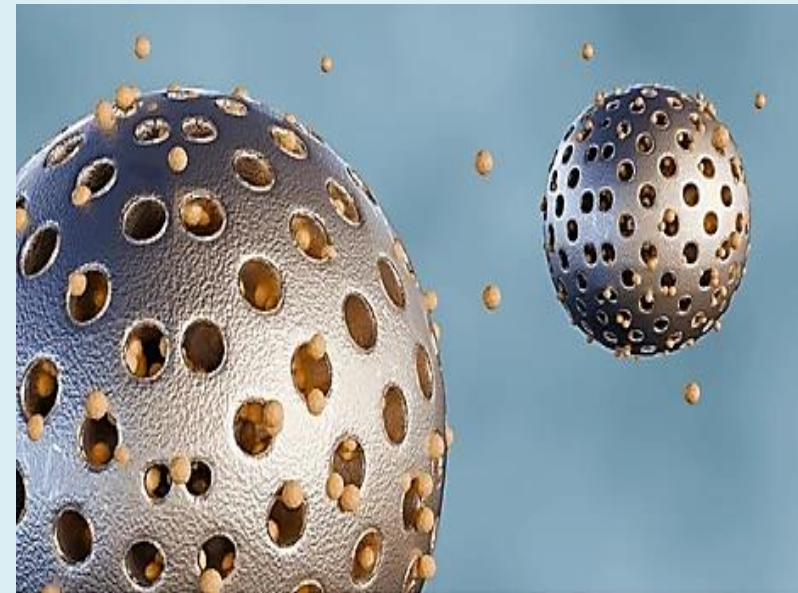




# MESOPOROUS MATERIAL:SYNTHESIS,STRUCTURE AND PROPERTIES

طالبة الدكتوراه  
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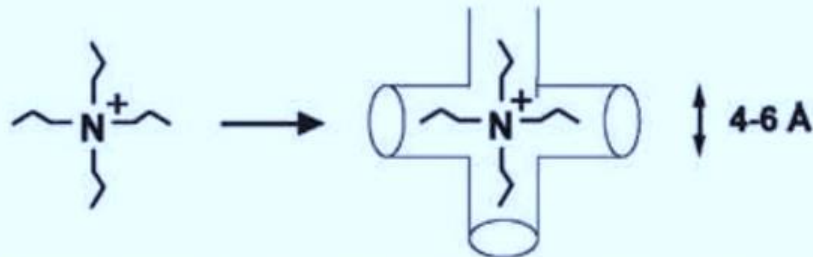
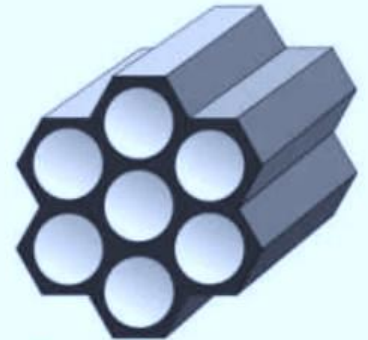
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# What are Porous materials

- Most generalized definition of porous materials is **continuous** and **solid network material filled through voids**.
- A material can be recognized as porous if its internal voids can be filled with gases.
- The history of porous materials began with the **zeolites having aluminosilicates framework** which was synthesized by the use single template molecule with small pore.



