材料科学基础（双语）考试（三）试卷答案

2016~2017 学年第二学期

A 卷选择和判断答案（B 卷）

一、判断

1-10 FTFTF TFTTT　　11-20FTTFF TFFFT　　21-28 TTFFF FFT

三、选择

1-10 dcacb dcbac　　11-20 acbda bdbaa　　21-22bc

二、填空题

1. Vacancies　　interstitials
2. Edge　　screw
3. Temperature
4. Solid solutions　　solubility
5. Slip plane

6.Parallel　　perpendicular

7.Dislocation density

8.Slip planes　　slip direations

9.{111}<110>

10. Critical resolved shear stress

11.Schmid factor

12.(1) grain-size reduction

(2)solid-solutions alloying

(3)Strain hardening

13. Grain size

14. Al_3Li

15. Forging

16. Annealing

17. Recovery　　recrystallization　　grain growth

18. Time　　temperature

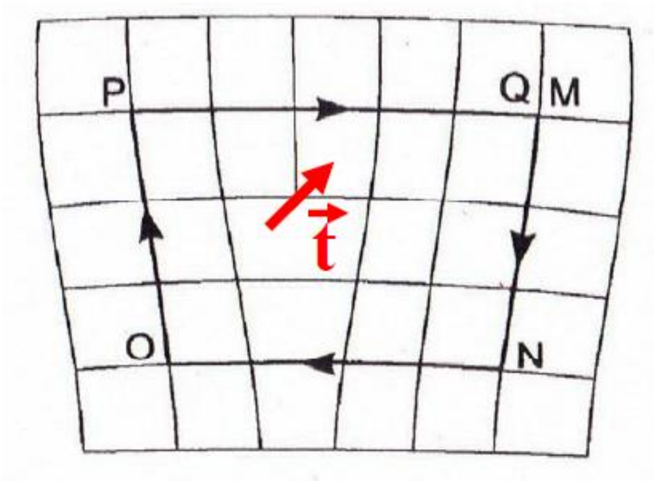
19. Recrystallization temperature

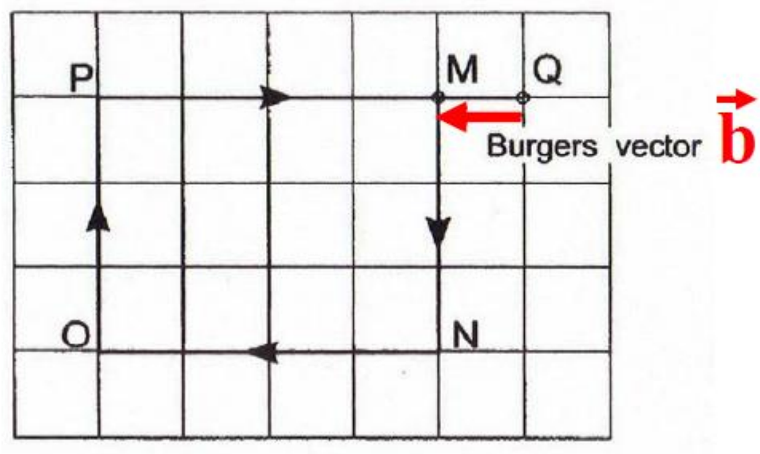
20. 1/3 to 1/2

大题

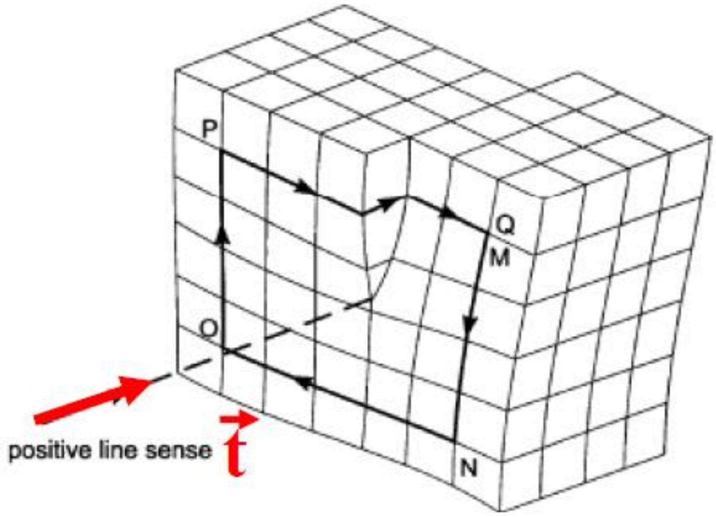
四、

