Differences between SEM, TEM, and AFM.

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SEM

The Scanning Electron Microscope is a type of electron microscope. It produces the images by scanning with a beam of electrons [1]. In this way, the electrons interact with atoms in the sample, originates signals [2]. These signals contain information about the sample's composition and topography [1]. In this method, the beam's position gets combined with the received signals to produce an image [2]. Resolution achieved is better than 1 nanometer; the specimen can be studied in high or low vacuum, or in wet conditions and in cryogenic or elevated temperatures. Because of SEM micrographs which provide three dimensional appearances, understanding the surface structure of a sample becomes easier [1].

TEM

The Transmission Electron Microscope or TEM works like light microscope and has the same principles. It uses electrons instead of light. Light microscope is limited to wavelength of light. TEM uses electrons which gives a thousand times better resolution. In this way, you can see objects to the order of a few angstroms [3]. This makes it a valuable tool in medical biological and materials research. At the top of the TEM; there is a light source. It emits the electrons. They move forward through vacuum in the column of the microscope. TEM uses electromagnetic lenses. It focuses them into a very tin beam [4]. Some electrons are sometimes scattered and disappear from the beam because of the density of the material at the bottom of the microscope. The unscattered electrons reach to a fluorescent screen [3]. Then we get a shadow an image of the specimen [4].

AFM

Among different atomic force microscope (AFM) is a scanning probe microscopes (SPM). SPMs measure local properties, such as height, friction, magnetism, with a probe [5]. AFM measures force between a probe and a sample. The probe is a sharp, tall pyramid with 15-40 nano meters. AFM can measure the vertical and lateral defections by using the optical lever. It reflects a laser beam off the cantilever and stickers a position sensitive photo detector that is combined of four segments. The AFM measures both the force on the sample and also gives regulations on it. The feedback loop consists of a tube scanner, the cantilever, and a feedback circuit. They essentially need a well-constructed loop in order to have microscope performance [5].

SEM produces perfect images of the surface of the cells and small organisms, but TEM suitable to study the ultra-structure of the cells and components; it shows tiny parts like protein molecule in nano level [2]. In SEM, electron beam scans the surface of the sample, but in TEM, electron beam pass through the sample, and it is based on electrons or gotten images by primary electrons which are transmitted from the sample, but in SEM, it is based scattered electrons [4]. In SEM, electrons are emitted from the surface by the primary electron beam. SEM produces three dimensional black and white images, but TEM produces by electron scattering [3]. In TEM, field of view is limited, but in SEM; field of view is large [4]. For preparation technique in SEM is easy, but in TEM, is hard [2]. SEM preparation is thickness, but TEM preparation is very thin. In SEM, specimen mounting is Aluminum stubs, but in TEM, thin films are on copper [4]. In TEM, magnifying power is higher than SEM [3].

Different methods of functionalization

The development and tailoring of the chemical bonds is challenging and might lead to an optimized interaction of the carbon nano tubes with solvent, and polymer matrices. Pristine nanotubes reveal properties that they might differ from the functionalized nanotubes. They are numerous approaches for functionalizing a material, mechanical, physical, chemical, and biological. Here chemical modifications are introduced [6]. Here in we discuss about non covalent functionalization and covalent functionalization.

Non Covalent Functionalization

It is based on the ability of the extended system of the carbon nano tube side wall to bind guest molecules via pi-pi stacking interaction [5]. Other approaches mentioned above take only advantage of the absorption via Vander walls interactions between the adsorbates and the nano tube [6].

Covalent Functionalization

In covalent surface bonding, biomolecules are chemically bonded to the scaffold surface. The defect functionalization of carbon nanotubes is based on the conversional carboxylic groups and other oxygenated sites formed through oxidative purification [5]. The carboxylic groups, located mainly at the ends of the nano tube, can be coupled with different chemical groups [6]. Covalent bonding is more complex and may limit the type of biomolecule that can be attached to the harsh condition. Covalent is a promising approach to bind GFs to biometrics, but on the other hand, enhanced cell survival and spreading MSC have been demonstrated. Covalent surface binding shows more efficient coating. To finish covalent coating just two steps are required: 1) The exposure of functional group, 2) The covalent binding to the exposed functional group [5].

In this process, the functionalization is: a) Oxidize, b) functionalized, c) produce nano composite [6].

In the side wall functionalization; it is associated to the change of hybridization from SP2 to SP3and requires loss of conjugation. The disadvantage of functionalization concerns weak forces. In nano covalent function has been shown that the molecules of the surfactants can interact with the hydrophobic surface of the carbon nanotubes which makes the Carbon Nanotube soluble in several solvents like water. In this process, this is based on the ability of pi system [5].

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