

國立臺北科技大學 111 學年度碩士班招生考試

系所組別：3301 材料科學與工程研究所

第二節 材料科學與工程導論 試題 (選考)

第 1 頁 共 2 頁

注意事項：

1. 本試題含計算題 3 題，合計 40 分；填充題 30 題，每題 2 分，合計 60 分；總分共計 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

Part 1: Calculation questions (40%)

1. MgO has the sodium chloride structure (Figure 1). The ionic radius of Mg is 0.072 nm and the atomic weight is 24.31 g/mol. The ionic radius of O is 0.140 nm and the atomic weight is 16.0 g/mol. The Avogadro's number is 6.022×10^{23} . Determine
 - (a) the lattice parameter. (3%)
 - (b) the atomic packing fraction. (6%)
 - (c) the theoretical density. (6%)

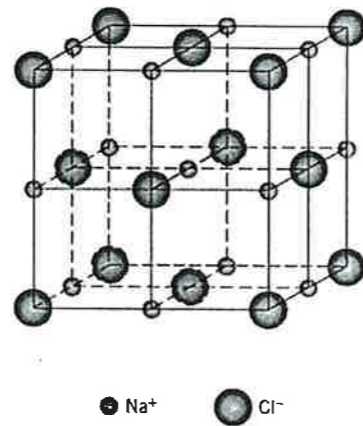


Fig. 1

2. Consider a steel that initially has a uniform carbon concentration of 0.20 wt% and is to be treated at 950°C. If the concentration of carbon at the surface is maintained at 1.20 wt%, and after a 6.0 hours heat treatment a carbon content of 0.70 wt% is obtained at a position 0.4 mm below the surface. How long will it take to produce this same concentration (0.70 wt% C) at a position 0.6 mm below the surface? The diffusion coefficient for carbon in iron at this temperature is $1.6 \times 10^{11} \text{ m}^2/\text{s}$; assume that the steel piece is semi-infinite. (10%)

$$\text{[Hint: } \frac{C_x - C_0}{C_s - C_0} = 1 - \text{erf}\left(\frac{x}{2\sqrt{Dt}}\right)\text{]}$$

3. Figure 2 is the lead-tin phase diagram, for a lead-tin alloy of composition 70 wt% Sn–30 wt% Pb alloy. Determine
 - (a) the maximum solubility of Pb in Sn. (3%)
 - (b) the mass fraction of each phase at 182°C. (6%)
 - (c) the mass fraction of each microconstituent at 182°C; (6%)

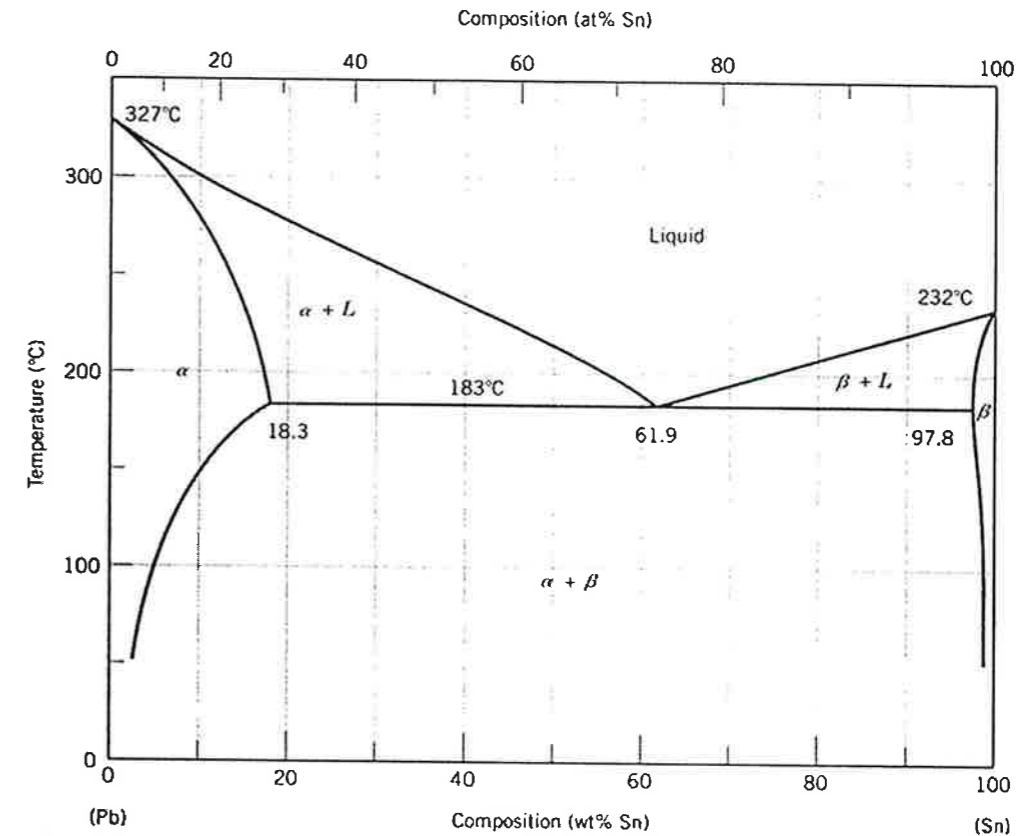


Fig. 2

Part 2: Blank filling questions (60%, each blank 2%)

Fill in each blank with an appropriate answer in English or Chinese.

