’t have enough water. Globally, water is abundant, but most of it is in the oceans, where it’s unsuitable for drinking without expensive desalination.

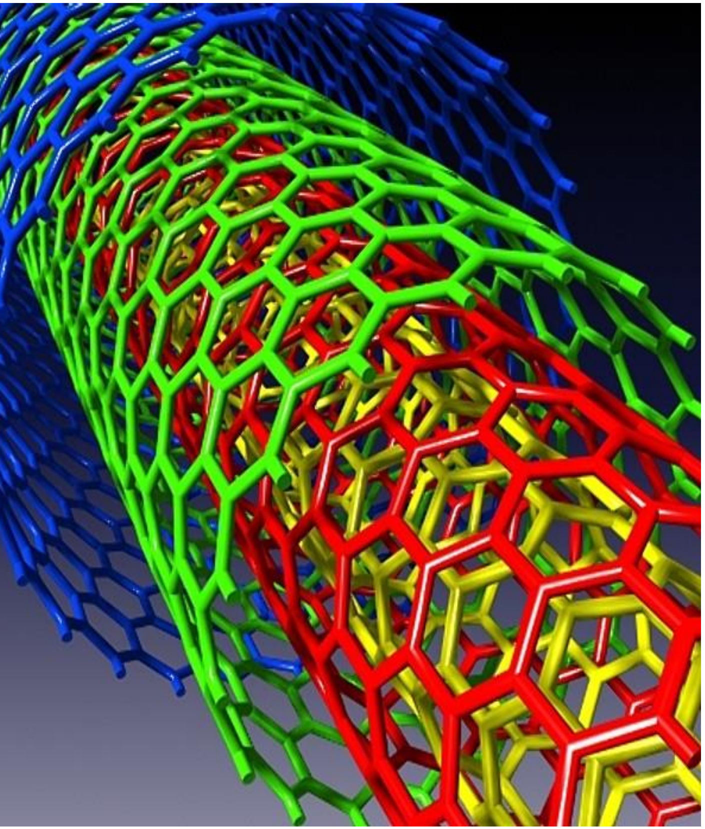
Another problem for some developing countries is that contaminated drinking water contains bacteria and other pollutants.

