DAF-003-0491101 Seat No. _____

B. Sc. / M. Sc. (Sem. X) (CBCS) Examination

April - 2022

Applied Physics : Paper -13 (Core-10)

(Ion Beams in Materials Science)

(New Course)

Faculty Code : 003

Subject Code : 0491101

Time : $2\frac{1}{2}$ Hours] [Total Marks : **70**

Instructions : (1) All questions are compulsory.

(2) Number in the right side margin indicate marks.

1 Attempt any **SEVEN** short questions (**Two** marks each) **14**

(1) What are the basic approaches in the synthesis of nanostructures ?

(2) Write down any two limitations of the Rutherford backscattering spectrometry (RBS).

(3) Define straggling with its types.

(4) List the name of line defect and define Burger's Vector.

(5) Define kinematic factor for RBS.

(6) What is channelling ?

(7) What is the sputter yield ? Write any two applications of sputtering ?

(8) Write down any two applications of Secondary Ion Mass Spectrometer (SIMS).

(9) Explain radiation enhanced diffusion process in solids.

(10) What is the disadvantage if one wishes to do ERD measurements on "RBS set-up" i.e., by using beam of a-particles ?

2 Write the answer of any two questions : **14**

(1) Give a brief overview of overview of what energetic ions can do while interacting with the material.

(2) Write a short note on the radiation enhanced diffusion process. State the difference between Schottky defect and Frenkel defects ?

(3) What is ion implantation ? What are the applications of ion implantation in material science ?

(4) What do you mean by kinematic factor in case of ERDA? In an elastic scattering recoil detection experiment, an incident, particle of mass M_1, having energy E_0 is colliding with the target atom at rest having mass M_2. After the collision, particle of mass M_1 has energy E_1 and it is scattered at an angle θ. The target particle is scattered at angle Φ with energy E_2, then derive the expression of kinematic factor ? Give a list of assumptions taken to derive this expression?

3 Write a the answer of any two questions. **14**

(1) Draw a schematic diagram to explain channeling in the single crystal ? How channeling can be used for identification of substitutional and interstitial types of impurities in the doped semiconductor ? Describe working principle of the $\Delta E - E$ telescope detector for analysis of carbon thin film having impurity of the Li and O ?

(2) Find the energy of the particles as well as the thickness of Au layer if the RBS spectrum contains 5,000 counts of α-particles backscattered from this Au layer ? Given : Incident angle $\alpha = 0^0$, scattering angle $\theta = 170^0, E = 2\ MeV, \Delta\Omega = 10^{-3}$ steridiam,

$Q = 10\ \mu C, d\sigma / d\Omega = 8.0634$ barn steridian^{-1} for E=2,000 ke V and density of Au as 19.31 g cm^{-3}

(3) State the working principle of the NRA. Why NRA is use to measure the low Z-elements ? Write down the parameters which determine the (a) energy and (b) yield of the emitted particle in case of NRA ?

(4) Explain the working principle of RBS ?

4 Write the answer of any two questions. **14**

(1) Write a short note on the in-situ technique used in the investigation of the irradiation induced phase transformations.

(2) What are advantages and drawbacks of ion implantation for incorporation impurity in a semiconductor ?

(3) Explain the role of swift heavy ions (SHI) in Nano structuring.

(4) Explain the depinning of Fermi level along ion tracks.

5 Write the answer of any two questions. **14**

(1) Define sputtering process. Write a short note on nuclear and electronic sputtering.

(2) What is the importance of ion implantation in the creation of controlled defects ? Explain point defects, line defects, and columnar defects produced by energetic ion irradiation.

(3) What is the difference between crystalline and amorphous solids ? Explain the ion beam induced epitaxial crystallization process.

(4) What is ion beam mixing ? Discuss importance of the ion beam mixing for the synthesis of alloys.
