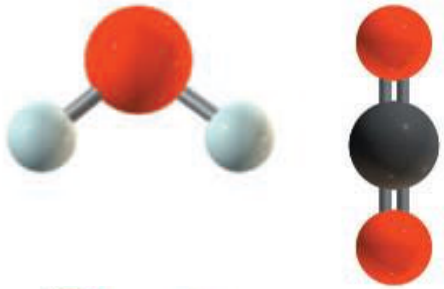
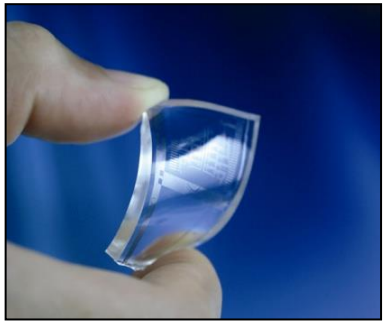
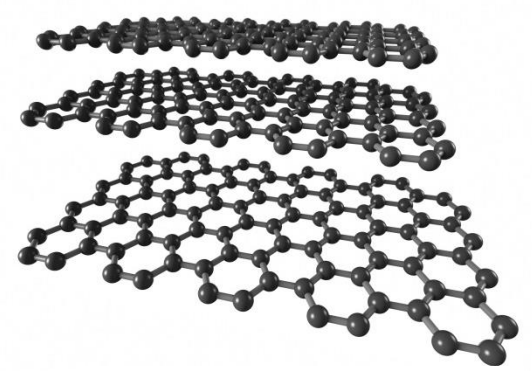
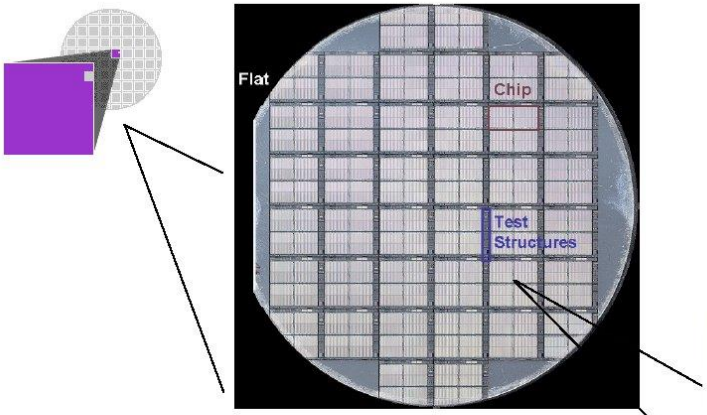
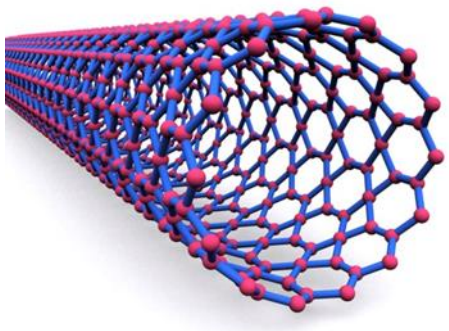


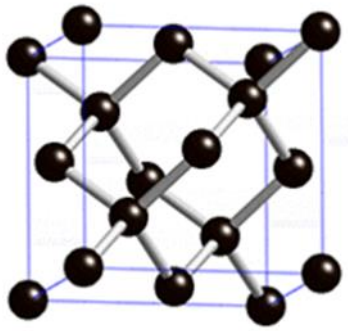
CHEMISTRY











AmAlIAmEsArOS

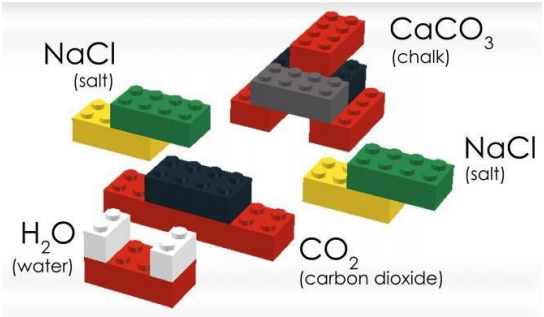
WHY CHEMISTRY ???

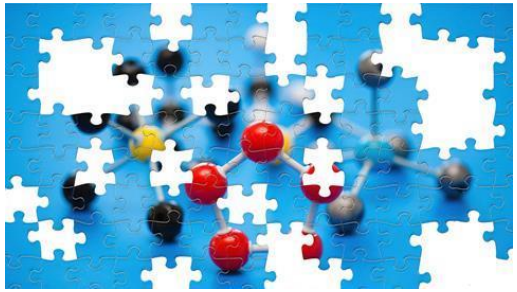
- ✓ *engineering systems are made of materials;*
- ✓ *engineering systems, solid-state devices present properties that can be tailored by carefully controlling their chemical compositions, morphological and structural characteristics;*
- ✓ *the design or optimization of processes in the chemical industry involve chemical reactions that take place in different solvents or in the air.*

CHEMISTRY

- ✓ THE SCIENCE OF MATTER
- ✓ THE CENTER OF SCIENCE
- ✓ A SCIENCE AT THREE LEVELS

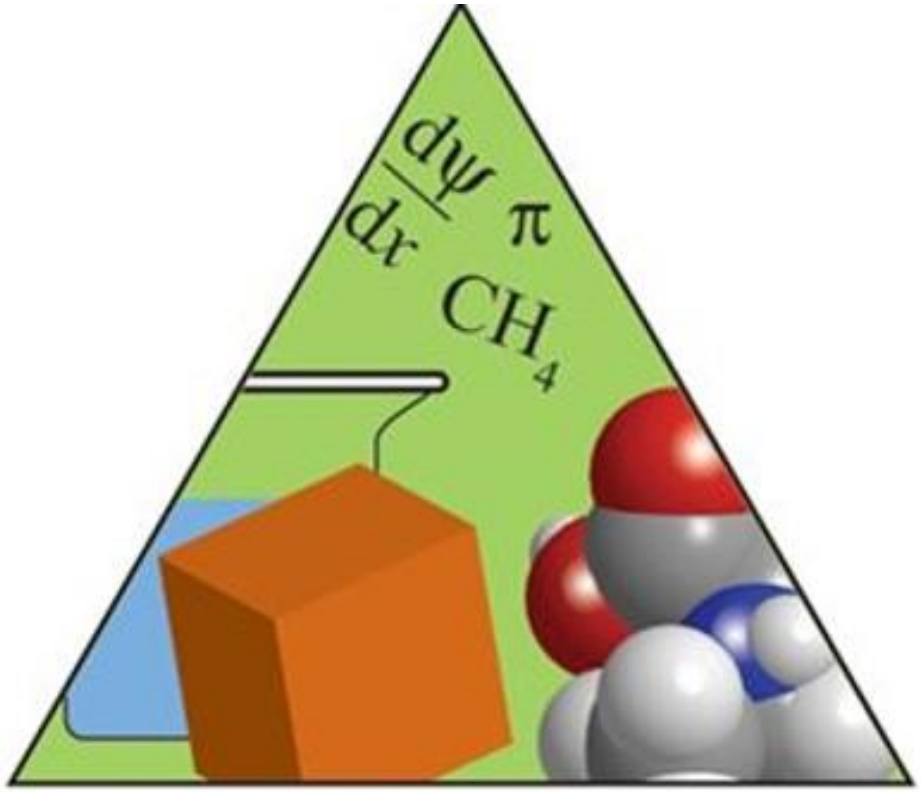
Q: LEGO OR PUZZLE ???





