Lahore College for Women University Lahore

Lecture:16

Course: Nanotechnology & Nanostructures

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Nanoproduct Forms

Nanoproduct Forms

- Nanocoatings
- Multilayers and Nanofilms
- Nanoadhesives
- Nanoporous

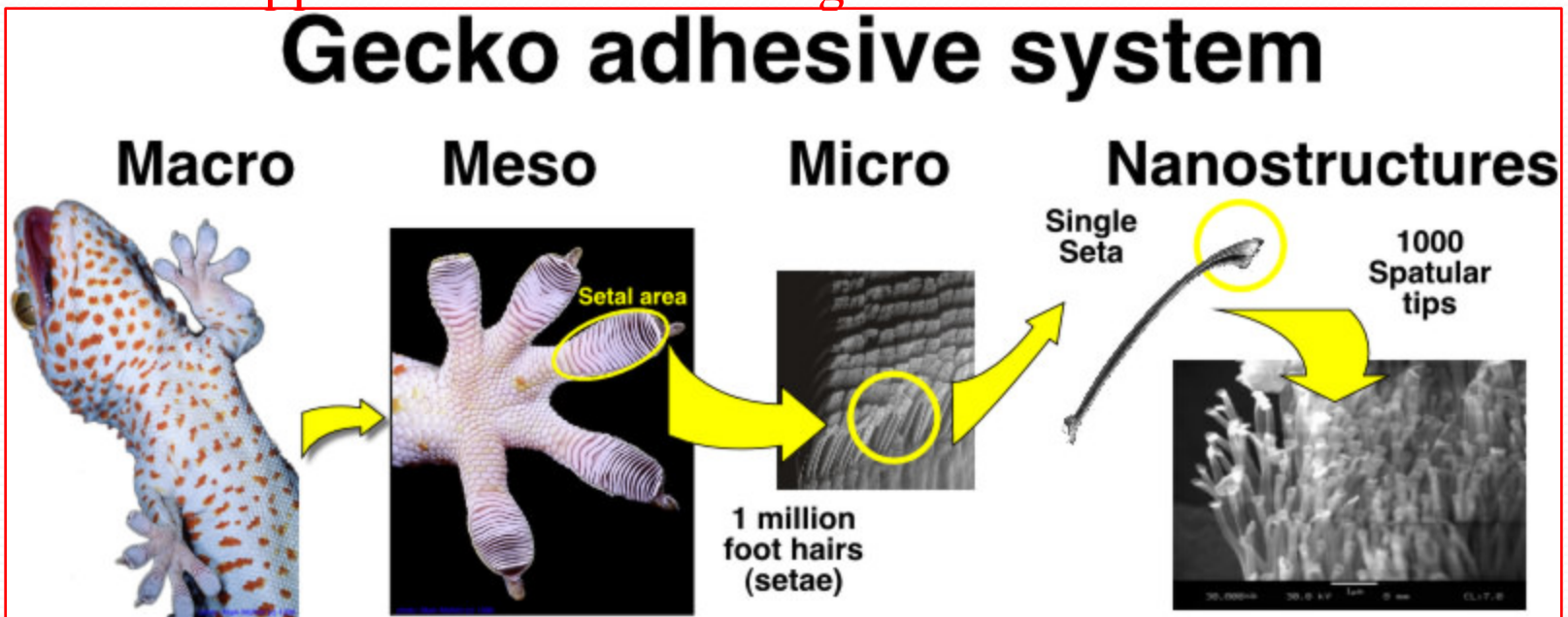
Nanoadhesives

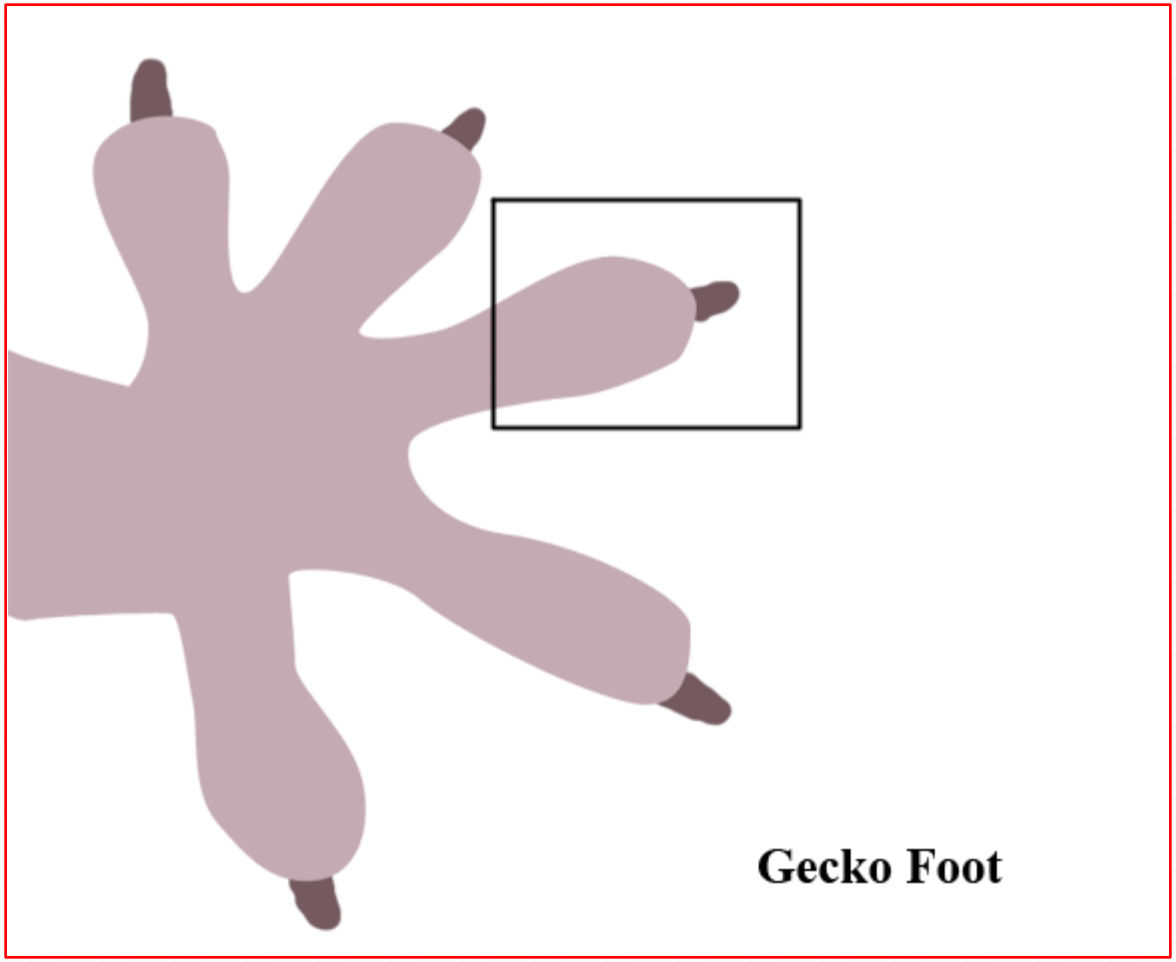
- Adhesives are substances that join two surfaces together.
- Historically, many **bulk adhesives** were made from natural materials, including plant resins, gums, animal glues and many other substances. Glues were made from a wide variety of both organic and inorganic substances (fish, rubber, caseins, and minerals).
- Adhesives are used in everything from simple consumer products to automobiles. Adhesive layers are relatively thin.
- In Nano-adhesives those are bio-inspired, mechanisms of adhesion are primarily either mechanical or chemical.
- Mechanical means involve the adhesive substance, providing a type of interlocking mechanism, typically by the substance filling small pores in each of the surfaces.
- Chemical means are more varied and include direct chemical bonding and the development of intermolecular forces.

- Corresponding to these several mechanisms, various types of adhesives are

1. Reactive adhesives
2. Light-sensitive adhesives
3. Contact adhesives
4. Simple solvent-based adhesives

- **Nanoadhesive** approaches are those inspired by nature, particularly geckos and mussels.
- Gecko has the ability to scamper up walls and even upside down across ceilings.
- This clinging ability, however, does not come from any kind of natural glue. Rather, it results from the presence of many small hairs that cover their feet. These hairs are much smaller than human hairs and are then divided into even smaller hairs at their ends **(called satae).** At the ends of these multiple tiny split hairs are **spatulae** that are cupped like and around in size. These spatulae radically increase the contact area between the hairs and a surface. These spatulae range from the high millions to the low billions. Adhesion results from intermolecular forces between the spatulae and the surface, including Van der Waals' forces and some capillary action.
- They are relatively weak forces, but the high contact area of the spatula results in an appreciable overall sticking force.




Gecko Foot

- Several approaches have been explored.
- Most use some type of nanosurface that is patterned after those of a gecko's foot soles. But this sticking power decreases in the presence of high humidity and often did not work on wet surfaces.
- Investigators working on "wet adhesion" inspired from nature. Here a primary model was the mussel, which can be seen in water environments sticking to seemingly everything, from rocks to pilings.
- Studies of mussels demonstrated that they secrete specialized proteins ("DOPA") that provide these unique adhesive qualities.
- Now investigators reported that by coating gecko-mimicked nanopatterns with a mussel mimicked polymer containing the needed protein, adhesive qualities could be greatly improved.

