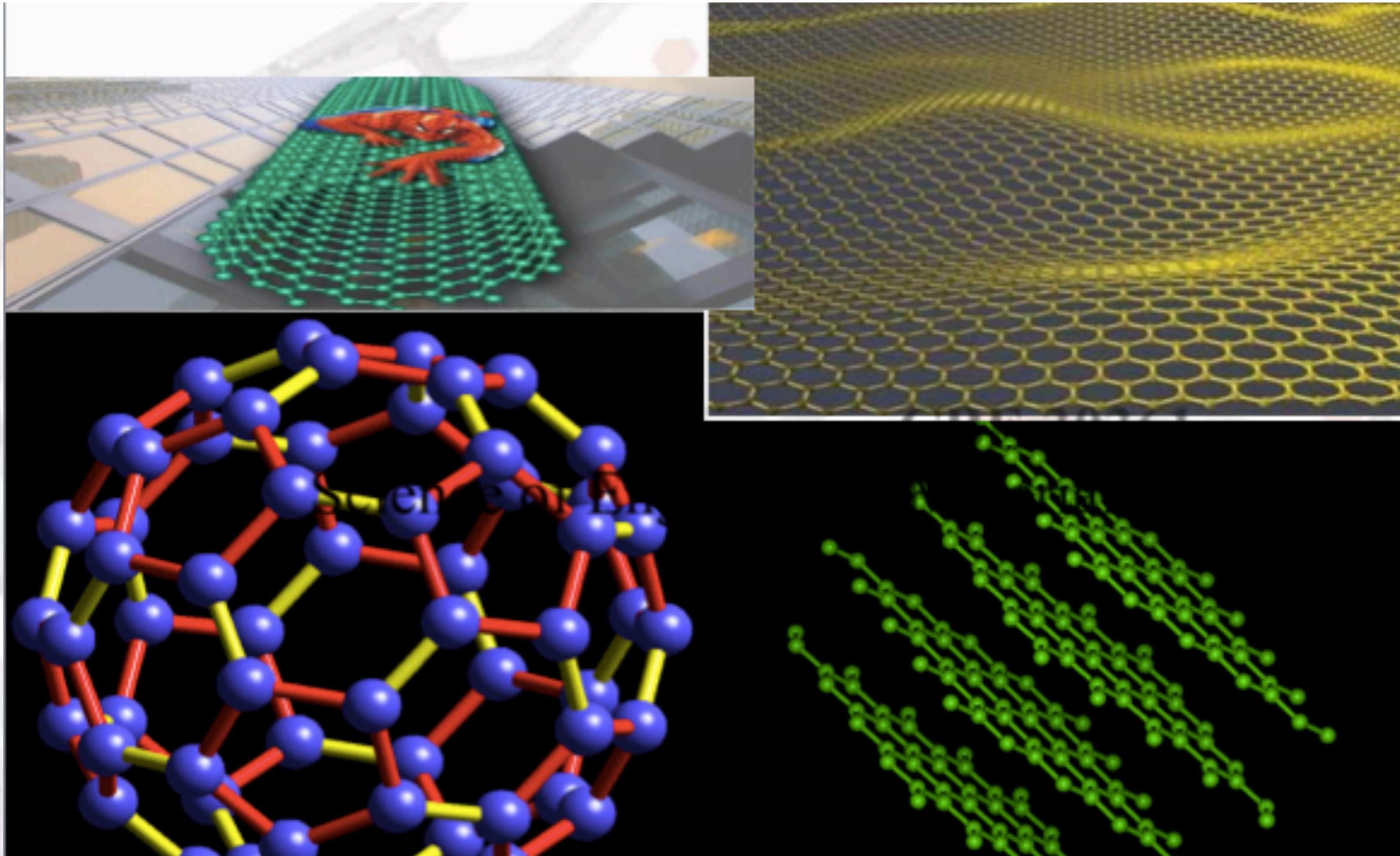
Fundusze Europejskie
Wiedza Edukacja Rozwój

Rzeczpospolita Polska

UNIWERSYTET TECHNOLOGICZNO-HUMANISTYCZNY
im. Kazimierza Pułaskiego w Radomiu

Unia Europejska
Europejski Fundusz Społeczny



Projekt pt.: „Zintegrowany Program UTHRad.", POWR.03.05.00-00-Z105/17
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General Information

