Ceramics

Ministry of higher education
Higher institute for engineering
and Technology
New Damietta
Course title: Ceramics

First Semester (Dec. 2017)
Final exam
Level five
Time allowed: 3 hours
Full Mark: 60 Marks

Model Answer

Question No. 1 **[20 marks]**

a) Define ceramic materials and compare between preparation method of traditional and advanced ceramic **[10 marks]**

The word ceramic can be traced back to the Greek term *keramos*, meaning "a potter" or "pottery". *Keramos* in turn is related to an older Sanskrit root meaning "to burn". Thus the early Greeks used the term to mean "burned stuff" or "burned earth" when referring to products obtained through the action of fire upon earthy materials

Comparison between traditional and advanced ceramic preparation.

Traditional ceramic methods	Advanced ceramic methods
Chemically inhomogeneous	Chemical reaction during firing
Complex microstructure	Mixture of powder with chosen reactivity
Low-cost powder preparation methods were used for traditional ceramics	★ The chemical composition and microstructure must be well controlled. ★ Attention to the quality of starting powder: ▪ Size. ▪ Size distribution. ▪ State of agglomeration. ▪ Structure of the surface. ▪ Chemical composition.
Usually used mechanical method for preparation of powder	★ Chemical and mechanical methods used in preparation of powder: ▪ Fine particle size is desirable for good chemical reactivity). If particle size decreased the contact surface increased, that's increases the reaction. ▪ High packing density is chosen to limit shrinkage and distortion during firing. ▪ Homogeneous packing of powder allows greater control of microstructure.

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b) What are the common powder preparation methods for ceramics ? [10 marks]

Common powder preparation methods for ceramics

Powder preparation method	Advantages	Disadvantages
Mechanical		
Comminution	Inexpensive, wide applicability	Limited purity, limited homogeneity, large particle size
Mechanochemical synthesis	Fine particle size, good for nonoxides, low temperature route	Limited purity, limited homogeneity
Chemical		
Solid state reaction		
Decomposition; reaction between solids	Simple apparatus, inexpensive	Agglomerated powder, limited homogeneity for multicomponent powders
Liquid solutions		
Precipitation or coprecipitation; solvent vaporization (spray drying, spray pyrolysis, freeze drying); gel routes (sol-gel, Pechini, citrate gel, glycine nitrate)	High purity, small particle size, composition control, chemical homogeneity	Expensive, poor for nonoxides, powder agglomeration commonly a problem
Nonaqueous liquid reaction	High purity, small particle size	Limited to nonoxides
Vapor phase reaction		
Gas-solid reaction	Commonly inexpensive for large particle size	Commonly low purity; expensive for fine powders
Gas-liquid reaction	High purity, small particle size	Expensive, limited applicability
Reaction between gases	High purity, small particle size, inexpensive for oxides	Expensive for nonoxides, agglomeration commonly a problem

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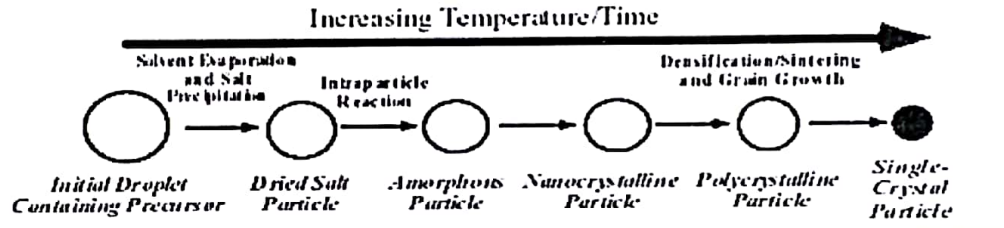
Question No. 2 **[20 marks]**

a) Draw spray drying and Sol gel techniques in the processing of ceramic materials [15 marks]

Spray drying

Is an example of the powder preparation methods based on the evaporation of the liquid. A solution of metal salts is sprayed (in the form of small droplets 10-100 μm in diameter) into a hot chamber and the resultant powder is collected with a cyclone separator. The breaking up of the solution into small droplets allows rapid evaporation so that the solution in each droplet can be brought rapidly to a state of supersaturation.