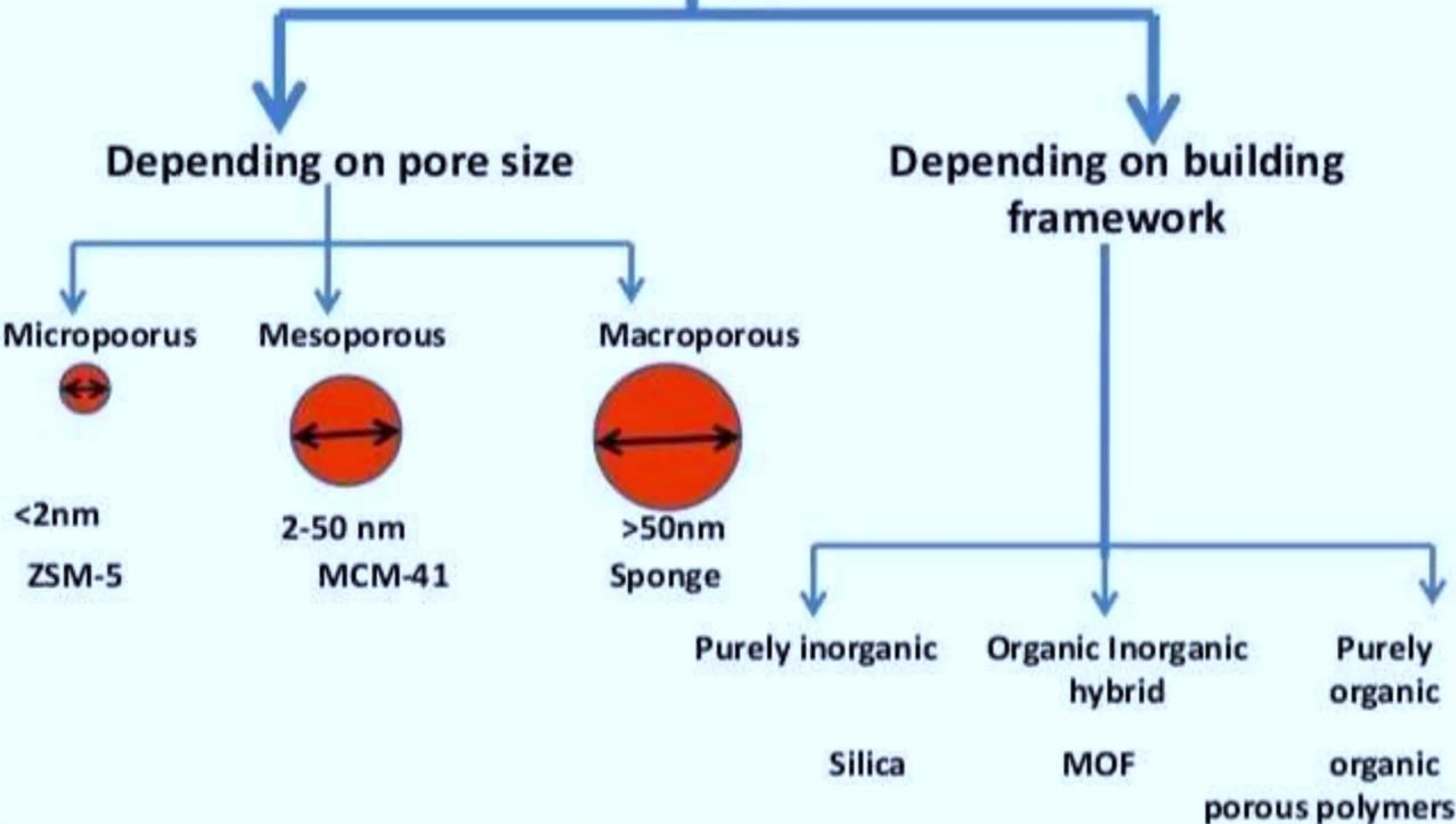
Individual Small Alkyl Chain Length Quaternary Directing  
Generate the Formation of Microporous Molecular







# Classification of porous materials



$< 2$  nm



**Microporous**

(Zeolite based materials, pillared clays)

2-50 nm



**Mesoporous**

(Mesoporous materials, MCM-41, MCM-48, MCM-50, SBA-15, SBA-16)

$> 50$ nm



**Macroporous**

(Ceramic based materials, porous gels, porous glasses)

# Mesoporus Materials

- **Meso** a Greek prefix – “ in between ” - micro and macro porous system
- Mesoporous materials may be ordered or disordered.