Course Number: **CBE 30361**
Course Title: Science of Engineering Materials
Credit hours: 3
Instructor: Dr.prof.Edwin Gevorkyan
Instructor: Dr.
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Office hours: to be discussed

LECTURES

1.Composite materials and prospects for their application.
2.Ceramic composite materials obtaining methods .
3. Composite materials based on alumina and zirconium oxide.
4. Composite materials based on carbides of refractory materials.
5. Composite materials based on nitrides of refractory materials.
6.Methods of obtaining and molding polimer composite materials
7.Nanomaterials and nanocomposites
8. The main characteristics of composite materials.
9. Carbon-carbon composite materials.
10. Polimer and ceramic coatings.

COURSE MATERIAL

- **Lectures**
- **Required text :**

- WileyPLUS for *Materials Science and Engineering: An Introduction,* W.D. Callister, Jr. and D.G. Rethwisch, 9th edition, John Wiley and Sons, Inc. (2014).

Optional Material:

- *Basic Concepts of Crystallography*, E. Zolotoyabko, Wiley-VCH, Weinheim, Germany, 2011.
- *Engineering Materials: Properties and Selections*, K. G. Budinski, M.K. Budinski, Pearson Education Inc., New Jersey, 2010.
- *Introduction to Materials Science for Engineers,* J.F. Shackelford, 7th Edition, Pearson Education, Inc., New Jersey, 2010.

Suggestions for success in this class:

1. Attendance is your **job** – come to class!
2. Read the relevant material in the book (**preferably before the lecture**!)
3. Review and **understand** the examples given in the book and/or website.
4. Do the **assigned homework**. If you are having difficulty with a particular concept, work additional problems given in the book and/or website on that topic that have the answers given in the back of the book.
5. Come to **office and TA's hours**!!

Academic success is directly proportional to the amount of time devoted to study!!

See "advise" file on my website for more details.

Complete Grasping of the Concepts

Possible obstacles:

1. *Poor organization* of the course – responsible: lecturer
2. *Too boring presentation* of the material – responsible: lecturer
3. *Insufficient background* – responsible: students; **I AM READY TO HELP!!**

What can be done?

1. Lectures, homework assignments, solutions, quizzes and exams are **ready** and will be held in class or assigned on the web-site in accordance with the **schedule**, shown in the file: List of Lectures for Course CBE 30361. Any comments on this issue are welcome during the semester.

2. Only 2-3 **main concepts** of the Chapters will be discussed during the lectures. A lot of **new materials** including Hot Topics in the field will be presented. Typical problems will be also solved during the lectures and TA's hours.

3. Self-education: by reading additionally recommended books + wonderful WilyPlus tool + *Piazza* !! **TA hours and office hours are times for detailed discussion of the difficult or not well understood concepts.**

My Essentials in Teaching:

1. **To share** knowledge with **passion**

2. To be ready **to help** and support young engineers

3. To support **creativity** and **willingness to learn**

4. To be **on the side of the students** on every 50:50 situation

5. A **high final grade** for the student is my **main goal**

Let us work hard together and we will succeed !!

Why Science of Engineered Materials is important for all ENGINEERS?

- ***Science of Engineered Materials*** is a *broad*, ***multidisciplinary field* of science** devoted to understanding and manipulating the different materials properties including physical, mechanical, electrical, optical and magnetic.

- It studies fundamental characteristics of variety of materials including **metals, ceramics, polymers, and composite materials**.

- It is closely related to ***chemical and mechanical, electrical and computing, bio- and civil engineering***.