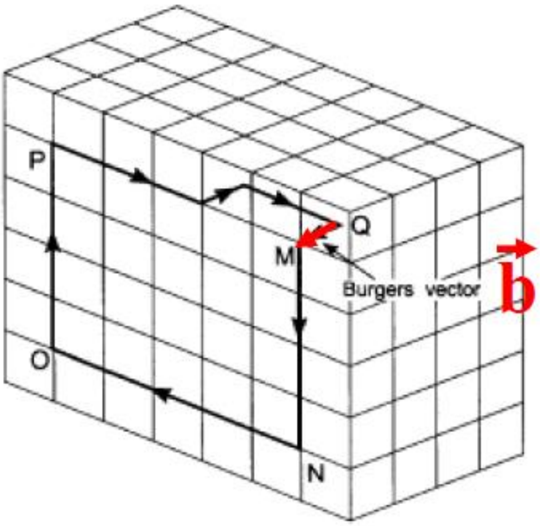
（1）



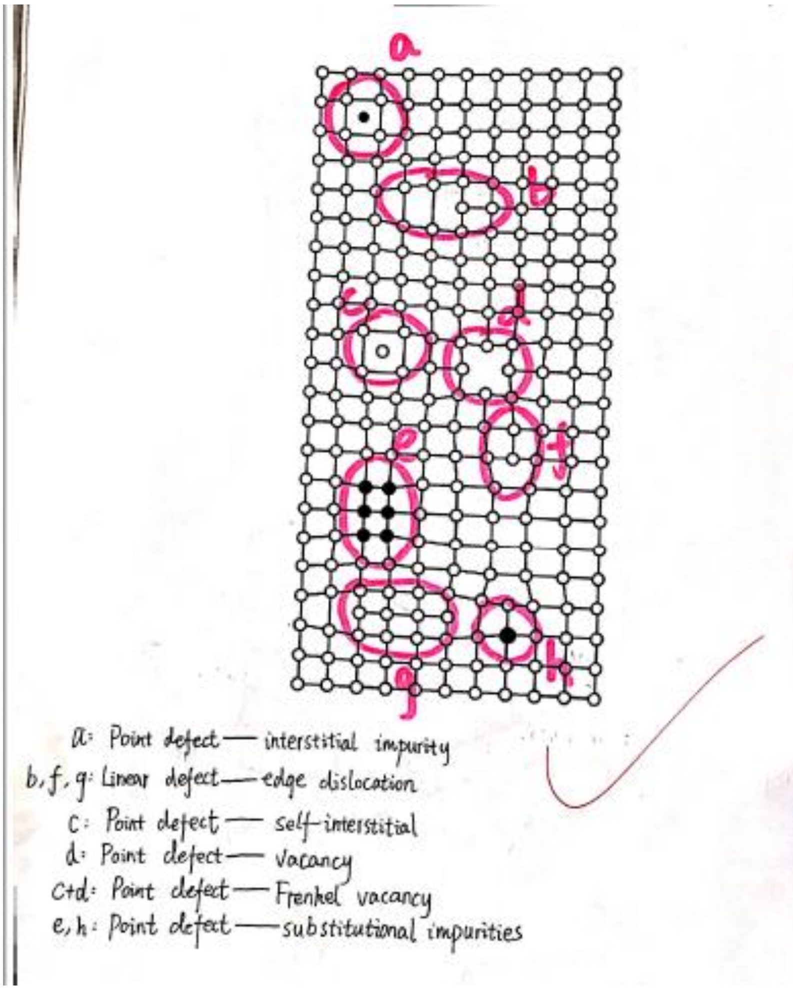


（2）




P
Q
M
Burgers vector
b
O
N

五、


a
b
c
d
e
f
g
h
a: Point defect — interstitial impurity
b, f, g: Linear defect — edge dislocation
c: Point defect — self-interstitial
d: Point defect — vacancy
c+d: Point defect — Frenkel vacancy
e, h: Point defect — substitutional impurities

六、

1.

… 8.31 J/(mol·K)，试计算其空位形成能Q_v。 (5 points)

Solution

According to the given numbers and Arrihnius Equation,

$$\frac{N_{V_1}}{N_{V_2}} = 5 = \frac{N\exp(-\frac{Q_v}{kT_2})}{N\exp(-\frac{Q_v}{kT_1})}$$

$$\ln 5 = \frac{Q_v}{kT_1} - \frac{Q_v}{kT_2}$$

$$\Rightarrow Q_v = \frac{k\ln 5}{\frac{1}{T_1} - \frac{1}{T_2}} = \frac{8.31\,J/(mol\cdot K) \times \ln 5}{\frac{1}{1000K} - \frac{1}{1130K}} = 116299.38\,J/mol$$

即空位形成能为 116299.38 J/mol

2.