Schematic presentation spray pyrolysis particle formation



Sol-gel process

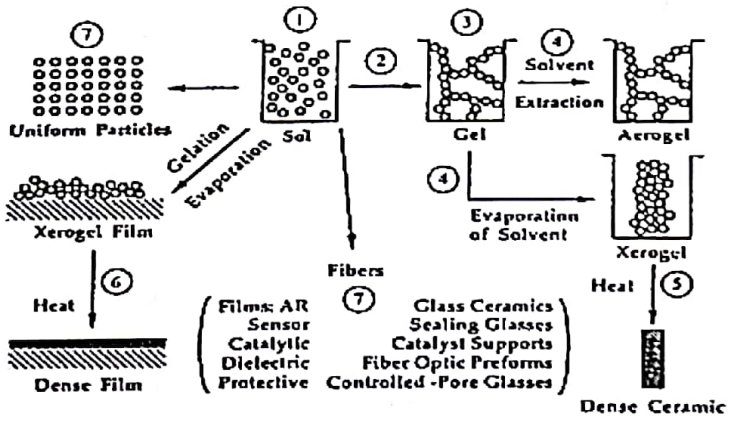


Figure 2.11 Sol gel processes (1) hydrolysis and condensation (2) gelation (3) aging of gel (4) drying (5) sintering (6) film formation and (7) application [7].

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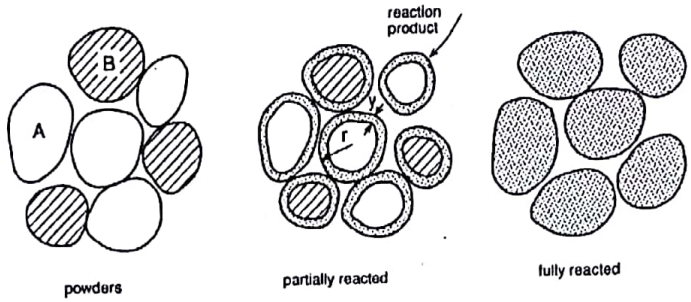
b) Draw and illustrate the solid state reaction in mixed powders? **[5 marks]**



Schematic solid state reaction in mixed powders.

Question No. 3 **[20 marks]**

a) What mean by freeze drying? **[5 marks]**

In freeze drying, the solution is sprayed by an atomizer, as an aerosol, into a very cold mixture (e.g., liquid nitrogen). The droplets are thus rapidly frozen before they have time to coalesce, removed from the cold mixture and stored in a cooled vacuum chamber. Under the action of the vacuum, the frozen carrier liquid sublimes, leaving a powder with very high surface area.

Lithium ferrite Li Fe_5O_8 powders prepared by freeze drying a solution of oxalates were found to have lower sintering temperatures and to afford better control of the grain size than similar powders prepared by spray drying [

b) Define nanotechnology and write about its range . **[5 marks]**

Nanotechnology is an emerging science; in nanotechnology the scale or size much in the way that micro technology is thought of. A nanometer is a thousand times smaller than a micrometer. Three to five atoms fit inside of one nanometer.