Mechanical Engineering

- **Mechanical engineering** is among the most diversified of the traditional engineering disciplines. Mechanical engineers design and build machines and devices that enable humans to live and work in space, in the air, on the ground, and under water.
- Naturally, much of what engineers can or cannot do depends on the materials they have available to tackle their tasks. This is why **engineers and material scientists work closely together** with the goal of tailoring not only the mechanical, but also chemical and electrical properties of materials to make new applications possible.
- **You have to be able to talk with materials scientist on the same professional language, formulate the problem and outline routes for it solution.**

Metals, Alloys (Al-alloy)

Polymers, Elastomers (Gears)

Ceramics, Glasses (Plugs)

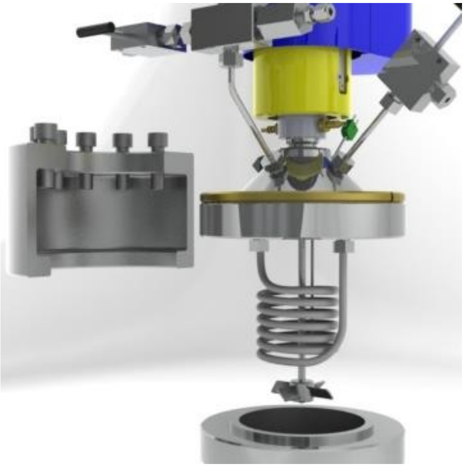
Hybrids, CFRP composites

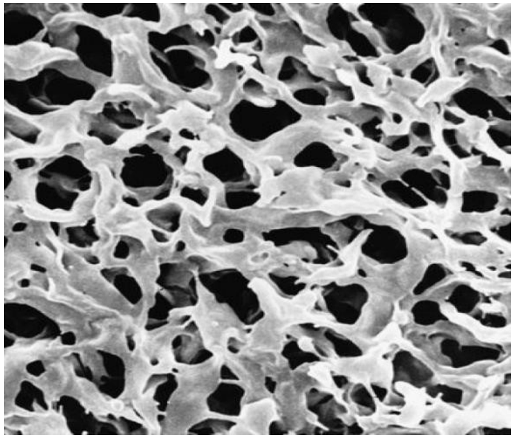
Ferrari prefers aluminum over carbon fiber

While carbon-fiber-reinforced plastic (CFRP) technology is understood to be the ideal combination of strength and weight, the difficulty of using it in automated production and high-price creates an opportunity for aluminum.
That's Ferrari's conclusion, as the company builds all its current production models—the 458 Italia, 458 Spider, 599 GTB, California, and the FF—from aluminum.

Chemical Engineering

- **Chemical Engineering** is a branch of engineering that applies the natural sciences and life sciences together with mathematics, materials science and economics to produce, transform, transport, and properly use chemicals, materials and energy.
- In addition, they are also concerned with pioneering valuable materials and related techniques – which are often essential to related fields such as nanotechnology, fuel cells and bioengineering.