Symbolic level

– the expression of chemical phenomena in terms of chemical symbols and mathematical equations

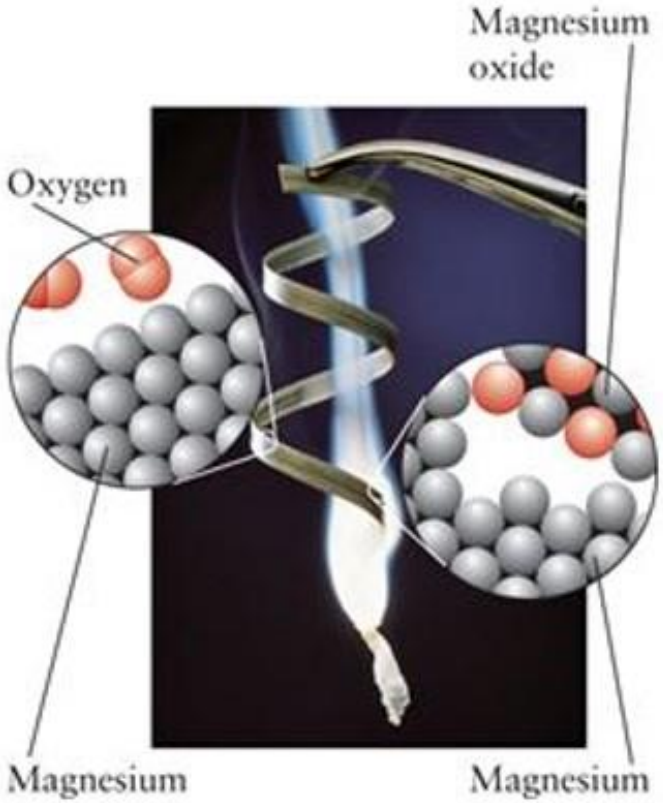


Macroscopic level

– the level dealing with the properties of large, visible objects

Microscopic level

– an underworld of change at the level of atoms and molecules.



reactants

conditions for reaction to occur

(e.g. heat, catalysts)

products

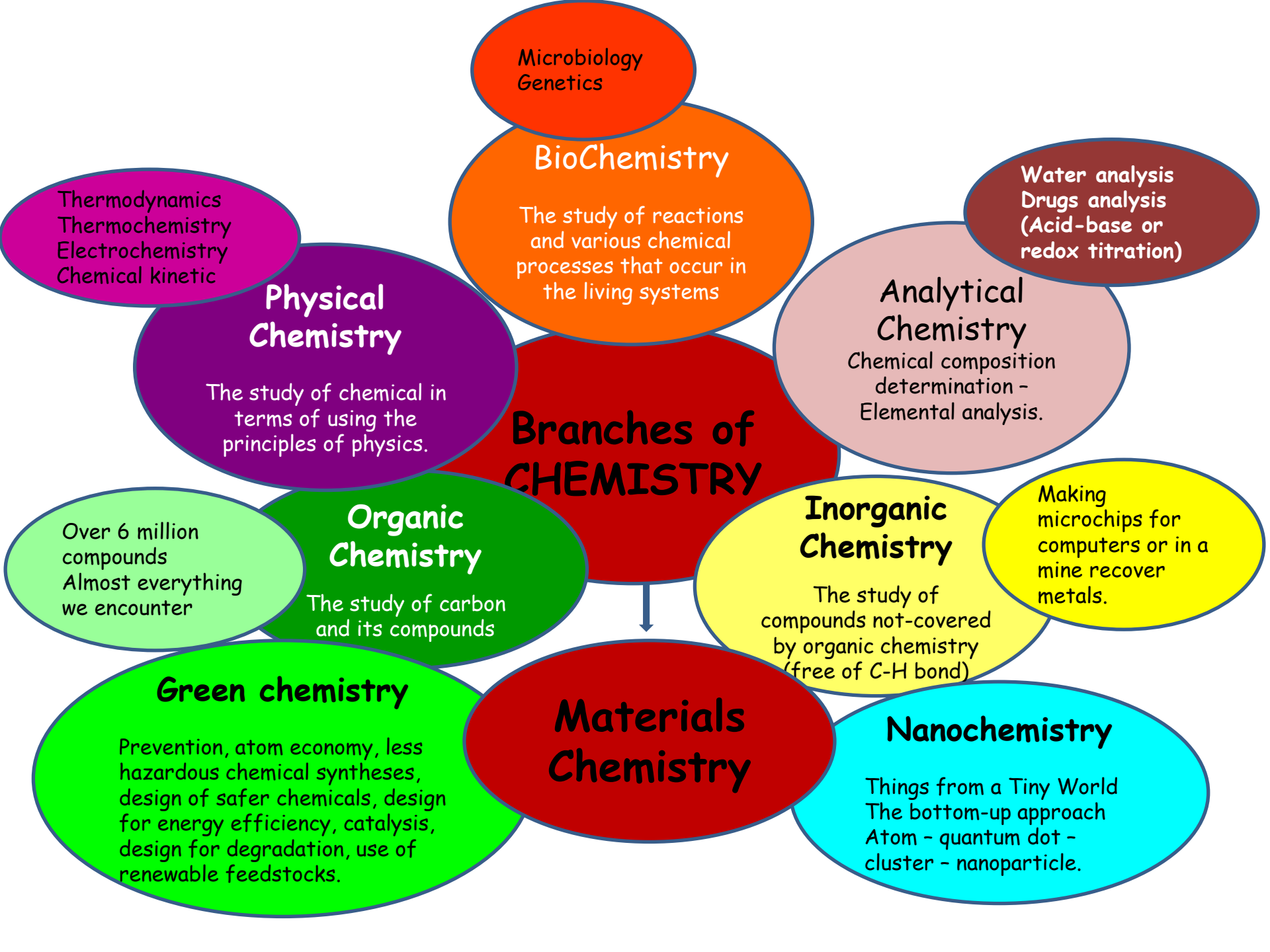
symbol equation

$$Mg_{(s)} + \tfrac{1}{2}O_{2(g)} \xrightarrow{\text{heat}} MgO_{(s)}$$

magnesium + oxygen → magnesium oxide

word equation

"gives"