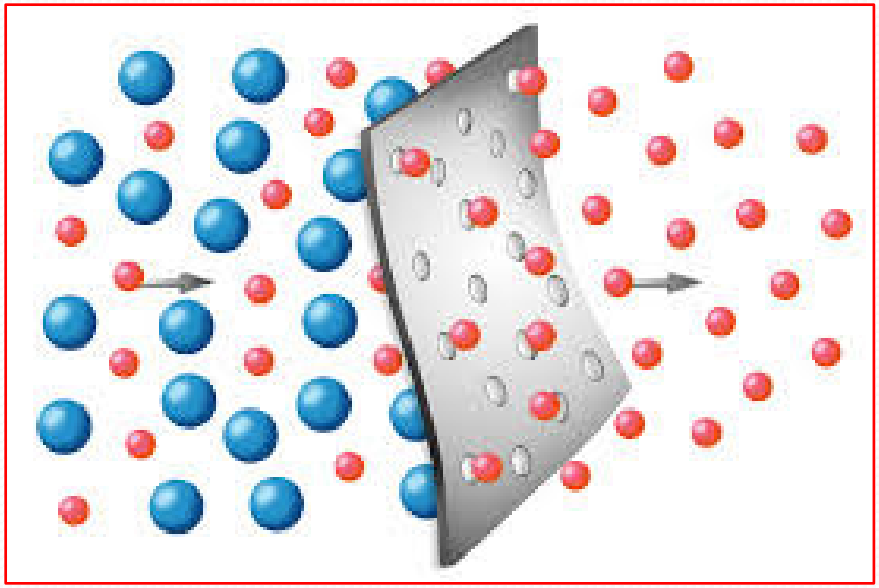
Nanoporous

- Nanoporous materials consist of a regular organic or inorganic framework supporting a regular, porous structure.
- The size of the pores is generally 100 nanometers or smaller.
- Most nanoporous materials can be **classified** as