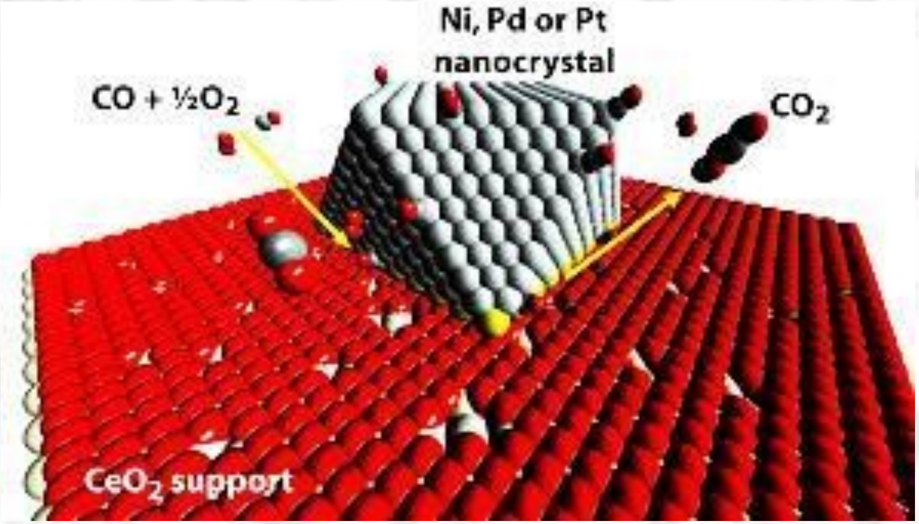


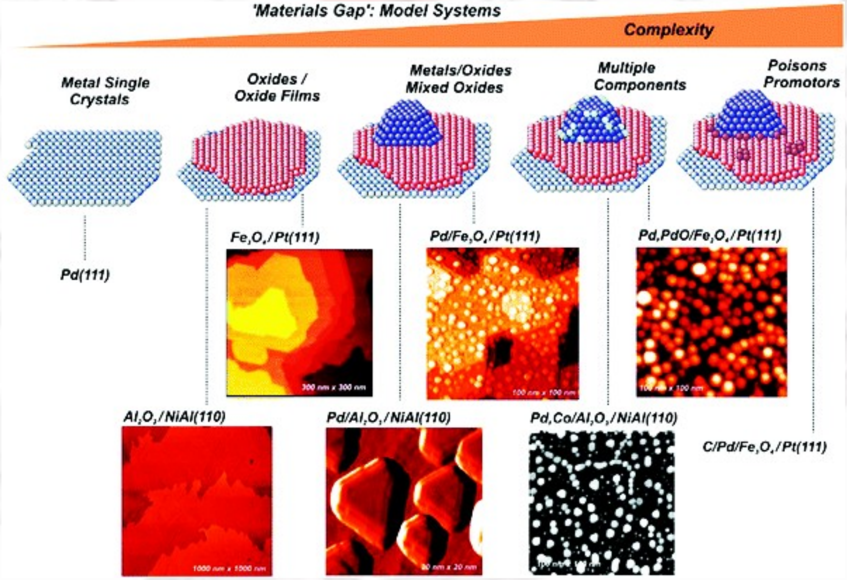


Catalysis & Materials

Definition: **Catalysis** is the acceleration (or deceleration) of a chemical reactions due to the presence of **a catalyst.**
Definition: **a substance** that increases the rate of a chemical reaction without itself undergoing any permanent chemical change.

The goal of catalytic science: To apply fundamental knowledge on molecular reactions and diffusion in/on heterogeneous catalysts for exploration of **new catalytic materials**, catalytic devices and processes of relevance for industry and society.





Aerospace Engineering

- US goals for subsonic, supersonic and hypersonic flight and for space exploration call for **alloys and composites notable for strength, light weight and resistance to heat.**
- The extraordinary diversity of todays **advanced materials** is based on better knowledge of how to attain **novel structures** displaying new properties that lead to improved performance.