Microbiology
Genetics
BioChemistry
The study of reactions and various chemical processes that occur in the living systems
Thermodynamics
Thermochemistry
Electrochemistry
Chemical kinetic
Physical Chemistry
The study of chemical in terms of using the principles of physics.
Water analysis
Drugs analysis
(Acid-base or redox titration)
Analytical Chemistry
Chemical composition determination – Elemental analysis.
Branches of CHEMISTRY
Over 6 million compounds
Almost everything we encounter
Organic Chemistry
The study of carbon and its compounds
Inorganic Chemistry
The study of compounds not-covered by organic chemistry (free of C-H bond)
Making microchips for computers or in a mine recover metals.
Green chemistry
Prevention, atom economy, less hazardous chemical syntheses, design of safer chemicals, design for energy efficiency, catalysis, design for degradation, use of renewable feedstocks.
Materials Chemistry
Nanochemistry
Things from a Tiny World
The bottom-up approach
Atom – quantum dot – cluster – nanoparticle.

OUTLINE

- ✓ Periodic system of the elements
- ✓ Atomic structure
- ✓ Chemical bonds
- ✓ Molecular shapes and structures
- ✓ Gases, liquids and solids
- ✓ Thermodynamics: the first, second and third laws
- ✓ Chemical and aqueous equilibria/Acids and bases – pH and pOH
- ✓ Electrochemistry
- ✓ Chemical kinetics

Materials chemistry

Advanced materials: polymers, ceramics, semiconductors, insulators, superconductors, metamaterials…

SYLLABUS !

Bibliography

Course

- P. W. Atkins, L. Jones, Chemical Principles, W. H. Freeman & Company, 2007 ISBN-13: 978-0-7167-7355-9

- 2. M.-L. Ungureşan, D. M. Gligor, General Chemistry, Ed. UTPRESS, Cluj-Napoca, 2012, ISBN: 978-973-662-707-1

Laboratory

- ✓ A. Mesaroş, L. Bolunduţ, M.-L. Ungureşan, Experimente de Chimie Generală, Ed. Galaxia Gutenberg, Colecţia Tehne 5, ISBN: 978-973-141-228-3, 2010
- ✓ L. Bolunduţ, A. Mesaroş, M.-L. Ungureşan, Electrochimia prin experimente, Ed. Galaxia Gutenberg, Colecţia Tehne 1, 2009
- ✓ M.-L. Ungureşan, L. Jantschi, D. M. Gligor, Aplicaţii Educaţionale de Chimie pe Calculator, Ed. Mediamira, Cluj-Napoca, 2004. 4.
- ✓ On-line references: http://mihaela.academicdirect.ro/free/Indrumator_laborator.pdf

Final EXAM:

- 2 hours
- Time and location - will be set later
- Final GRADE COMPOSITION:

20% - Laboratory – individual work

80% - Final written EXAM

Permissible aids:
- ✓ notes
- ✓ periodic table
- ✓ table of constants
- ✓ pocket calculator

+ Extra points :

1 point - at least 3 assignments

1 point – short ppt presentation for a specific topic related to chemistry

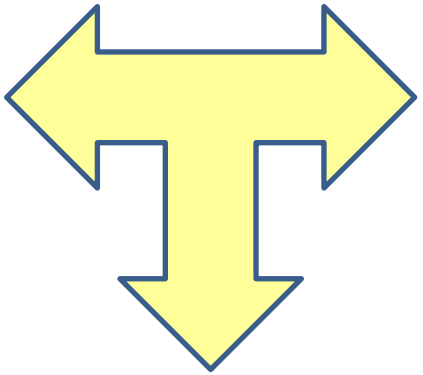
MATERIALS CHEMISTRY

studies the relationship between the structure/morphology and the properties of materials.

MATERIALS SCIENCE

MATERIALS ENGINEERING

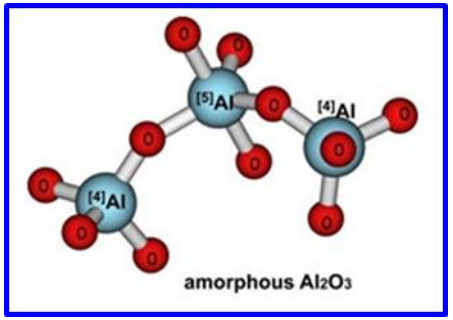
Structure

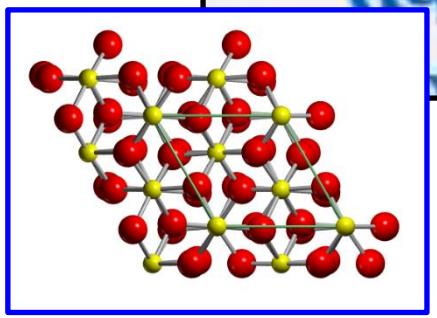


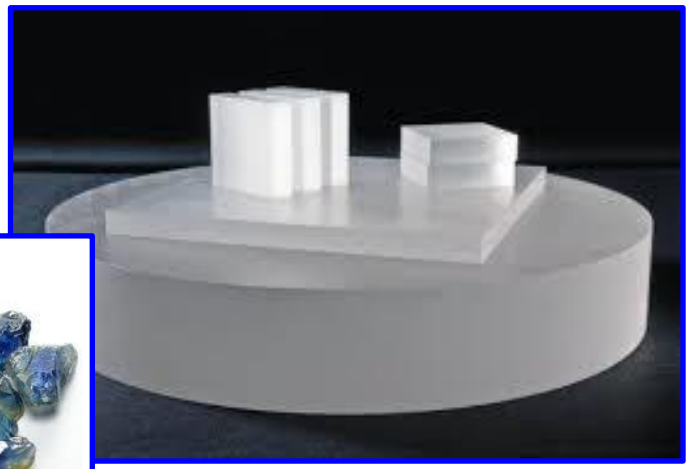
Morphology

Properties

Three thin disk specimens of Al_2O_3







Fe, O

Iron (II) oxide: wüstite (FeO)