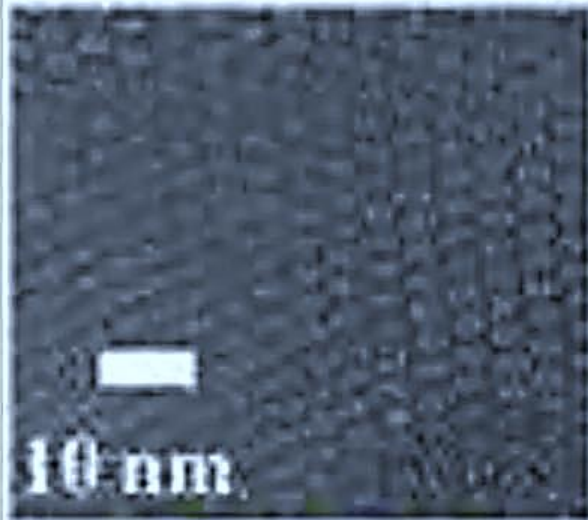
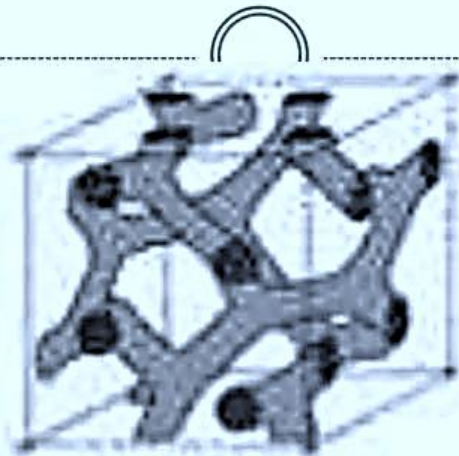
**They possess high**

- Surface area -400 -1000 m<sup>2</sup>/g
  - Large pore volume
  - High stability -500 -600 °C
- They are usually synthesized by the use of Soft template method.

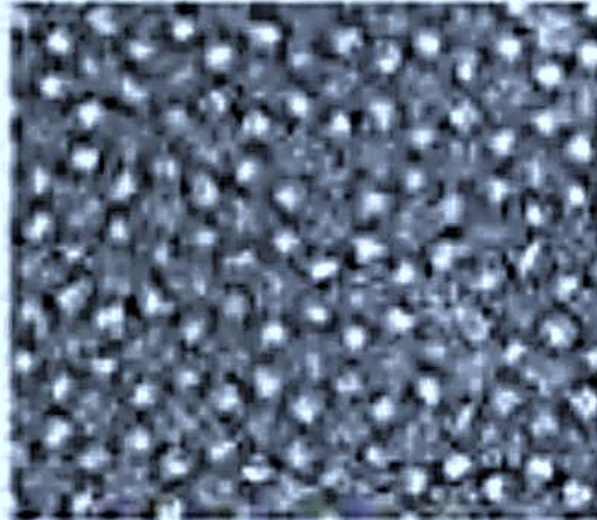
**Ex: MCM-41,SBA-15,FDU-11,IITM-56 etc.**