1. Atoms that tend to easily give up the electrons in the outermost energy level are said to be _____ elements.
2. Materials with _____ bonding tend to have good conductivity and ductility.
3. Materials exhibiting different values of a property in different crystallographic directions is termed _____.
4. The slip planes in FCC crystal structures have miller indices of the form _____.
5. The Burgers vectors in BCC crystal structures (lattice parameter = a) have miller indices of the form _____.
6. A _____ interstitial site has six nearest neighbors in a crystal structure.

注意：背面尚有試題

7. _____ is a linear crystalline defect associated with the lattice distortion created when normally parallel planes are joined together to form a helical ramp. The Burgers vector is parallel to the dislocation line.
8. A _____ boundary is a special type of grain boundary across which there is a specific mirror lattice symmetry; that is, atoms on one side of the boundary are located in mirror image positions to those of the atoms on the other side.
9. Fick's first law expresses that the _____ is proportional to the concentration gradient.
10. _____ is a time-dependent elastic behavior, and it is due to time-dependent microscopic and atomistic processes that are attendant to the deformation.
11. _____ is the phenomenon by which a ductile metal becomes harder and stronger as it is plastically deformed.
12. _____ is the formation of a new set of strain-free and equiaxed grains that have low dislocation densities and are characteristic of the precold-worked condition; normally, an annealing heat treatment is necessary.
13. Charpy test is used to measure the _____ of a standard notched specimen in which a weighted pendulum hammer is released from fixed height and strikes the specimen.
14. _____ is the ability of a material to absorb energy and plastically deform before fracturing. For the static (low strain rate) situation, it may be ascertained from the results of a tensile stress-strain test. It is the area under the stress-strain curve up to the point of fracture.
15. One of the most effective methods of increasing fatigue performance is by imposing residual _____ stresses within a thin outer surface layer. The net effect is that the likelihood of crack formation and therefore of fatigue failure is reduced.
16. Materials are often placed in service at elevated temperatures and exposed to static mechanical stresses (e.g., turbine rotors in jet engines and steam generators that experience centrifugal stresses; high-pressure steam lines). Deformation under such circumstances is termed _____.
17. A reaction in which, upon cooling, a solid and a liquid phase transform isothermally and reversibly to a solid phase having a different composition. This is called a _____ reaction.
18. _____ is an austenitic transformation product found in some steels and cast irons. It forms at temperatures between those at which pearlite and martensite transformations occur. The microstructure consists of ferrite and a fine dispersion of cementite.
19. The stainless steels are highly resistant to corrosion in a variety of environments, especially the ambient atmosphere. Their predominant alloying element is _____; a concentration of at least 11 wt% is required. Corrosion resistance may also be enhanced by nickel and molybdenum additions.
20. For most of gray cast irons, the _____ exists in the form of flakes (similar to corn flakes), which are normally surrounded by a ferrite or pearlite matrix. Because of these flakes, a fractured surface takes on a gray appearance.
21. The _____ are used in aircraft turbine components, which must withstand exposure to severely oxidizing environments and high temperatures for reasonable time periods. These materials are classified according to the predominant metal(s) in the alloy, of which there are three groups: iron-nickel, nickel, and cobalt.
22. _____ is a heat treatment for ferrous alloys, austenitizing above the upper critical temperature, then cooling in air. The objective of this heat treatment is to enhance toughness by refining the grain size.
23. The Jominy end-quench test is one standard procedure widely used to determine _____ of steel alloy. With this procedure, except for alloy composition, all factors that may influence the formation of martensite (i.e., specimen size and shape and quenching treatment) are maintained constant.
24. The strength and hardness of some metal alloys may be enhanced by the formation of extremely small, uniformly dispersed particles of a second phase within the original phase matrix; this must be accomplished by phase transformations that are induced by appropriate heat treatments. The process is called _____.
25. Atomic defects involving host atoms may exist in ceramic compounds. Frenkel defect and Schottky defect are two types of defect found in ceramics, in which Schottky defect is a _____ pair.
26. _____ is a high-temperature reaction by which one solid material dissociates to form a gas and another solid. This process produces physical and chemical changes in the raw materials. It is one step in the production of cement.
27. _____ corrosion occurs when two metals or alloys having different compositions are electrically coupled while exposed to an electrolyte. The less noble or more reactive metal in the particular environment experiences corrosion; the more inert metal, the cathode, is protected from corrosion.
28. For a _____ extrinsic semiconductor, an energy level lying within yet near the bottom of the energy band gap that may accept electrons from the valence band, leaving behind holes. The level is normally introduced by an impurity atom.
29. A _____ material is one that is electrically insulating (nonmetallic) and exhibits or may be made to exhibit an electric dipole structure—that is, there is a separation of positive and negative electrically charged entities on a molecular or atomic level.
30. Permanent magnetic moments in _____ materials (e.g., transition metals) result from atomic magnetic moments due to uncanceled electron spins as a consequence of the electron structure. Furthermore, coupling interactions cause net spin magnetic moments of adjacent atoms to align with one another, even in the absence of an external field.