Iron (II,III) oxides:

magnetite (Fe_3O_4)

Fe_4O_5

Fe_5O_6

Fe_5O_7

$Fe_{25}O_{32}$

$Fe_{13}O_{19}$

Iron (III) oxide: (Fe_2O_3)

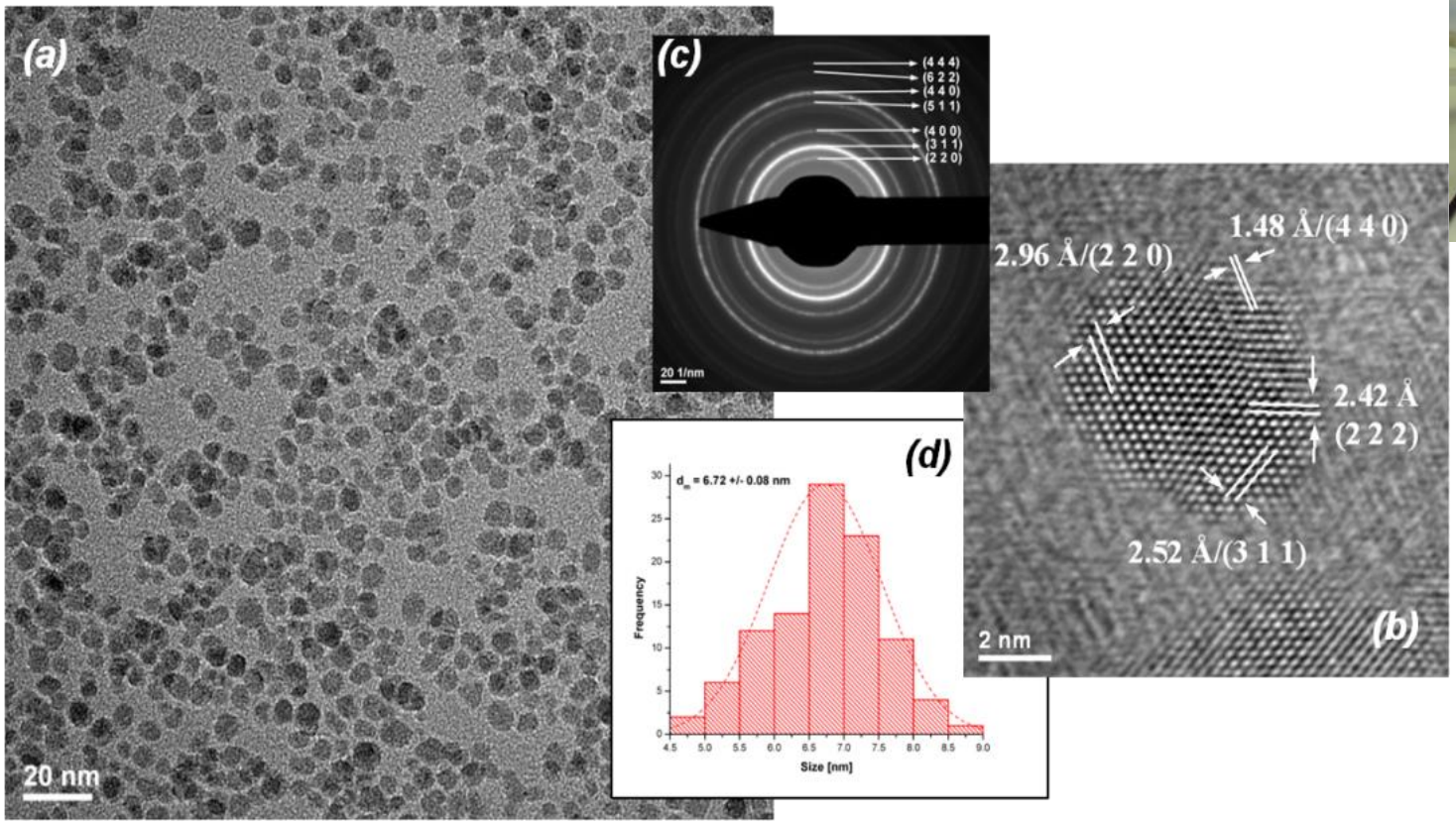
alpha phase, hematite (α-Fe_2O_3)

beta phase, (β-Fe_2O_3)

gamma phase, maghemite (γ-Fe_2O_3)

epsilon phase, (ε-Fe_2O_3)

Synthesis of the Fe_3O_4 nanoparticles by solvothermal decomposition method

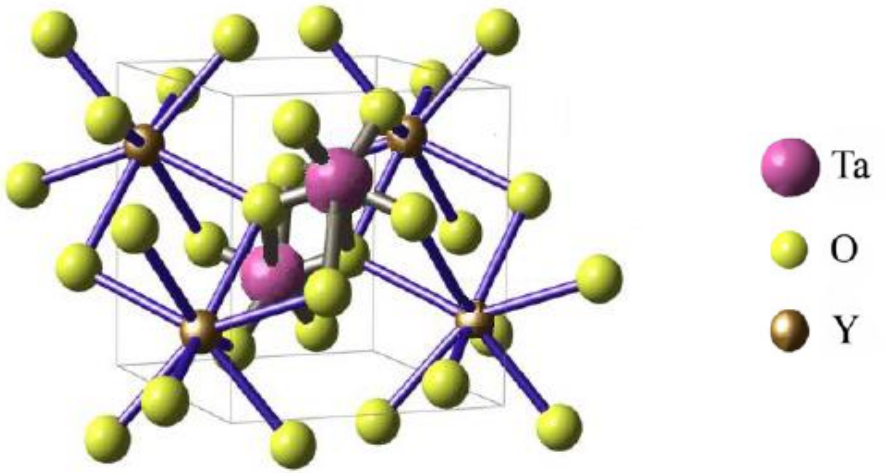


Y_2O_3 – Ta_2O_5

Compound	Y_2O_3:Ta_2O_5 ratio	Name	Structure
YTa_7O_{19}	1:7	Polytantalate	tetragonal
YTa_3O_9	1:3	Metatantalate	cubic - perovskite ortorombic
$YTaO_4$	1:1	Orthotantalate	monoclinic - fergusonite (M) monoclinic - fergusonite (M') tetragonal - scheelite (T) tetragonal - scheelite (T')
Y_3TaO_7	3:1	Paratantalate	cubic - fluorit orthorombic –weberit
$Y_{10}Ta_4O_{25}$	5:2	-	orthorombic