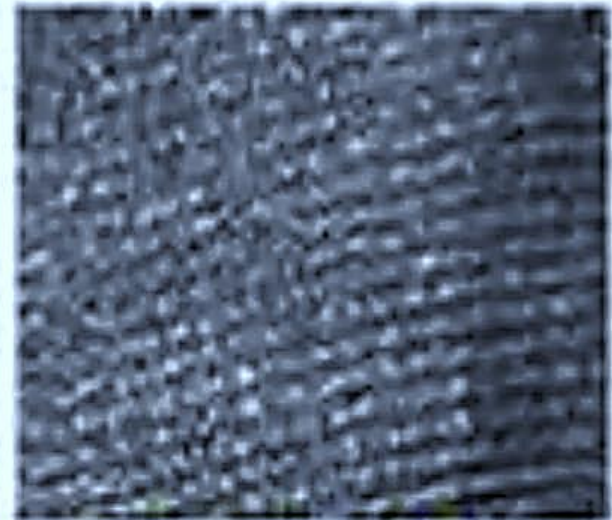
# TYPES OF MESOPOROUS MATERIALS



**MCM-41**



**MCM-48**



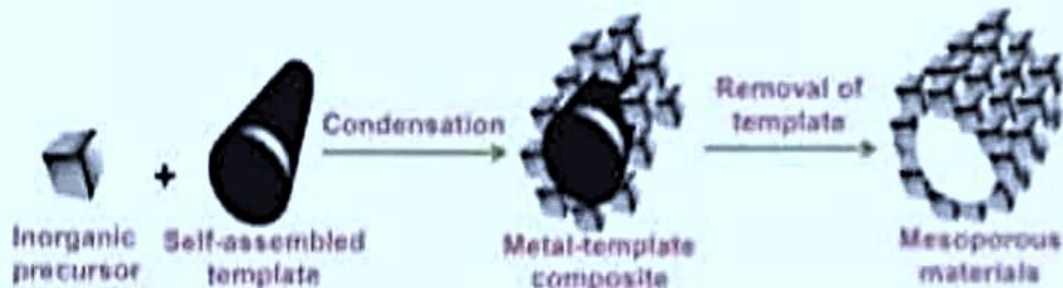
**MCM-50**



# Synthesis of mesoporous materials

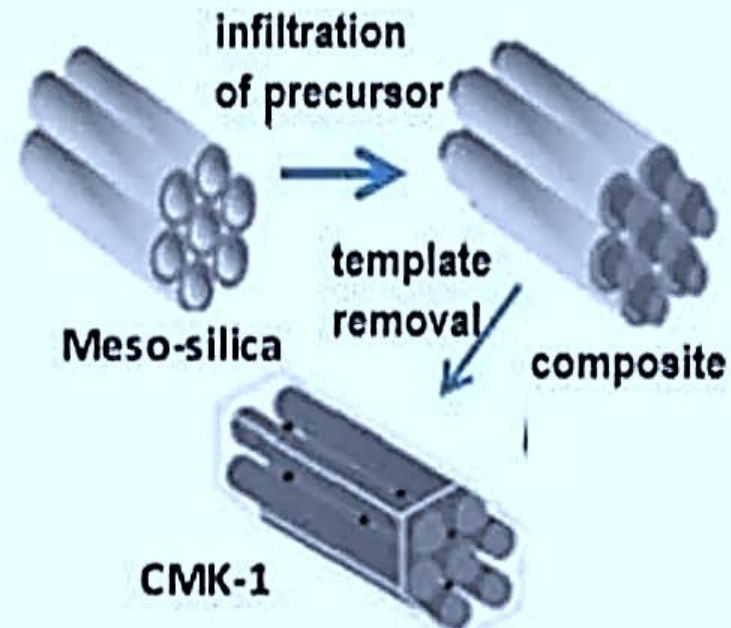
## Soft template (endo template)

- Uses soft templates like organic molecules .
- Good shape , Size and morphology. simple
- SBA-15 ,MCM-41 etc

