Definition 材料的定义:
The materials making up the surrounding world consist of discrete particles, having a submicroscopic size.
Atomic structure and the nature of bonds(原子结构和化学键)
—metals and their alloys (metallic bonding 金属键)
—organic polymers 有机聚合物(covalent bonding and secondary bonding 共价键和二次键)
—ceramics (ionic bonding and covalent bonding)
Mechanical properties：力学性能
Which reflect the behavior of materials, deformed by a set of forces （概念）
Four basic types of**stresses**: tensile, compressive, shear ,torsion (拉力，压力，剪切力，扭转力)
Physical properties:**物理性能**
the behavior of materials subjected to the action of temperature, electric or magnetic fields, or light.
电性能 Electric properties
磁性能 Magnetic properties
热性能 Thermal properties
光性能 Optical properties
Chemical properties:化学性能
Which characterize the behavior of material in a reactive environment. （概念）
The four basic aspects of materials science and technology are:**manufacturing processing**,**structure,properties**and**performances**
结构－性能－工艺之间的关系：
First, the processing of a material affects the structure, second the original structure and properties determine how we can process the material to produce a desired shape
一、METAL:（**金属**）
1、金属最显著的特性：good conductors of heat and electricity(热导性，电导性)
2、**性能:**are opaque to visible light; are hard, rigid; can undergo plastic deformation; have a high melting temperature
3、金属的晶体点阵：
crystal structure（晶体结构）: body-centered cubic structure , face-centered cubic structure , hexagonal close-packed structure（体型、面型，六角形放射状）
4、properties of alloys（合金的性能）:(more carbon ,more brittle.) have relatively high thermal and electrical conductivities; good energy absorption characteristics ;nonmagnetic properties
5、**铸铁概念：**cast iron, essentially an alloy of iron, carbon and silicon, is composed of iron and from 2 to 6.67 percent carbon, plus manganese, sulfur, and phosphorus, and shaped by being cast in a mold.
6、The types and properties of cast iron； white cast iron(hard , brittle) , gray cast iron (brittle ,withstand large compressive loads but small tensile loads), alloy cast iron , nodular or ductile cast iron (good castability ,toughness, good wear resistance ,low melting point ,and hardenability), malleable cast iron (strength ,toughness, ductility ,and machinability)
7、**carbon steels**（碳钢）：low carbon steels（含碳 0.05~0.32%）；medium carbon steels（含碳 0.35~0.55%）；high carbon steels（含碳 0.60~1.50%）
8、**不锈钢**：there are three types of stainless steels:
--the martensitic types；the ferritic types；the austenitic types
9、advantages of using Al: one-third of the weight of steel ;good thermal and electrical conductivity ;high strength-to-weight ratio ;can be given a hard surface by anodizing and hard coating ;most alloys are weldable ;will not rust ;high reflectivity ;can be die cast ;easily machined ;good formability; nonmagnetic ;nontoxic and one –third of the stiffness of steel.
10、copper is known for its high thermal (**热导性**)and electrical conductivity.
11、crystal structure : body-centered cubic structure (barium), face-centered cubic structure (copper), hexagonal close-packed structure (zinc)
二、**CERAMIC**（**陶瓷**）
1、**The property of ceramics （陶瓷的性质）**
Extreme hardness（**硬度高**） Heat resistance Corrosion resistance Low electrical and thermal conductivity Low ductility (brittleness)
2、**Porosity（孔隙度）**
Open porosity:refers to the network of pores in a material that is open to the surface and into which a liquid such as water can penetrate if the part were submerged in it。
Closed porosity:refers to those pores that have become sealed within the grain structure 。
Pores affect the strength of ceramics in two ways：（影响强度的毛孔陶瓷两种方式）
①、they produce stress concentrations. Oncethe stress reaches a critical level, a crackwill form and propagate.
②、pores reduce the cross-sectional areasover which a load can be applied and,consequently, lower the stress that thesematerials can support。
Conventional ceramic processing（传统陶瓷处理）；
manufacture of the powder ,its calcinations ,milling ,grading and mixing ,incorporating additives ,shape forming , drying and densification.
三、GLASS（**玻璃**）
1、the measured mechanical strength of glass is much**lower**than the theoretical strength
causesof this loss of strength：
①、the presence of surface defects, such as caused by chemical corrosion or mechanical abrasion。
②、If the glass is cooled too rapidly it does not have time to release stresses set up within it during cooling . these are "frozen-in" and can cause the glass to shatter when it becomes a solid.
the transparency is explained by two properties:
first ,it has no surface of internal structure which gives reflection or scattering。
second ,it has no free electrons which can interact with the electron magnetic nature of wave motion including visible light

四、CEMENT CONCRETE（水泥混凝土）

Concrete

The properties of the**flesh or plastic concrete:**

1. the wetness or dryness of the mix is referred to as the consistency or slump
2. uniformity indicates that the concrete is mixed thoroughly ,has a standard appearance ,and all ingredients are evenly distributed in the mix .
3. Workability is the ease with which concrete is placed and consolidated.