$YTaO_4$

Unit cell parameters	Tetragonal T' (fluorite)	Monoclinic M' (fergusonite)	1325°C →	Tetragonal T (scheelite)	răcire →	Monoclinic M (fergusonite)
a (Å)	3,648	5,292		7,732		5,326
b (Å)	3,648	5,451		7,732		10,931
c (Å)	5,466	5,110		11,490		5,050
β (°)	90	96,44		90		95,50
V (Å³)	69,152	146,480		686,920		292,65

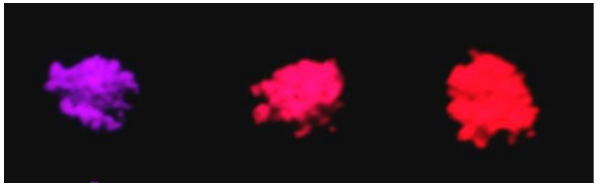


Y_2O_3, RE_2O_3

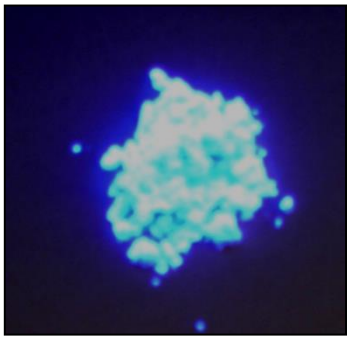
Ta_2O_5, Nb_2O_5, *flux*

RE: Eu

✓ *Solid State Reaction*



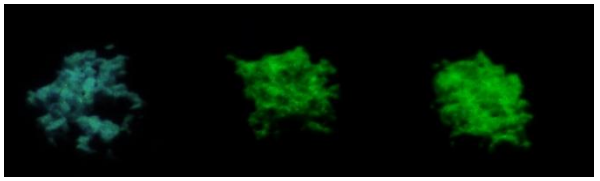
$YTaO_4$



Powders

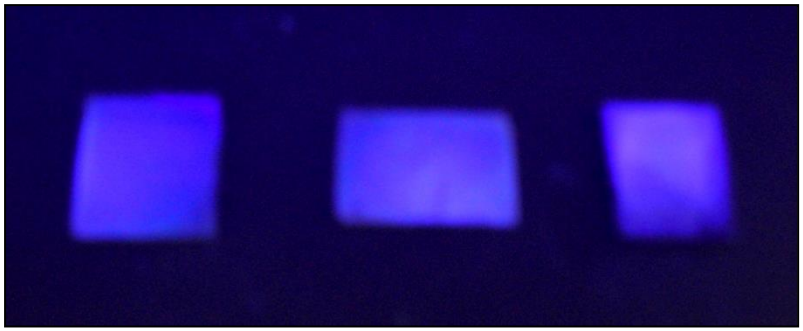
$Y_{1-x}RE_xTa_{1-y}Nb_yO_4$

RE: Tb



$YTa_{1-x}Nb_xO_4$

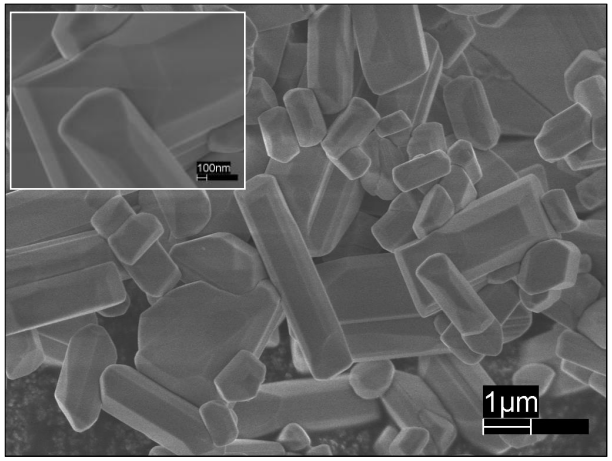
Thin Films



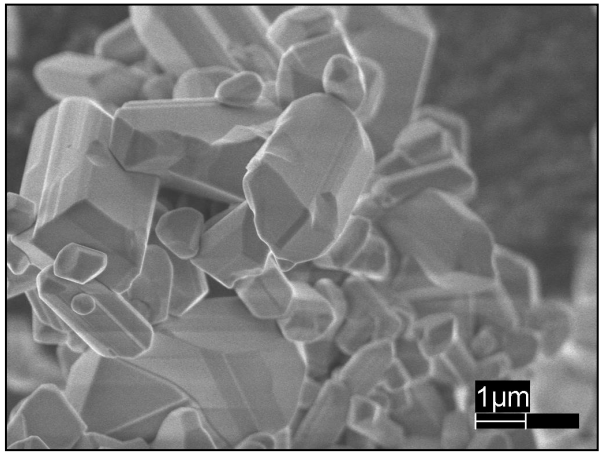
✓ *Pulse Laser Deposition*

✓ *Chemical Solution Deposition*

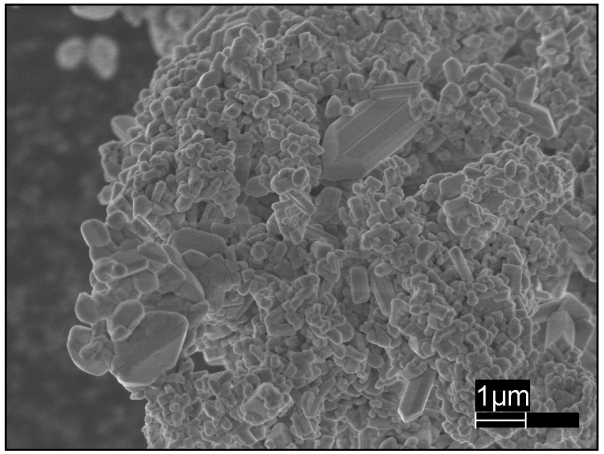
$YTa_{1-x}Nb_xO_4$ powders



T7 (Li_2SO_4 / 1200°C)