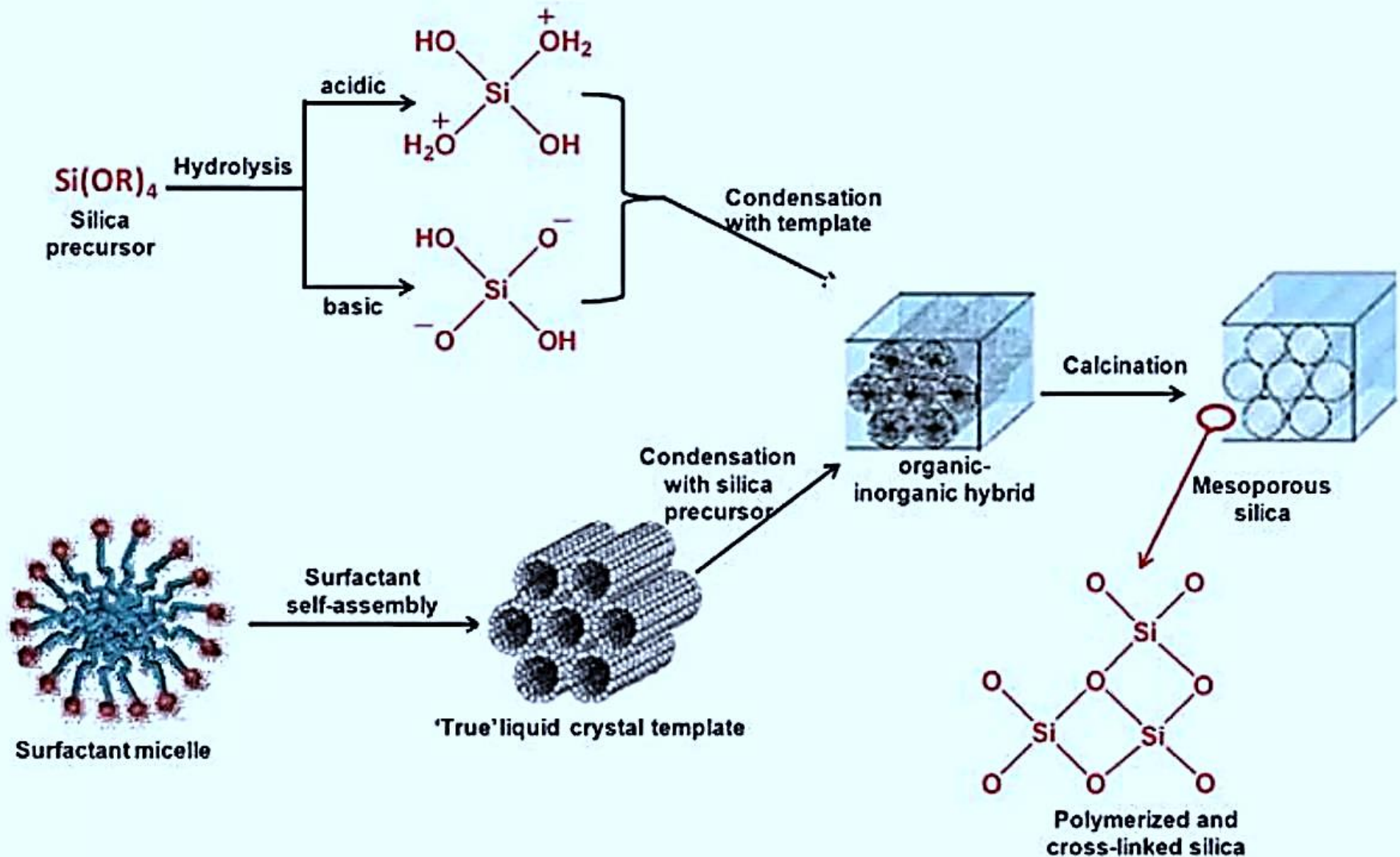


## Hard template (exo template, nano casting)

- Uses inorganic materials like silica, carbon etc
  - Tedious work up, hard to get good morphology and costly
- CMK-1



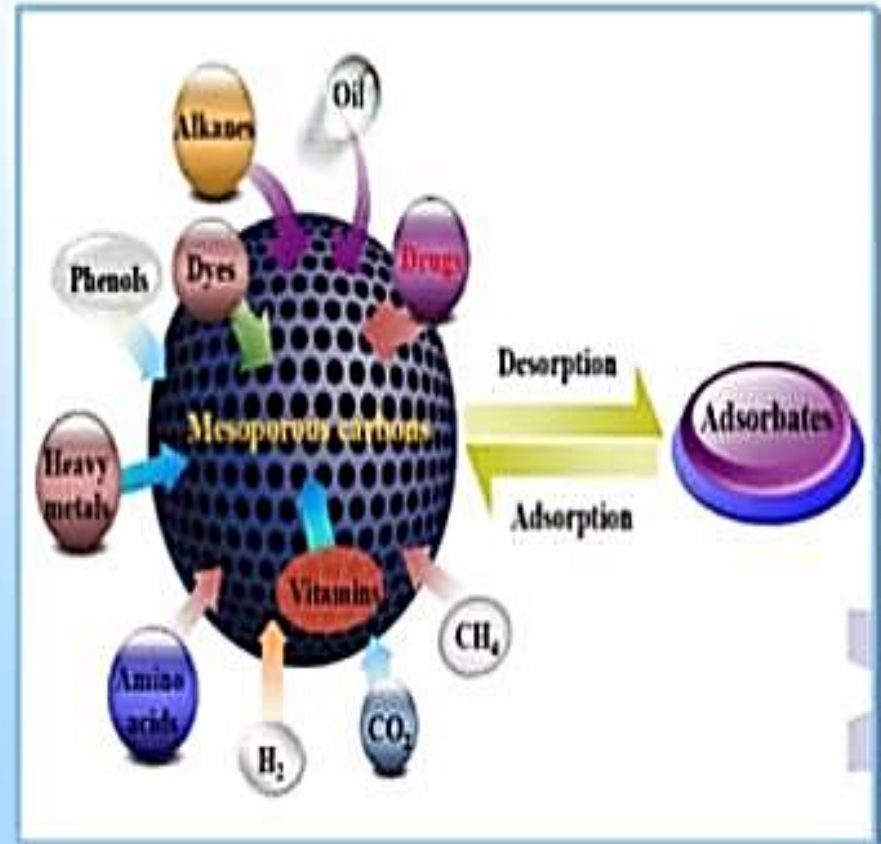
# Complete synthesis summary





# Applications of mesoporous materials

- Adsorption
- Chromatography
- Electrochemistry
- Filtration
- Sensors
- Catalysis