2. Determine the composition, in weight percent, of an alloy that consists of 6 at% Pb and 94 at% Sn. (4 points)

Known numbers: $A_{Pb} = 207.2\,g/mol$

$A_{Sn} = 118.71\,g/mol$

Solution

$$\%wt_{Pb} = \frac{C_{Pb}A_{Pb}}{C_{Pb}A_{Pb} + C_{Sn}A_{Sn}} \times 100 = \frac{6\,at\% \times 207.2\,g/mol}{6\,at\% \times 207.2\,g/mol + 94\,at\% \times 118.71\,g/mol} \times 100$$

$$= 10.0\,wt\%$$

$$\%wt_{Sn} = 1 - \%wt_{Pb} = 90.0\,wt\%.$$

Thus, in weight percent, the composition is 10.0 wt% Pb - 90.0 wt% Sn.

3.

Solution

Factors for high solubility:

① Atomic radii: < 15%

② Crystal structure: same

③ Electronegativity: comparable

④ Valency: solute < solvent ⇒ easier.

(1) Ni. Pd. Pt

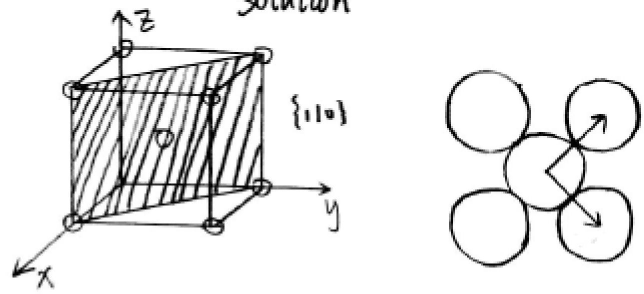
(2) Ag. Al. Co. Cr. Fe. Zn

(3) C. H. O

Because ~~their~~ atomic radius are significantly smaller than copper's.

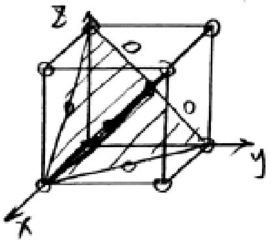
4.

Solution



5.

Solution



For FCC crystal structure, slip plane is {111}.
slip direction is <110>.

φ is the angle between [111] and [100].

$\cos\varphi = \frac{1}{\sqrt{3}}$

λ is the angle between [110] and [100].

$\lambda = 45^\circ \Rightarrow \cos\lambda = \frac{\sqrt{2}}{2}$

Thus, the magnitude of the Schmid factor is,

$m = \cos\varphi \cdot \cos\lambda = \frac{1}{\sqrt{3}} \times \frac{\sqrt{2}}{2} = 0.408$

6.

Solution

(a) The slip direction is most favored when Schmid factor is a max, that is, $\cos\varphi \cdot \cos\lambda$ is a max, according to given numbers,

$\cos\varphi = \cos 65^\circ$. $\quad \cos\lambda_1 = \cos 30^\circ = 0.866$

$\cos\lambda_2 = \cos 48^\circ = 0.669$

$\cos\lambda_3 = \cos 78^\circ = 0.208$

Thus, the angle of 30° is the most favored slip direction.

(b). $\tau_{CRSS} = \sigma_y (\cos\varphi \cdot \cos\lambda)_{max} = 2.5 MPa \times (\cos 65^\circ \times \cos 30^\circ)$

$= 2.5 MPa \times 0.423 \times 0.866 = 0.916\ MPa$

7.

Solution

$$\%CW = \frac{A_0 - A_d}{A_0} \times 100 = \frac{\pi r_0^2 - \pi r_d^2}{\pi r_0^2} \times 100$$
$$= \frac{\pi(16mm)^2 - \pi(11mm)^2}{\pi(16mm)^2} \times 100$$
$$= 52.7\ \%CW$$

As the second specimen has the same deformed hardness as the first specimen

$$\%CW = \frac{A_0' - A_d'}{A_0'} \times 100 = \frac{\pi r_0'^2 - \pi r_d'^2}{\pi r_0'^2} \times 100$$
$$= \frac{(12mm)^2 - r_d'^2}{(12mm)^2} \times 100 = 52.7\%CW \Rightarrow r_d = (12mm)\sqrt{1 - \frac{52.7\%CW}{}} = 8.25\ mm$$

8.

Solution

According to the Hall-Petch Equation,

$$\sigma_y = \sigma_0 + k_y/\sqrt{d}$$

According to the given numbers,

$$\begin{cases} 260 = \sigma_0 + k_y / \sqrt{8\times10^{-3}} \\ 135 = \sigma_0 + k_y / \sqrt{5\times10^{-2}} \end{cases} \Rightarrow \begin{cases} \sigma_0 = 52.0\ MPa \\ k_y = 18.6\ MPa\ (mm)^{\frac{1}{2}} \end{cases}$$

When the lower yield point is 205 MPa,

$$205 = 52 + 18.6/\sqrt{d}$$
$$\Rightarrow d = 1.5\times10^{-2} mm$$

9.