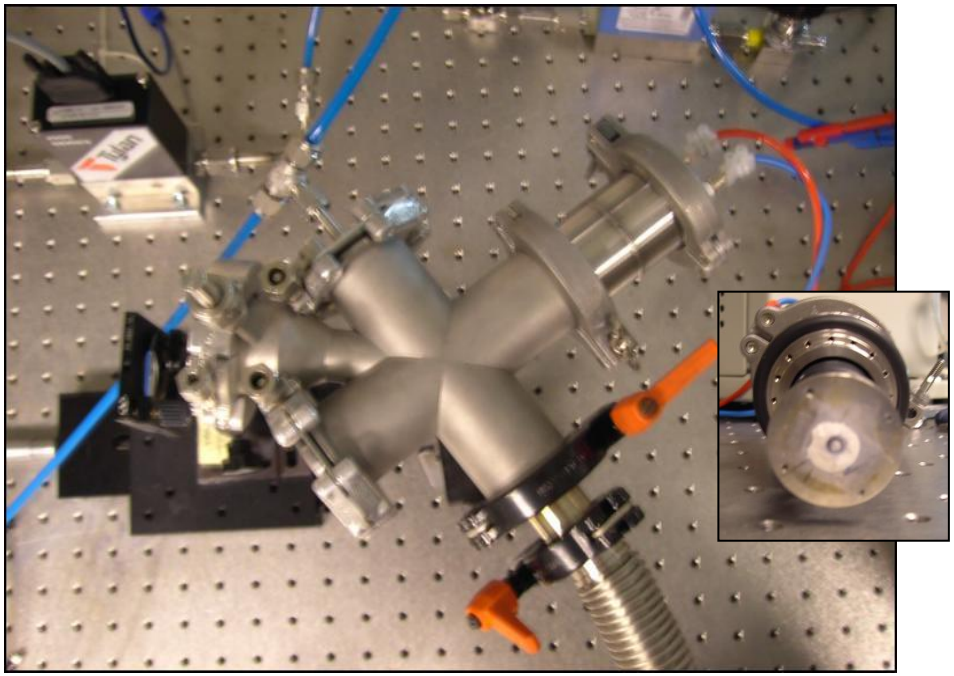


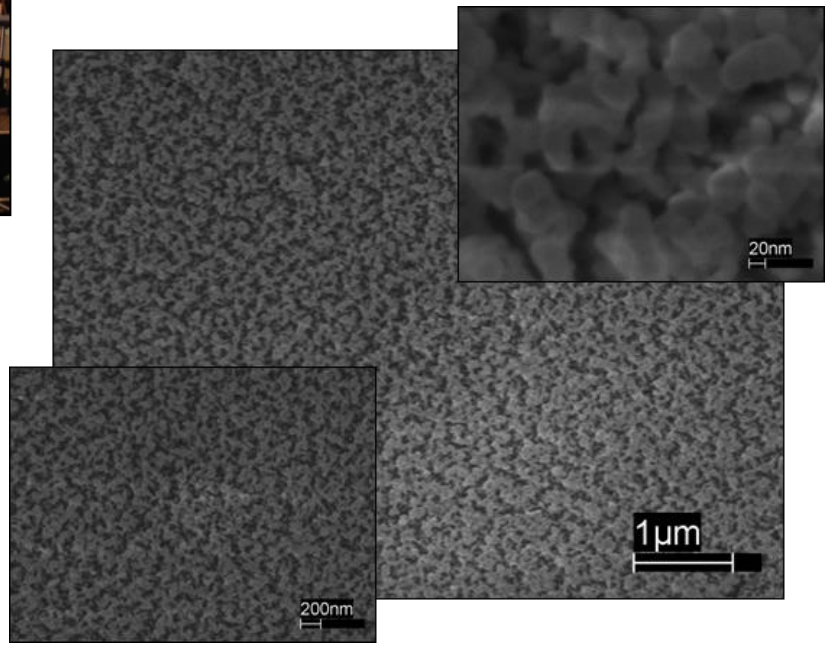
T8 (Li_2SO_4 - Na_2SO_4 /1200°C)



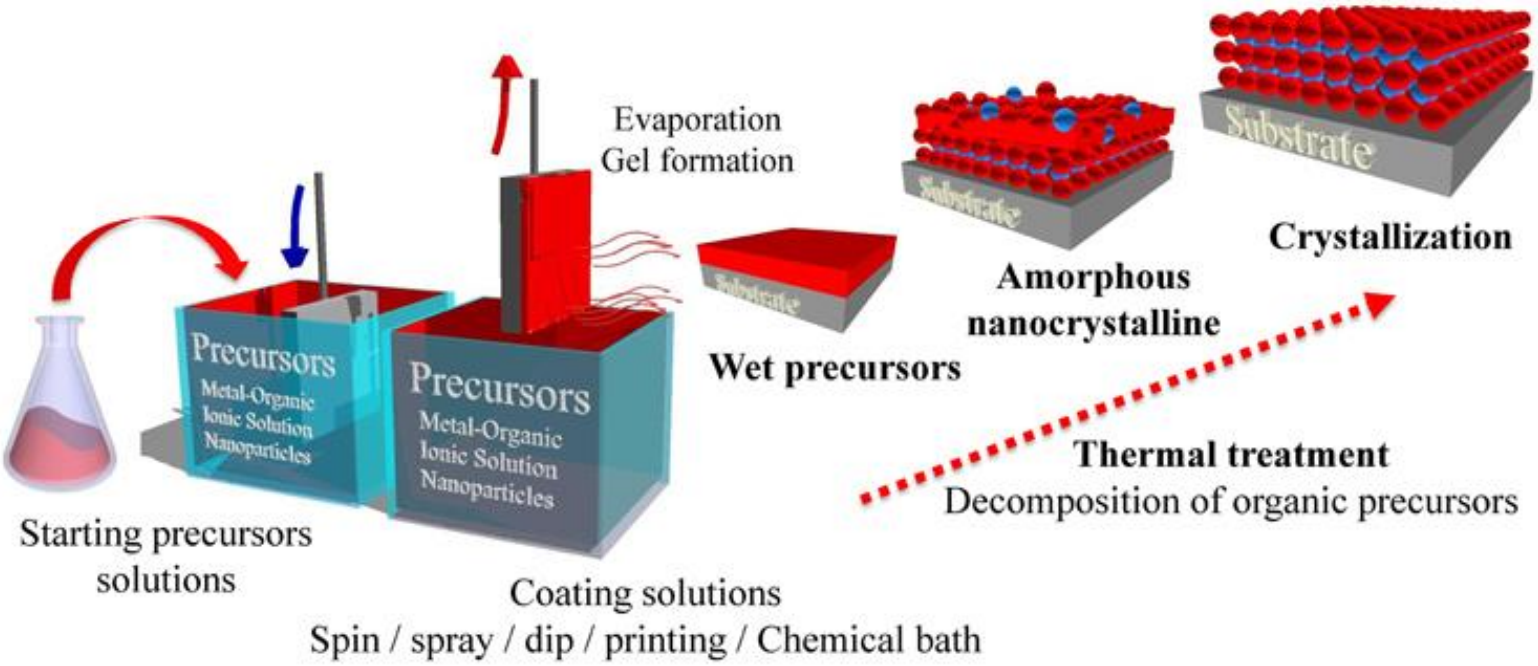
T9 (Na_2SO_4/ 1200°C)

