Electron Diffraction and Imaging

Assignment No – 4

1. If the beam is tilted by an angle α then choose the correct option,
   a. The reciprocal lattice of the crystal will rotate
   b. The Ewald sphere will rotate
   c. Both the Ewald sphere and the reciprocal lattice will rotate simultaneously
   d. No change in reciprocal lattice and Ewald sphere

   Answer: (b)

2. If the sample is rotated by an angle α, then
   a. The reciprocal lattice of the crystal will also rotate in the same sense by angle α
   b. The Ewald sphere will also rotate in the same sense by angle α
   c. The reciprocal lattice rotates by angle which is reciprocal of rotation in direct lattice
   d. Rotation of reciprocal lattice neutralises the rotation of Ewald sphere.

   Answer: (a)

3. Plain electromagnetic wave of $|k|=1/\lambda$ is incident on a crystalline sample, then
   a. Scattering from each atom occurs in a specific direction
   b. Scattering from each atom occurs in all directions
   c. Scattered wave has 90˚ phase relationship with incident wave.
   d. The scattered wave amplitude is the same in all directions

   Answer: (b & C)

4. If compressive load is applied along [100] direction on a simple orthorhombic crystal then, the what change will happen in the diffraction pattern,
   a. The (100) spot will shift away from the origin (000) spot
   b. All (h00) spots will shift away from the origin (000) spot
   c. The (100) spot will shift towards the origin (000) spot
   d. The (h00) spot will shift towards the origin (000) spot

   Answer: (b)

5. The scattering from (001) plane is forbidden in x-ray diffraction
   a. (001) plane doesn't satisfy the Bragg condition in BCC structure
   b. The waves scattered from atoms in (001) planes causes destructive interference
   c. Plane of atoms halfway between two other (001) planes causes destructive interference
   d. The waves scattered from atoms in (002) planes causes destructive interference

   Answer: (C)

6. The structure factor rule for body centre orthorhombic is
    a. The sum of the three integers h, k, l must be an even number
    b. The three integers h, k, l must be all even, or all odd.
    c. All values of h, k, l are permissible
    d. None of these

    Answer: (a)

    The structure factor does not depends upon the shape and size of the unit cell.

7. The BCC crystal has atoms of same type at (0 0 0) and (½ ½ ½) positions. If the atom at (½ ½ ½) position is replaced with another atom having high atomic number, then
    a. The Intensities of the fundamental diffraction spots will increase
    b. Intensities of the fundamental diffraction spot will decrease
    c. Diffraction spots will appear at superlattice position
    d. The space group symmetry of the lattice increases

    Answer: (a & c)

    Due to the presence of different atom at the centre of the unit cell, the crystal structure will change from BCC to simple cubic structure. Those spots which were not present in the diffraction pattern will show superlattice reflections due to the incomplete destructive interference. The intensity of the diffraction spots will also increase because the higher atomic number atom will have high atomic scattering factor.

8. Coherent scattering of waves
    a. Coherent scattering of waves
    b. Elastic scattering of waves
    c. Periodic arrangement of scattering points
    d. All of above

    Answer: (d)

9. Position of X-ray diffraction spot gives information about
    a. Magnitude of Periodic potential in the lattice
    b. Magnitude of electron density distribution in the lattice
    c. Periodicity of electron or nuclear charge distribution in the lattice
    d. Electron spin distribution in the lattice

    Answer: (c)

    Since the X-rays are scattered by electrons present around the nucleus, therefore the x-ray diffraction pattern gives information about the periodicity of electron density distribution in the lattice.

10. Coefficients of components of vector R in the lattice has to be
    a. Only Positive Integers
    b. Can be positive or negative integers including zero
    c. Only negative integers
    d. Can be fractional numbers

    Answer: (b)

The lattice translation vector is defined as,

R= na + mb + oc

Where, a, b, c are lattice translation vector along the three principle axes and n, m, o are the coefficients. Therefore the permissible values of the coefficients would be any integer value.

11. The angle at which diffraction first order diffraction spot occurs
    a. Increases with increasing the ratio of radius of Ewald sphere to d spacing of the plane
    b. decreases with increasing the ratio of radius of Ewald sphere to d spacing of the plane
    c. Increases with increasing the ratio of radius of Ewald sphere to reciprocal lattice spacing
    d. Decreases with increasing the ratio of radius of Ewald sphere to reciprocal lattice spacing

    Answer: (d)

    According to Bragg's law,

    $\lambda = 2d \sin\theta$

$$\sin\theta = \frac{1}{\frac{(1/\lambda)}{(1/d)}}$$

The ratio of radius of Ewald sphere to reciprocal lattice

12. Choose the correct statements
    a. Brillouin zone is a primitive unit cell of the lattice in reciprocal space
    b. Brillouin zone exhibits the full symmetry of the lattice
    c. Brillouin zone is a primitive unit cell of the reciprocal lattice exhibiting full symmetry of the lattice
    d. Diffraction occurs when the wave vector of incident beam touches the Brillouin zone boundary

Answer: (a, b, c, d)

13. The amplitude of the diffraction spot is equal to
    a. The sum of amplitude of wave scattered by all atoms illuminated by incident wave in the diffraction direction
    b. Structure factor of the unit cell
    c. Atomic scattering factor of each atom
    d. Scattering power of each electron

    Answer: (a)

    Since diffraction is a coherent elastic scattering phenomenon, therefore the amplitude of the scattered wave can be written as the sum of amplitudes of the scattered waves coming from all atoms in the diffraction direction.

14. If atoms are placed at general positions in the fcc lattice, then
    a. diffraction spots will appear for all hkl values
    b. diffraction spots will appear satisfying extinction condition for simple cubic lattice
    c. diffraction spots will appear satisfying extinction condition for face centred cubic lattice
    d. the intensity of diffraction spot depends on atom position in the lattice

    Answer: (c)

15. Choose the correct statement
    a. The width of the diffraction spot increases as the size of precipitate increases.
    b. The width of the diffraction spot decreases as the size of precipitate increases
    c. The maximum intensity of diffraction spot from a precipitate depends only on the number of atoms in the precipitate and not its size
    d. The maximum intensity of diffraction spot from a precipitate depends only on both the number of atoms in the precipitate and its size

    Answer: (b & c)

    The statement (b) is correct because, as the size of the precipitate increases the shape factor decreases hence the width of the diffraction spot decreases.

    The statement (c) is also correct because the maximum intensity depends upon the structure factor only, not in shape factor.