1. Nanoporous Membranes
2. bulk nanoporous materials

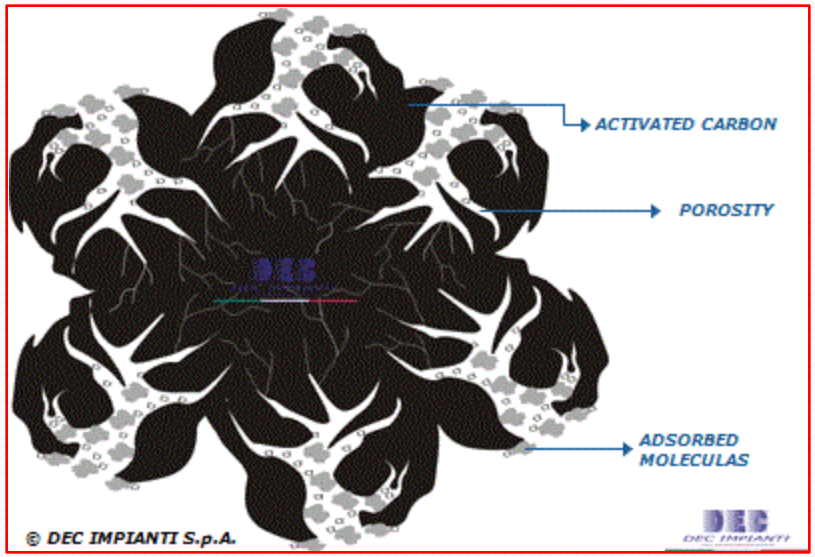
Nanoporous Membranes

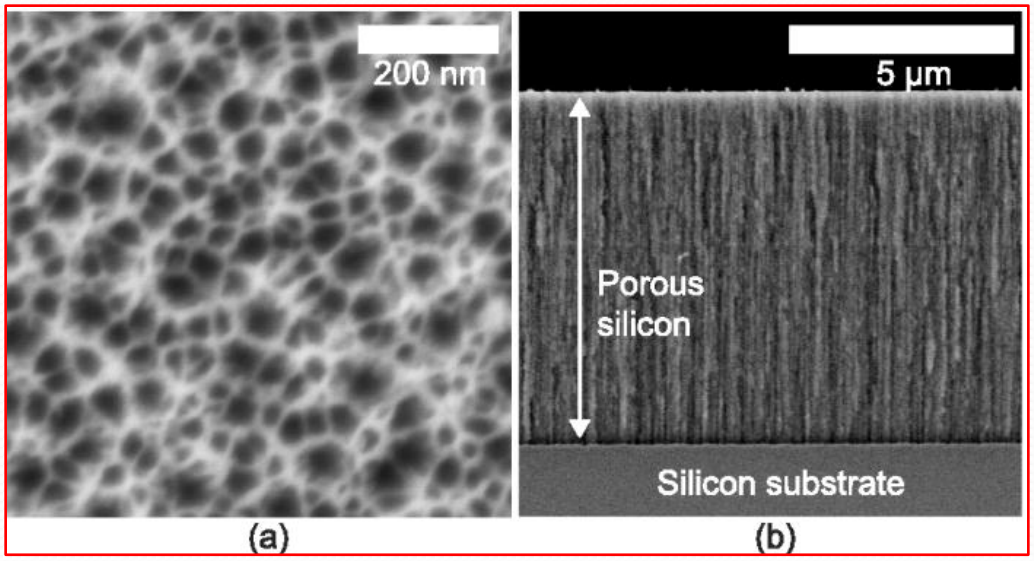
- Cell membranes can be thought of as nanoporous membranes.



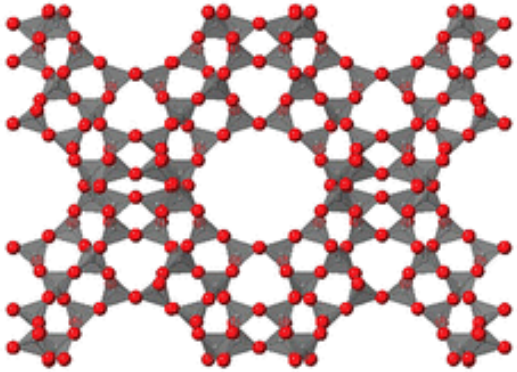
Bulk Nanoporous

- Activated carbon, nanoporous silicon and zeolites (zeolite" means "boiling stone) are examples of bulk nanoporous materials.
- The petroleum industry has been using naturally occurring zeolites as catalysts for decades.

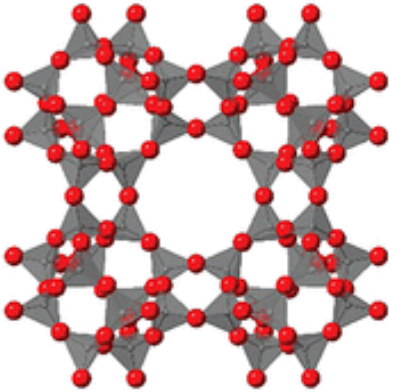




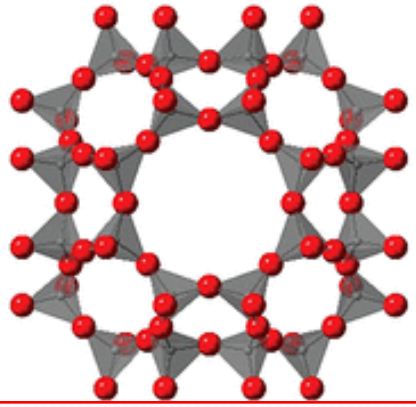
zeolite Na-X (FAU)
$Fd\bar{3}m$



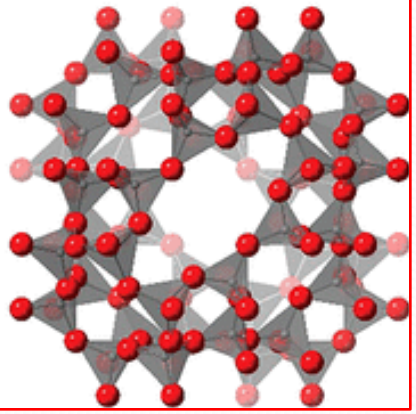
zeolite ZK-5 (KFI)
$Im\bar{3}m$



zeolite RHO (RHO)
C-form-$Im\bar{3}m$



zeolite RHO (RHO)
A-form-$I\bar{4}3m$



- There are many natural nanoporous materials, but artificial materials can also be manufactured.
- Processing methods generally fall into three primary categories:

1. methods that employ thermal or mechanical means only,
2. methods that use some type of pore-generating agent,
3. methods that use some form of template (molecular imprinting or micellar imprinting)

- A nanoporous material with consistently sized pores has the property of letting only certain substances pass through, while blocking others.
- With nanoporous materials, as pore sizes (diameters) decrease, the relative pore surface area radically increases.