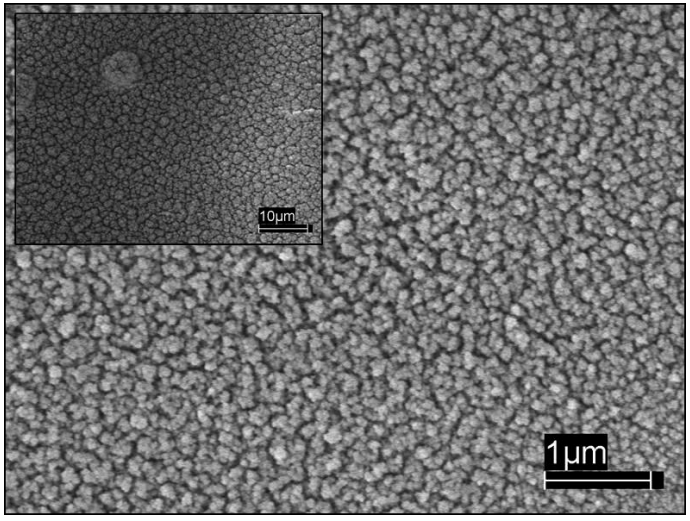
Pulsed Laser Deposition

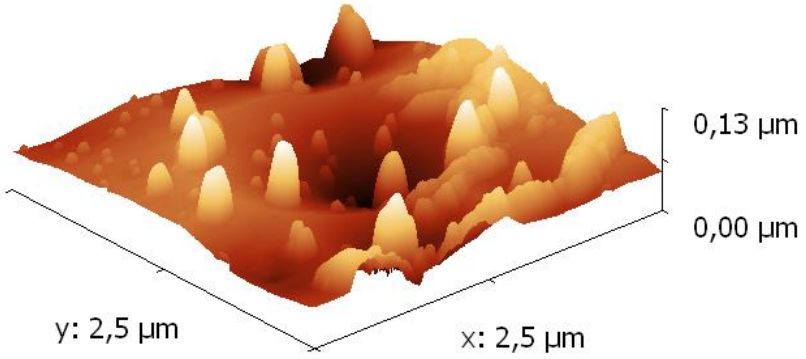




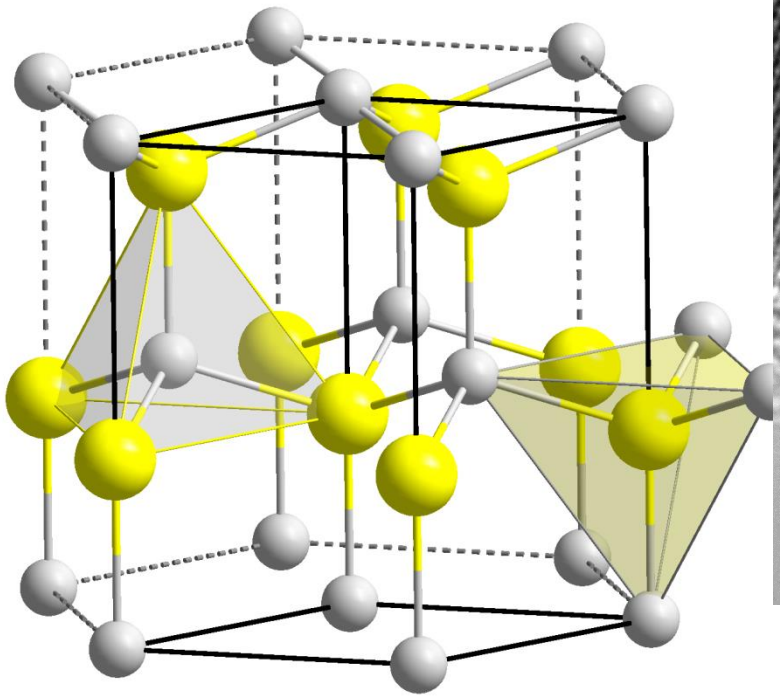
Chemical Solution Deposition

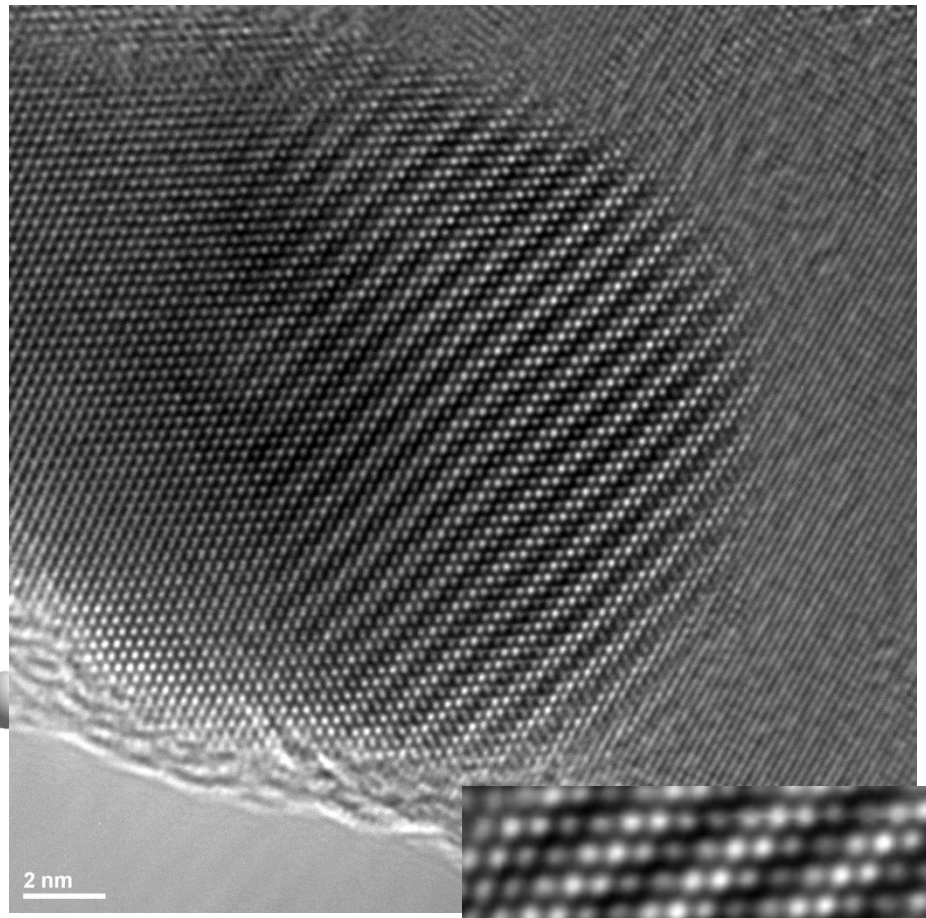


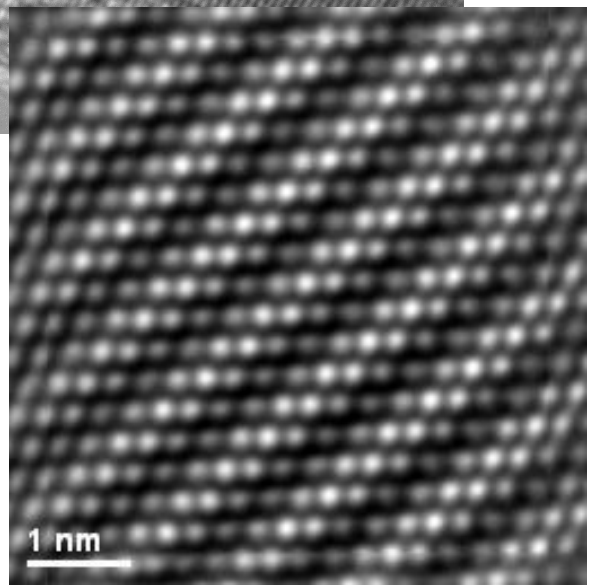




ZnO nps







Ceramics International, 40(2), 2014, 2835-2846

What is matter ?

- ✓ Substance
- ✓ Physical properties
- ✓ Chemical properties
- ✓ Energy

Chemical species { atoms, ions, molecules

Chemical compound

Inorganic compounds

- Compounds that consist primarily of elements other than carbon and hydrogen;
- Include both covalent and ionic compounds;
- Formulas are written when the component elements are listed beginning with the one farthest to the left in the periodic table with those in the same group listed alphabetically.

Organic compounds

- Covalent compounds that contain predominantly carbon and hydrogen;
- Formulas of organic compounds written with carbon first, followed by hydrogen and then by other elements in alphabetical order.

- ***Molecular formula***

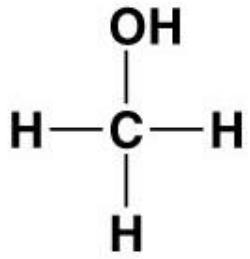
  - Gives the elemental composition of molecules

- ***Structural formula***

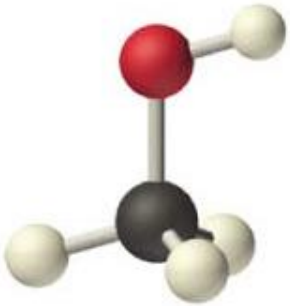
  - Shows which atoms are bonded to one another and the approximate arrangement in space;