E. Coli

cheaper water-treatment

multiwalled carbon nanotubes

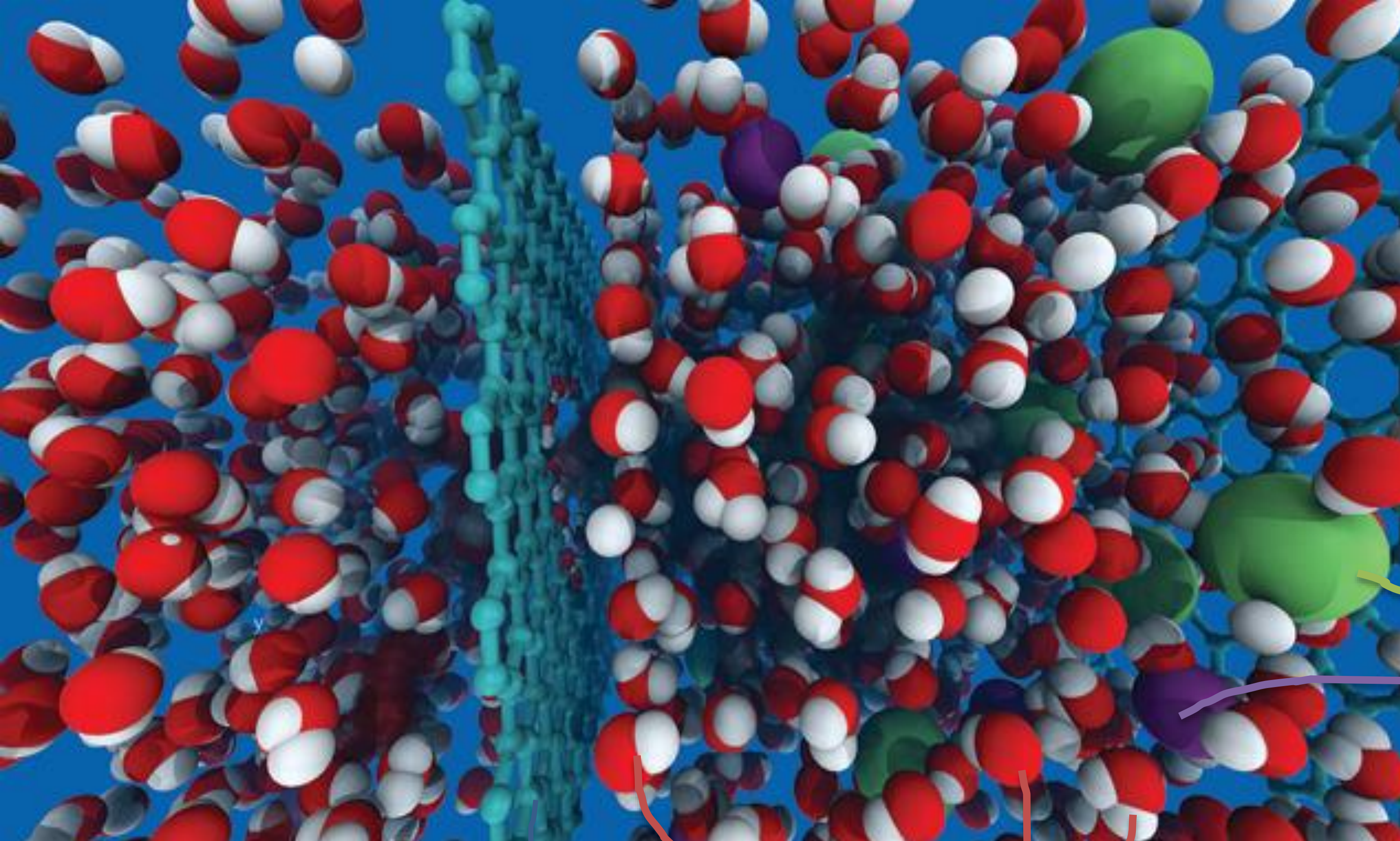




*system uses a **magnet** and **clusters of multiwalled carbon nanotubes**. The clusters capture bacteria such as **E. coli**, and as illustrated above, the rare earth element neodymium magnet attracts the nanotubes.*

Low cost rather than other supplements

*bacteria such as E. coli can be captured and killed on-site and the carbon nanotubes can be **reused** later*



sodium & chlorine ions

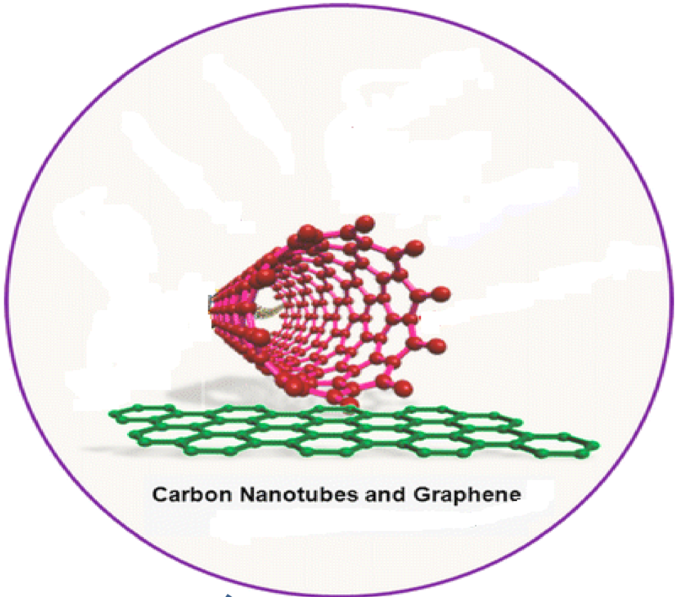
sheet of graphene (membrane)

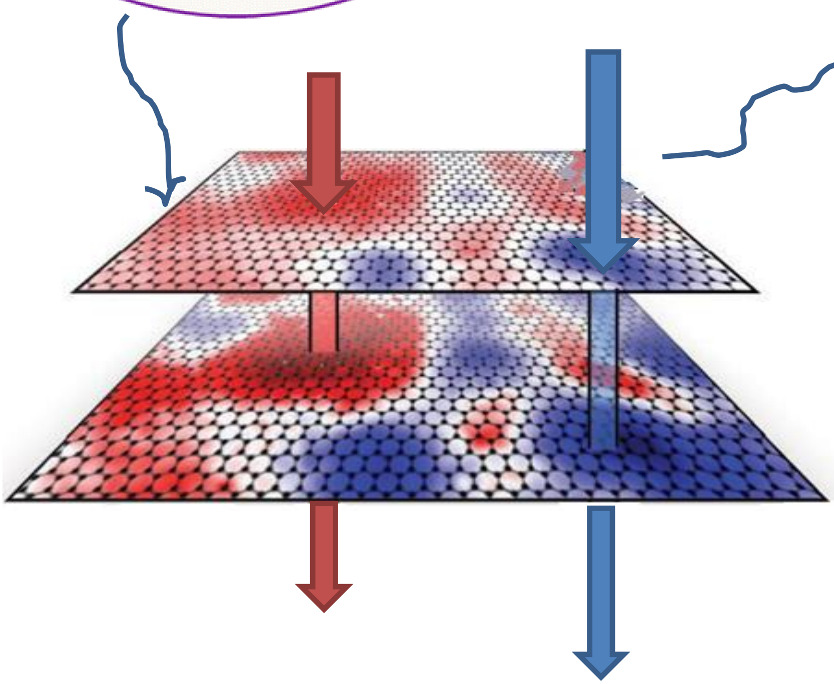
500 times more permeable than other …

Water Molecules

water passes through from right to left, but the sodium and chlorine from the salt are blocked

Idea : Combination of Carbon nonotube and Graphene





A new approach to water desalination.mp4


THANK YOU