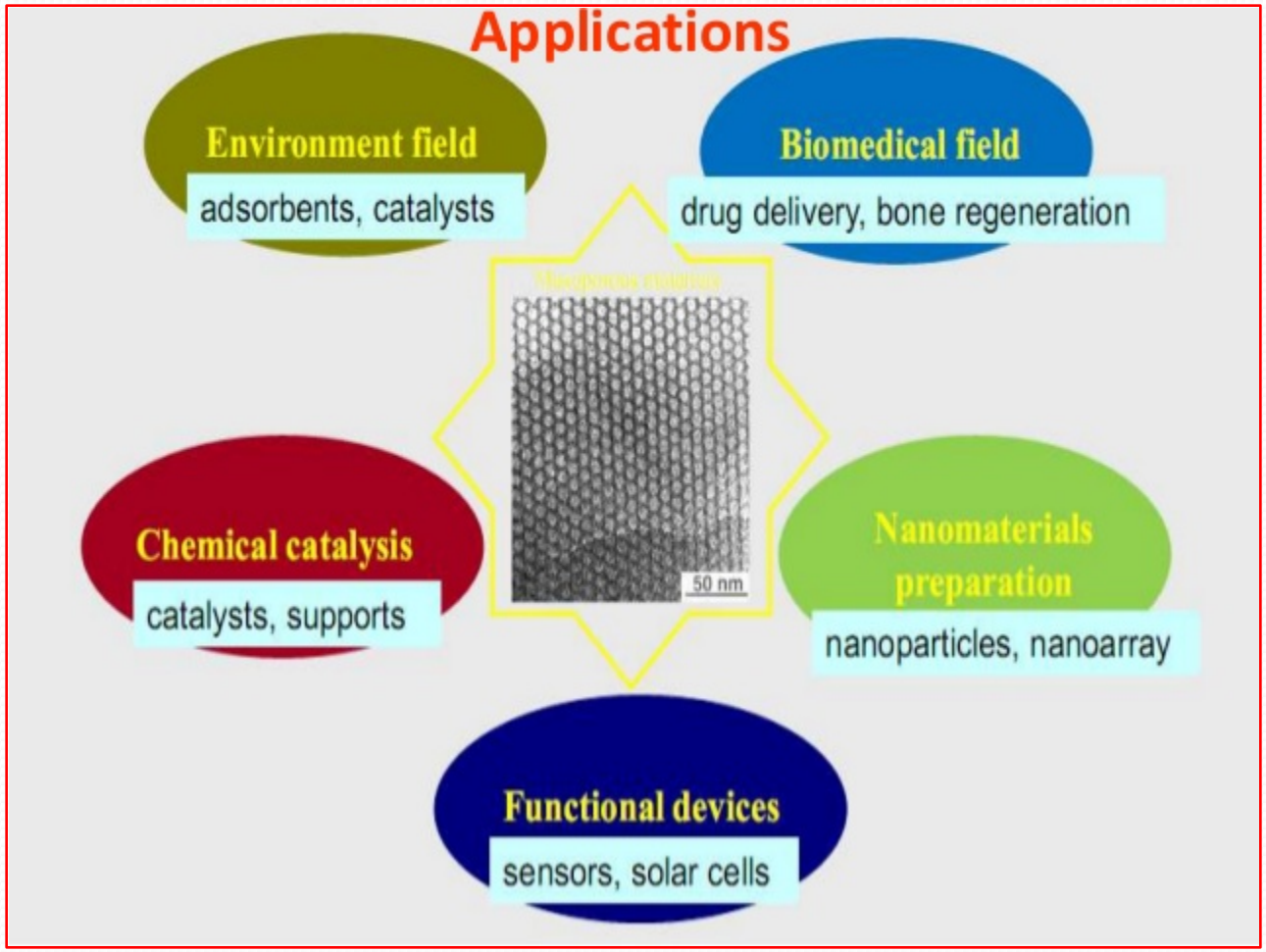
Subdivisions OF Nanoporous Materials

- Nanoporous materials can be subdivided into 3 categories:

1. Microporous materials: 0.2–2nm pores
2. Mesoporous materials: 2–50nm pores
3. Macroporous materials: 50–1000nm pores

Uses

- Porous materials are used in many fields with different industrial applications:
- They serve as permeable membranes for filtering or other functions.
- Nanoporous materials are being used as catalysts.
- Nanoporous materials are being developed as breathable films for product packaging that have useful chemical and physical properties.


Applications
Environment field
adsorbents, catalysts
Biomedical field
drug delivery, bone regeneration
50 nm
Chemical catalysis
catalysts, supports
Nanomaterials preparation
nanoparticles, nanoarray
Functional devices
sensors, solar cells

Thank You