The properties of**hardened concrete(硬化混凝土的性质)**

1. Hardened concrete should be durable, strong, watertight, and resistant to abrasion.
2. Concrete must be durable enough to withstand extreme exposure conditions and to give long service with a minimum of upkeep.
3. The most destructive weathering factor that can act on concrete is the freezing and thawing if concrete while it is wet or moist.
4. Concrete must be strong enough to carry the heavy loads placed on it.

混凝土的硬化是水和水泥之间发生化学和物理作用的结果。按阶段来分:产生快速放热期(第一阶段)大约 15 min 停止,随后为潜伏期(第二阶段)， 1~3 h 出现初凝,此时潜伏期结束,进入第三阶段,再出现激烈反应,硅酸盐继续水化且速度加快,直到末期达到最大反应速度,亦即达到最大放热率,5~8 h 产生终凝并开始早期硬化,以后反应速度再慢下来(第四阶段),在 12~14 h 内达到稳定期。初凝相当于第二阶段结束,终凝相当于第三阶段结束而达到最大的化学反应速度,相应达到最大放热率。

5、Properties of concrete (混凝土的性能)

a) concrete hardens in the presence of water .
b) it does not corrode or decay
c) freshly mixed concrete can be formed into any shape
d) concrete can be molded at normal temperatures
e) can withstand heat and fire

Variables that influence concrete quality:

aggregate gradation； water-cement ratio；

air entrainment

strength test used as hardened concrete :

firststrength of concrete, in compression, tension, shear, or a combination of these ,has, in most cases ,a direct influence on the load-carrying capacity of both plain and reinforced structures ;

secondthe properties of hardened concrete ,those concerning strength can usually be determined most easily

thirdby means of correlations wit h other more complicated tests ,the results of strength tests can be used as qualitative indications of other properties of hardened concrete

硅酸盐水泥的生产:

两磨（磨原料，磨石膏）一烧（clinker 熟料）；basic components of concrete :cement ,aggregate ,water ,additives

五、**POLYMER（聚合物）**

A Polymersis*macromolecule*(大分子）built up by the linking together of large numbers of much smaller molecules

性能：**low strength,·low melting point·flexible·easily to be formed into different shapes**

Additionpolymerization（加聚反应）

Here are three significant reactions that take place in addition polymerization:***initiation*,*propagation*, and*termination*.**

initiation(birth) 链引发

propagation(growth) 链增长

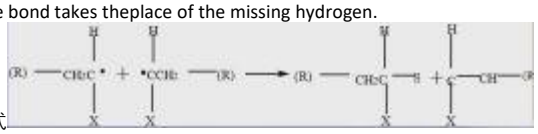
termination(death) 链终止

Termination Reaction:Termination typically occurs in two ways:***combination(*偶合终止*)***and***disproportionate(*歧化终止*)***

Combinationoccurs when the polymer'sgrowth is stopped by free electrons fromtwo growing chains that join and form asingle chain.

反应式 

Disproportionationhalts the propagationreaction when a free radical strips ahydrogen atom from an active chain. Acarbon-carbon double bond takes theplace of the missing hydrogen.

反应式 

Living polymerization: There exists a type of additionpolymerization that does not undergoa termination reaction. This so-called "living polymerization" continues until the monomer supply has beenexhausted

Polymers vary in their mechanical behavior depending on the degree of crystallinity , degree of crosslinking, and the values of Tg and Tm.

There are**two types**of plastics：—**flexible plastics（柔性塑料）**and**rigid plastics（刚性塑料）.**

The flexible plasticspossess moderate to high degrees of crystallinity and a wide range of Tm and Tg values.They have moderate to high tensile strengths, and ultimate elongation.

The rigid plasticshave high moduli and moderate to high tensile strengths, they undergo very small elongations before rupturing.

Tm-polt of melt temperature Tg-glass transition temperature Tg/Tm=0.5-0.8

A highly flexible chainhas a low Tg and strong intermolecular forces tend to raise Tg and also increase crystallinity, the controlling factor in determining Tg is chain flexibility

六、COMPOSITE**（复合材料）**

Definitionof Composite（复合材料的定义）

A composite is a combined material created by the synthetic assembly of two or more components a selected filler or reinforcing agent and a compatible matrix (基体) binder (e.g. a resin) in order to obtain specific characteristics and properties.

Advantagesof using Composites: Composites are superior to metals for many applications due to**（优点）**

- High strengths
- Stiffnesses,
- Ease of moulding complex shapes
- High environmental resistance
- Low densities

The properties of the composite are determined by:

- The properties of the fibre
- The properties of the resin
- The ratio of fiber to resin in the composite (Fiber Volume Fraction (FVF))
- The geometry and orientation of the fibres in the composite

Matrixcomposite（**基复合材料**）

PolymerMatrix Composites,**Metal**Matrix Composites,**Ceramic**Matrix Composites.（**树脂基复合材料、金属基复合材料、陶瓷基复合材料。**）

Physical properties :（**物理性质**）

which describe the behavior of materials subjected to the action of temperature ,electric or magnetic fields ,or light

Chemical properties（**化学性质**）: the behavior of materials in a active environment

Mechanical properties： which reflect the behavior of materials ,deformed by a set of forces； elasticity （弹性）,hardness ,toughness(韧性)，abrasion resistance(耐磨性)