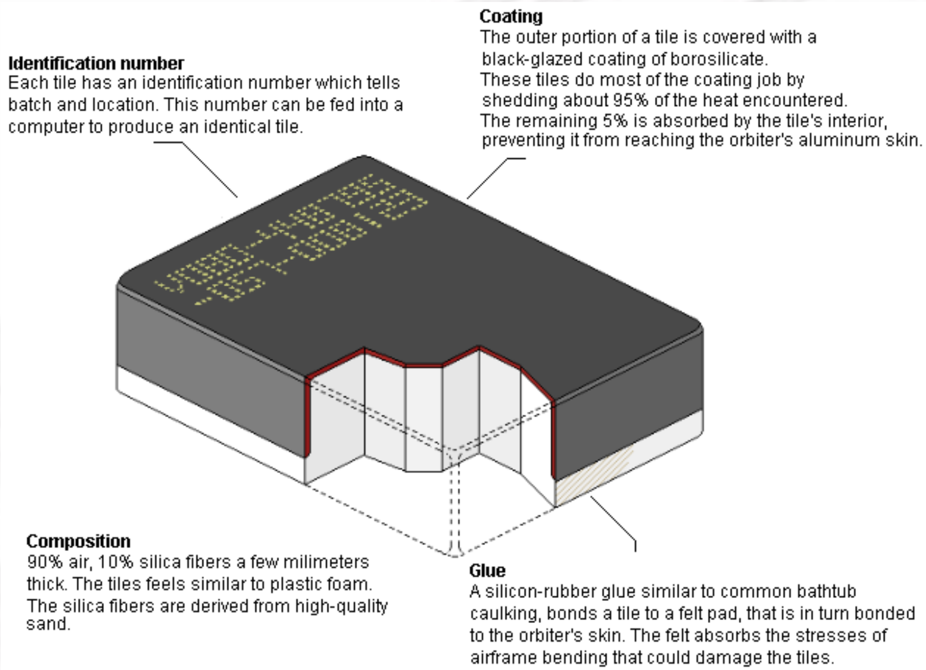
Metals, alloys

Polymers, elastomers

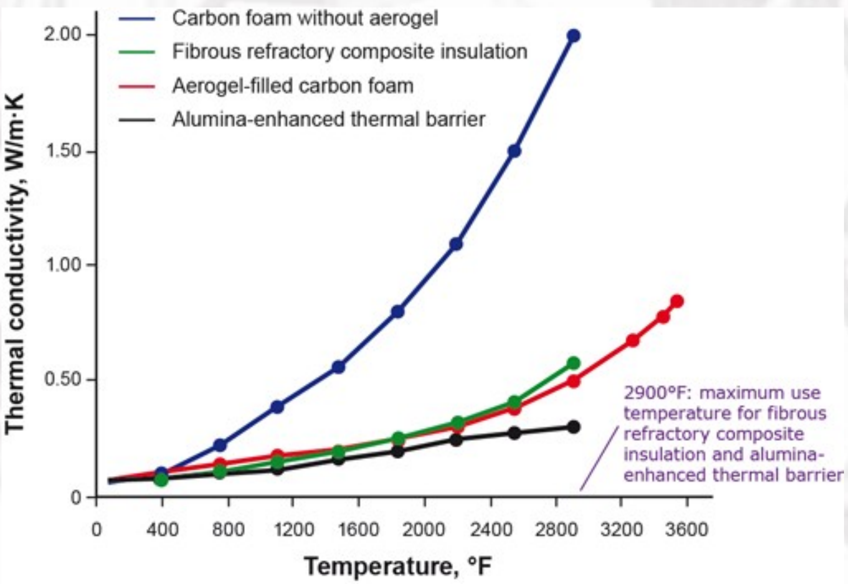
Ceramics, glasses

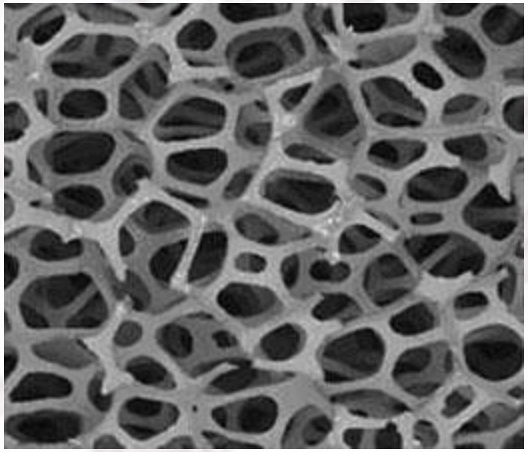
Hybrids, composites

Shuttle Thermal Protection System (TPS)



STS-114 Discovery thermal protection system (S114-E-6412)



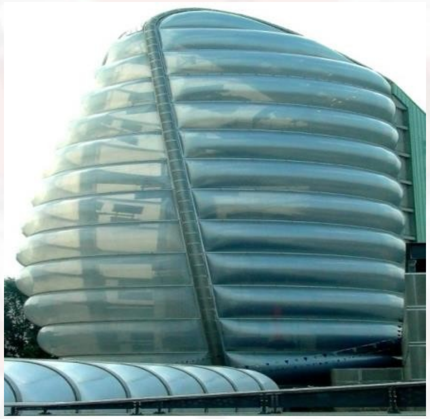


Civil Engineering

❑**Civil engineering** is a discipline that deals with the design, construction, and maintenance of the physical and naturally built environment, including bridges, canals, dams, and buildings.

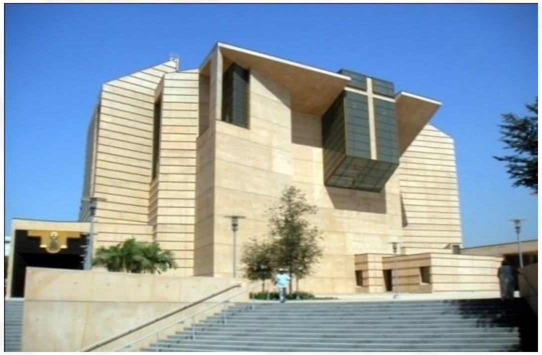
❑***Materials science* is closely related to civil engineering**. Material engineering studies fundamental characteristics of materials, and deals with ceramics such as concrete and mix asphalt concrete, strong metals such as aluminum and steel, and polymers and carbon fibers.