# Applications

## Environment field

adsorbents, catalysts

## Biomedical field

drug delivery, bone regeneration

## Chemical catalysis

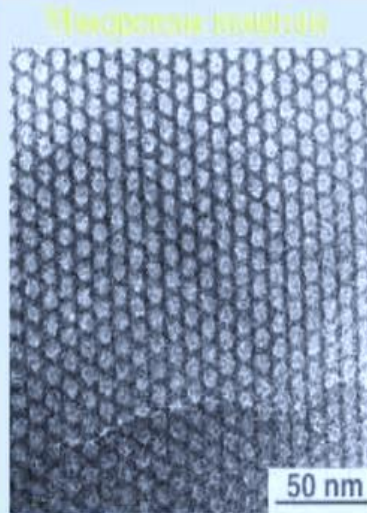
catalysts, supports

## Nanomaterials preparation

nanoparticles, nanoarray

## Functional devices

sensors, solar cells





# Diagnostics



- Chemical stability.
- Low toxicity
- Flourescent markers
- Drugs can be used to track the location of therapeutic agents and their activity.

# ADSORBENT



- Use as adsorbents for various gases, liquids and toxic heavy metals.
- Based upon surface property

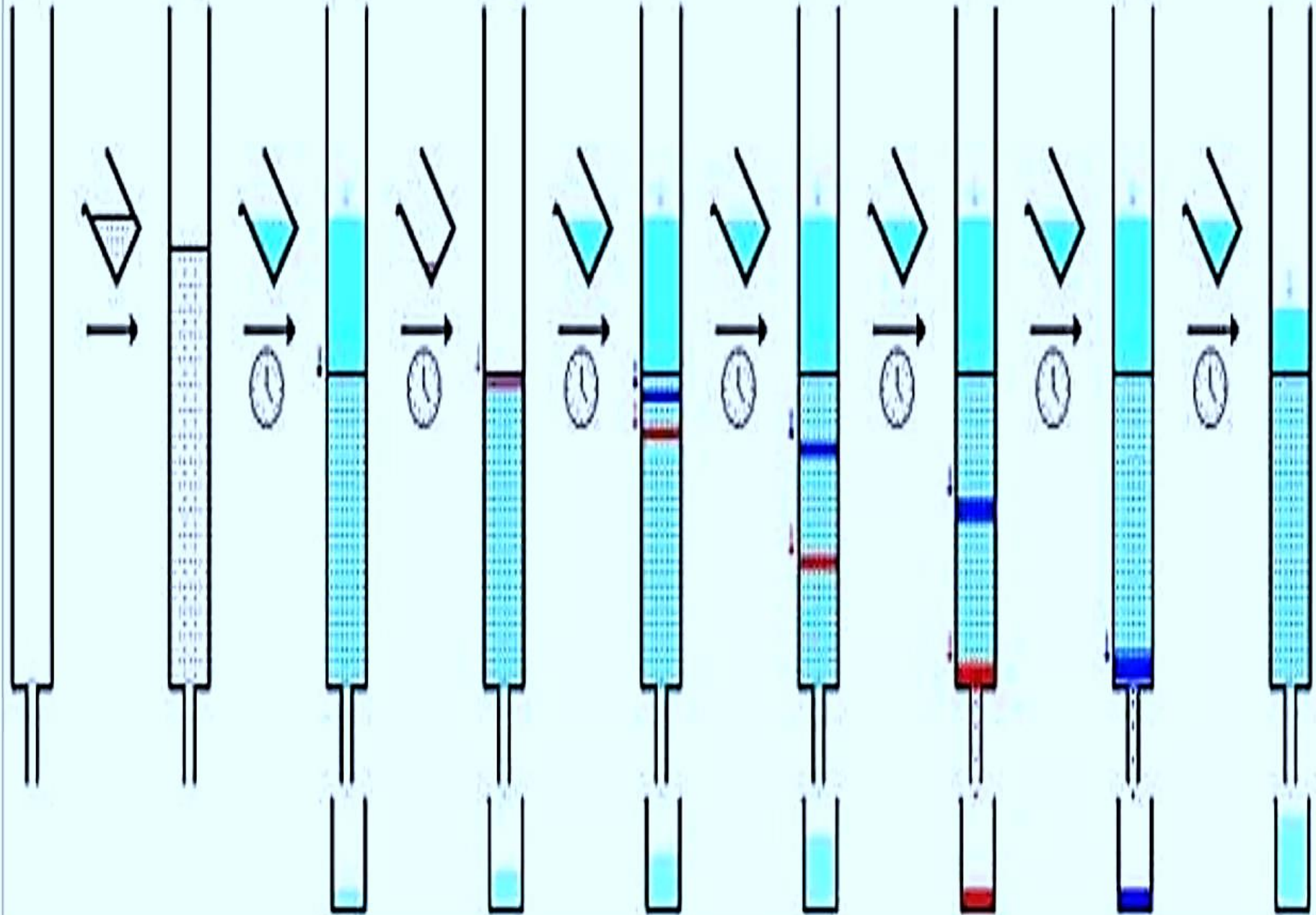
hydrophobic, hydrophilic



# CHROMATOGRAPHY



- Large pore volume surface area pore-size distribution of mesoporous silica, make it a good candidate for size exclusion chromatography.
- As stationary phases.





# DRUG DELIVERY SYSTEMS



- Drug efficiency.
- Drug carrier must be non-toxic and inert during the treatment period.
- Silica based Mesoporous materials have great relevance for such life science applications.