  - Enables chemists to create a three-dimensional model that provides information about the physical and chemical properties of the compound;
  - A single bond, in which a single pair of electrons are shared, is represented by a single line (–)
  - A double bond, in which two pairs of electrons are shared, is indicated by two lines (=)
  - A triple bond, in which three pairs of electrons are shared, is indicated by three lines (≡)

CH_4O

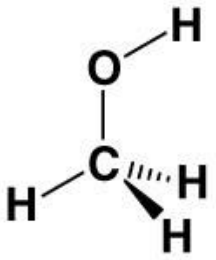
(a)
Molecular formula



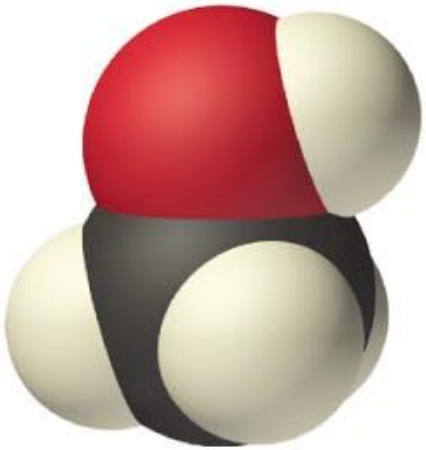
(b)
Structural formula



(c)
Ball-and-stick model



(d)
Perspective drawing



(e)
Space filling model

CH_3OH

(f)
Condensed structural formula

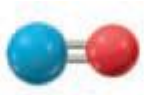
Chemical nomenclature

Greek prefixes for the first ten numbers

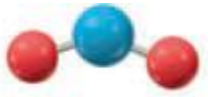
Number	Prefix
One	Mono-
Two	Di-
Three	Tri-
Four	Tetra-
Five	Penta-
Six	Hexa-
Seven	Hepta-
Eight	Octa-
Nine	Nona-
Ten	Deca-

Nitrogen forms a number of binary compounds with oxygen.

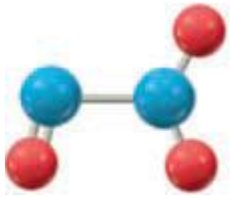
Dinitrogen oxide, N_2O



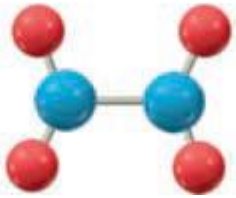
Nitrogen monoxide, NO



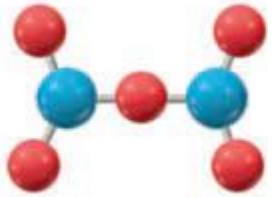
Nitrogen dioxide, NO_2



Dinitrogen trioxide, N_2O_3



Dinitrogen tetroxide, N_2O_4



Dinitrogen pentoxide, N_2O_5