Metals, alloys

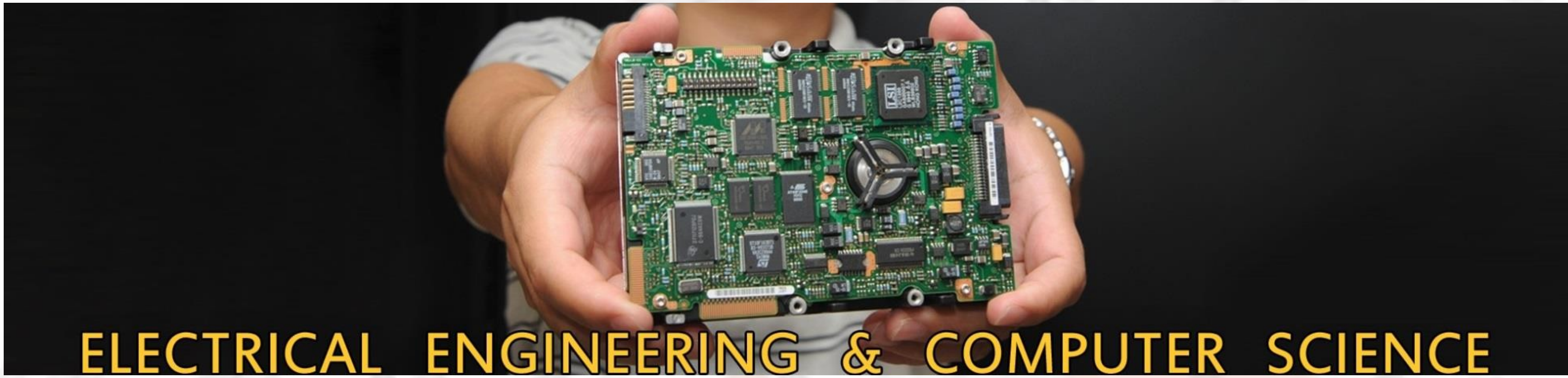


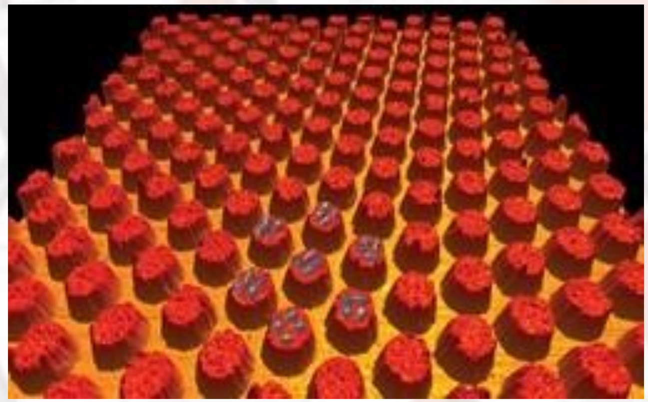
Polymers, elastomers

Ceramics, glasses



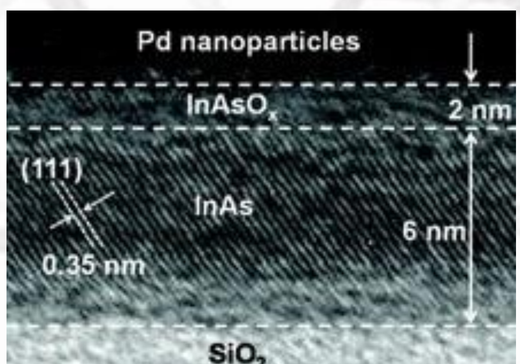
Hybrids, composites





Atomic force microscope (AFM) micrograph of arrays niobium islands (red) on gold underlayer (yellow).
Arrows illustrate fluctuating superconducting properties of the niobium islands.

This development may lower the barriers to broader use of high temperature superconductors on the grid, magnetic chains in electronics, and for applications of other inhomogeneous materials. (2012)



The research focuses on the relationships between synthesis and processing conditions and the structure, properties, and stability of semiconductor materials systems. Progress in these areas is essential for the performance and reliability of a number of technologies that lie at the heart of the DOE mission, including solar power conversion devices, solid state sources of visible light, visual displays, and a large variety of sensors and power control systems for energy generation, conservation, distribution and use.