# CATALYSIS



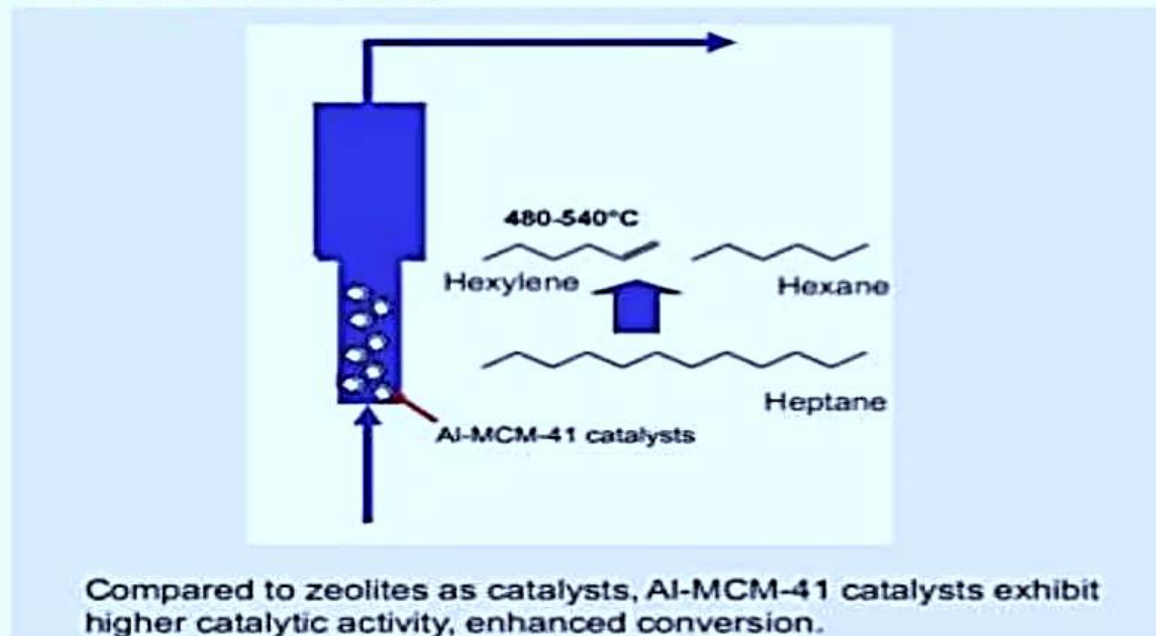
## Application Chemical Catalysis

### 1. Mesoporous Materials as catalyst

Al-MCM-41 ,B-MCM-41, Sn-SBA-15 - Acidic

**K- AIMCM-41 , Cs-AIMCM-41 -basic**

TiMCM-41 ,V-MCM-41 -Redox



# SENSORS



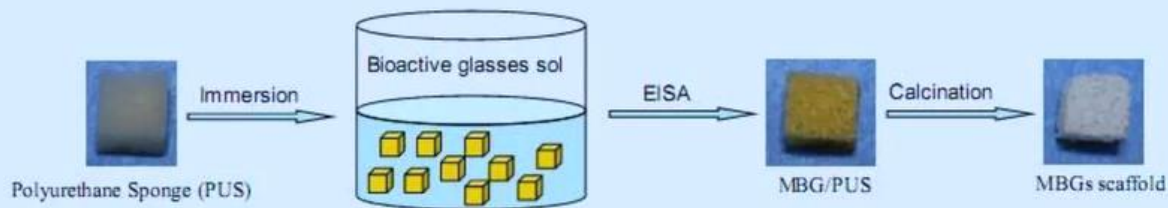
- Have great potential in the field of gas sensing.
- Act as active layers in gas sensors based on various operating principles, such as capacitive, resistive, or optical sensing.



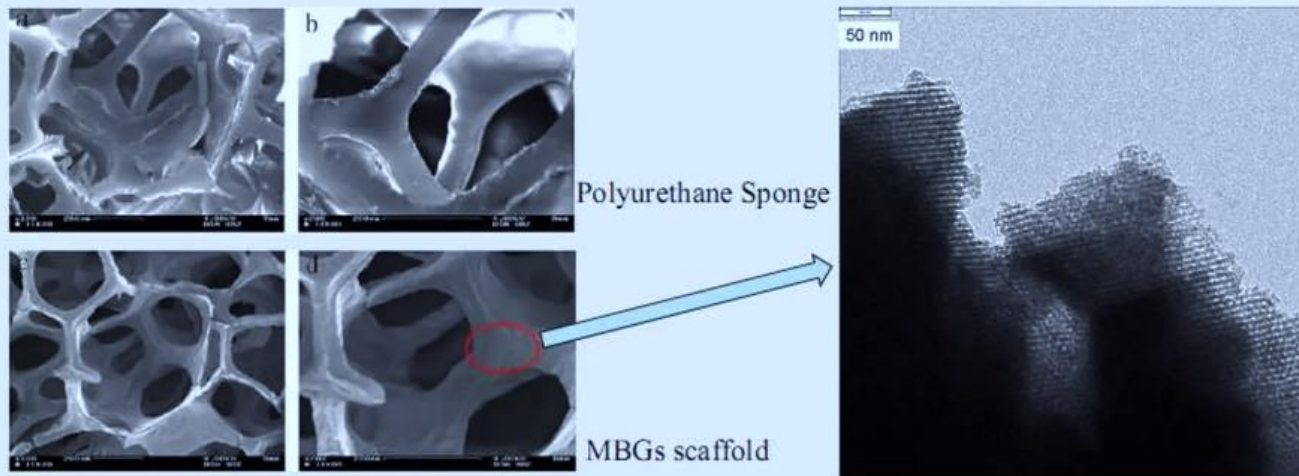
# Mesoporous Bioactive scaffolds

Scaffolds are needed that can act as temporary templates for bone regeneration and actively stimulate vascularized bone growth so that bone grafting is no longer necessary.

Bioactive glass is an ideal material because it rapidly bonds to bone and degrades over time, releasing soluble silica and calcium ions that are thought to stimulate osteoprogenitor cells.



The schematic procedure for preparation of mesoporous bioactive glasses scaffolds



SEM images of templates and MBGs scaffold

TEM image of MBGs scaffold



## Conclusion



- ▶ Mesoporous materials have attracted ever-growing attention owing to their unique structural characteristics such as tunable pore size, controllable morphology, large surface area, and moderate pore size range with easy access for guest species.
- ▶ These remarkable features open up a broad application spectrum of mesoporous materials, making them promising candidates in catalysis, absorption, membranes and separation, sensors.
- ▶ A key issue for the applicability of these mesoporous materials is associated with the thermal, and more importantly the hydrothermal and mechanical stabilities.