Size relationships of chemistry, nanoparticles and solid-state physics

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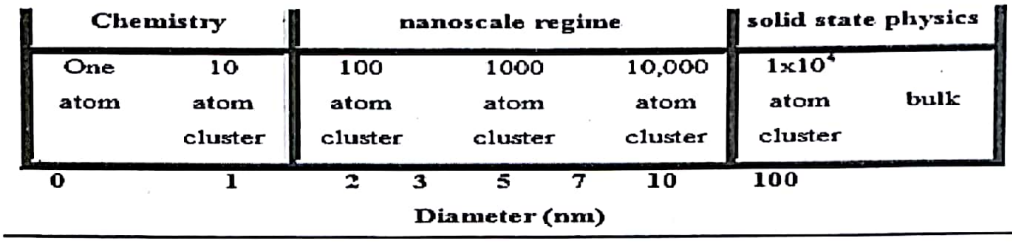
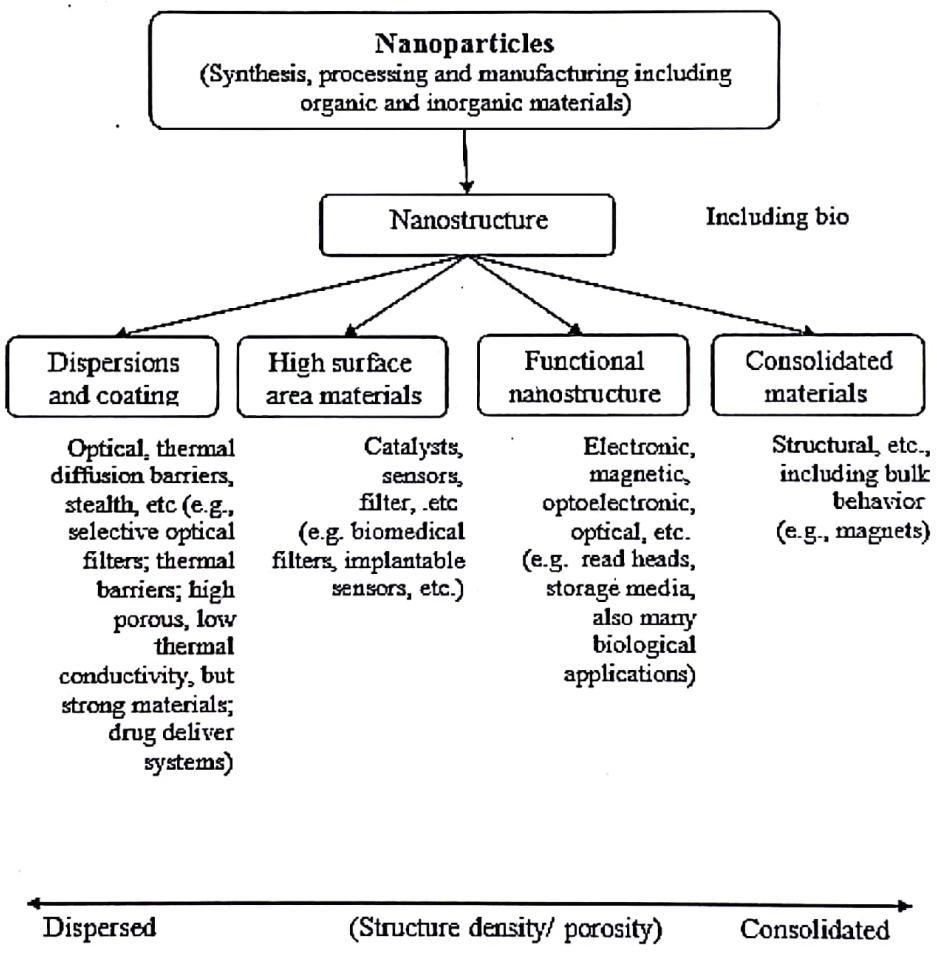


c) Ceramic nano structures used in different fields , Write in details. **[10 marks]**

The field of nanostructure science and technology.



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Applications of Nano Ceramics

1. Nanostructured Hard Materials
2. Nanostructures Used for Giant Magneto Resistance Devices
3. Fire Retardation in Plastics
4. Manufacturing of Nanostructured Coatings
5. Some Other examples of the applications of nanostructured materials
   - Signature control.
   - Electrical energy generation and storage.
   - Chemical sensors with increased selectivity and sensitivity.
   - Ultra-high strength structural materials.
   - Improved polymer composites with multifunctionality.
   - Improved warhead materials.