Biosensors An Introductory Textbook 1st edition Narang Solutions Manual

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and make them easier to administer. Opticians apply nanocoatings to eyeglasses to make them easier to keep clean and harder to scratch, and nanoenabled coatings are used on fabrics to make clothing stain-resistant and easy to care for.

Almost all high-performance electronic devices manufactured in the past decade use some nanomaterials. Nanotechnology helps build new transistor structures and interconnects for the fastest, most advanced computing chips.

Problem 3: Describe the advantages of nanomaterials for biosensor fabrication.

Advantages of using nanomaterials in the fabrication of biosensors include large surface area, promotion of faster electron kinetics, electrocatalysis, increased conductance, biocompatible microenvironment for biomolecules, capability of engineering, and facile synthesis.

Problem 4: What are the major advantages and disadvantages of green synthesis of nanoparticles?

Green synthesis of nanoparticles has many advantages such as facile preparation protocols and lesser toxicity compared to chemically synthesized ones, which are significant in bio-based applications. However, on the flip side, it is a challenge to control the size of green synthesized nanoparticles in view of difficulties in standardization of the synthesis process. An important challenge in technology is to tailor various properties of nanoparticles by controlling their size and shape.

Problem 5: What are the advantages of the sol–gel process in the synthesis of nanomaterials?

Advantages of the sol–gel process in the synthesis of nanomaterials are high purity, isotropy, tunable porosity and composition, and low temperature annealing.

Chapter 2

Problem 1: What is the major problem associated with Ag nanoparticles synthesis?

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During the preparation of Ag nanoparticles using precursors such as $AgNO_3$ and reducing agents such as $NaBH_4$ in an ice bath, the following factors should be taken into consideration:

- Fresh preparations of $AgNO_3$ and $NaBH_4$ should be made.
- The pH of water should not be above 8.0, which could produce external nucleation.
- Stirring speed should be considered since high stirring speeds give smaller particles and better size dispersion, while stirring at lower speeds gives bigger particles but progressively affects the size distribution.
- For the stability of nanoparticles, polymers such as PVP can be added.

Problem 2: Explain the differences between a nanowire and a nanorod.

Nanowires are one-dimensional nanostructures that generally have diameters of the order of tens of nanometers, with unconstrained length scales. The length-to-diameter ratio may be as much as 1000.

Nanorods are also one-dimensional nanostructures where each of their dimensions range from 1 to 100 nm. Standard aspect ratios (length divided by width) are 3–5.

Problem 3: Explain various techniques involved in the synthesis of nanomaterials.

Physical methods involve preparation of nanomaterials using methods such as ball milling or vapor deposition methods. These methods do not involve any chemicals.

Chemical methods involve preparation of nanomaterials using chemicals. Materials such as precursors and reducing agents or surfactants are from chemical source.

Biological methods involve preparation of nanomaterials using compounds obtained from biological sources such as plants or microbes.

Problem 4: Explain the parameters that affect the size of nanoparticles.

The parameters that affect the size of nanoparticles are as follows:

- **Reaction rate**: The faster the reaction rate, the smaller the resulting nanoparticles.

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- **Stabilizing agent**: A larger amount of stabilizing agent results into smaller nanoparticles.
- **Temperature**: High temperature results in more monodispersed particles.
- **Stabilizing agent**: Weak stabilizing agents result in more monodispersed particles.
- **Differential stabilization**: Differential stabilization of crystal faces controls the shape of nanoparticles.

Problem 5: Explain nucleation and growth.

Nucleation involves the formation of a crystal from a solution, a liquid, or a vapor, in which a small number of ions, atoms, or molecules become arranged in a pattern characteristic of a crystalline solid, forming a site upon which additional particles are deposited as the crystal grows. This process occurs spontaneously in a substance in response to a change in temperature or pressure. Growth is defined as a process in which additional material deposits on this particle causing it to increase in size.

Chapter 3

Problem 1: How can we avoid the aggregation of nanoparticles in SEM images?

Washing of nanoparticles with the solvent should be done carefully. For microscopic images, samples should be diluted for the visualization and dispersed in ethanol and sonicated for 1 or 2 h.

Problem 2: Why there are no sharp peaks in the XRD of nanoparticles?

When particle size decreases, the possibility of having an analogous crystal structure over large areas becomes improbable. Hence, it is difficult to get high-peak intensities for nanomaterials unless one has very crystalline powders. But the main variable parameters associated with this problem are calcination temperature (if in the protocol) and heating temperature.

Problem 3: Why there is a cloudy appearance of nanoparticles in SEM imaging?

A cloudy appearance is observed in SEM imaging when there is carbon contamination around the particles. This happens when

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