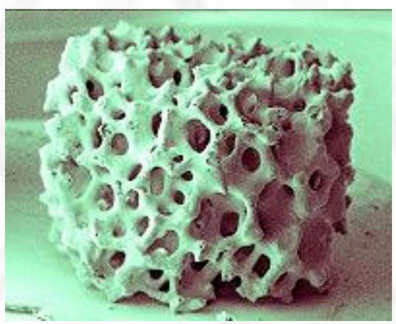
Bio-engineering

- A **biomaterial** is any matter, surface, or construct that interacts with biological systems.
- Biomaterials science encompasses elements of medicine, biology, chemistry, tissue engineering and **material science**.

Metals, alloys

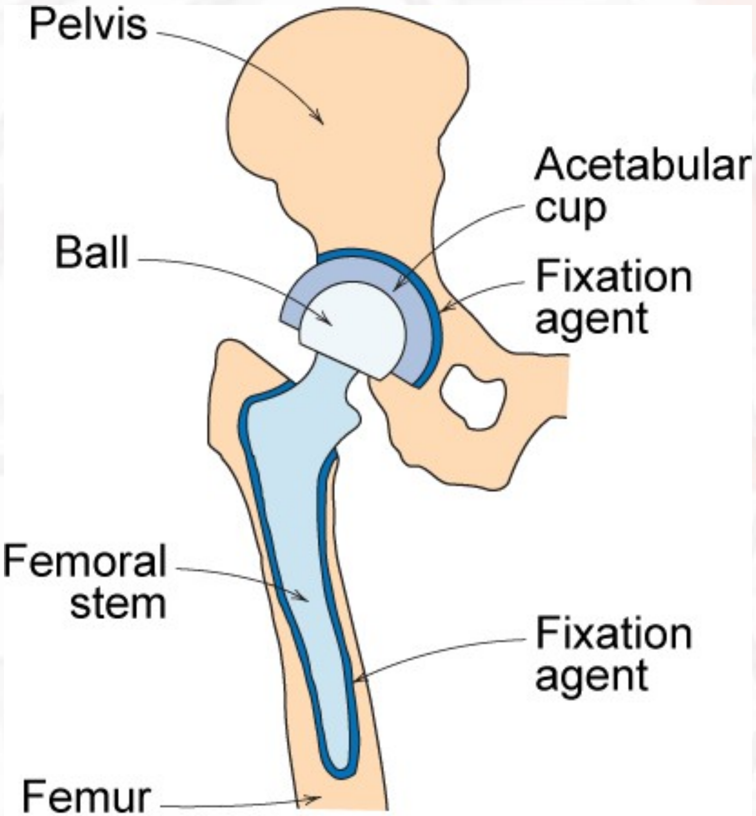
Polymers, elastomers

Ceramics, glasses



Hybrids, composites

Example: Hip Implant



(a)

(b)

Solution: Hip Implant

- Key Problems to overcome:
  - **fixation agent to hold acetabular cup**
  - **cup lubrication material**
  - **femoral stem – fixing agent ("glue")**
  - **must avoid any debris in cup**
  - **Must hold up in body chemistry**
  - **Must be strong yet flexible**

Materials "Drive" our Society!

- **Ages of "Man" we survive based on the materials we control:**

  - **the Stone Age** (>10,000 BC) – naturally occurring materials
    - Special rocks, skins, wood, ceramics and glasses, natural polymers and composites
  - **the Bronze Age**, (4000 BC-1000 BC)
    - Casting and forging
  - **the Iron Age**, (1000 BC-1620 AD)
  - High Temperature furnaces; Cast iron technology (1620's) established the dominance of metals in engineering;
  - **Steel Age** (1859 and up)
    - High Strength Alloys
  - **Non-Ferrous and Polymer Age** (light (1940's) and special alloys)
    - Aluminum, Titanium and Nickel (super-alloys) – aerospace
    - Silicon – Information
    - Plastics and Composites – food preservation, housing, aerospace and higher speeds
  - ***Exotic Materials Age***?
    - Nano-Material and bio-Materials – they are coming and then…