Topics in Nanoscience

Assignment-1-24

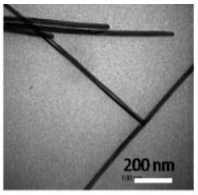
Nanomaterials: A material with any external dimension in the nanoscale (the length ranging from approximately 1 nm to 100 nm) or having internal structure or surface structure in the nanoscale

1. Define nanomaterials. (2)

2. Mention one application for each of the following cases. Also, name the nanomaterial's characteristics/properties that are utilized in the applications.
   (i) Metal-organic framework (FOM). Gas Adsorption , Catalysis, Sensing , reason : large surface areas
   (ii) An organic nanomaterial used in agriculture. (4+4)

nano carbon,silica,silver,alumino silicates : reduceds size offer broader surface area

3. Write the conventional names used to identify the following nanoparticles as shown in the TEM image. (2)



nano wire

quantom dots : all dimension are nano, well : one dimension is nano, quantum dots are more efficient and tunable when compared o quantum well whch have faster more response time

4. Differentiate Quantum Dots from Quantum Wells. (4)

5. "Organic pigment molecules used in dyeing textiles bleach when exposed to the sun while the glittering colors of peacock feathers do not." Explain. (3)

Organic pigments in dyes fade under sunlight because the UV rays break down the chemical bonds, altering the pigments' ability to reflect light. In contrast, the colors of peacock feathers are due to microscopic structures that cause light interference, not pigments. These structural colors do not degrade under sunlight, so they remain vibrant.

6. For a spherical particle of radius R (in nm), calculate (i) the surface area to volume ratio and (ii) the approx. ratio of surface atoms (N_s) to total atoms (N_v) is given by ≈ 1/R. (2+3)

total atom > volumne so 3/r

Based on this, calculate approx. how many atoms will be at the surface of a spherical particle of radius, 5 nm, having a total of 8,000 atoms. At what size would one expect the proportion of surface atoms to be 100%? 3/r*8000 and other part r=3nm (2+2)

7. Surface is abundant, but why do the surface effects become dominant in determining the material properties in the nanomaterials? (4)

fraction of surface ara to volums is siginifncant: chemcal reactivity , solubility,surface asoption ,mp depend on that surface

8. (a) How is hydrophobicity of a surface usually determined experimentally? (2) contact angle hysteriss
   (b) Define "superhydrophobic" and "ultrahydrophobic" surfaces. (4)

contact angle > 150
roll off < 5
hysteresis < 10

advancing receding > 150

9. "*CA hysteresis on hydrophobic surfaces increases with increasing surface roughness in the low-roughness region but drastically decreases when the roughness becomes large and the composite configuration, in which the liquid does not penetrate the asperities.*" Provide an

explanation for the above observations. (5)

shifting from wenzel to cassie bextra, liquid droplet start to see surface as vapor, suspension of packet is enough to drive

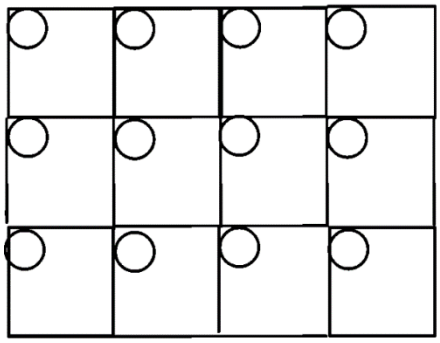
10. Compare the CA hysteresis and roll-off angle (α) values according to the Wenzel state and Cassie–Baxter state. Give justification. (4)

11. A silicon surface is patterned to have cylindrical pillars of diameter *d* and height *h* placed a distance *s* apart in a square array (see the Fig. below). The surface is slightly oxidized so as to have a contact angle of 50°.

(a) Find the roughness factor *r* and the fractions f_1 and f_2 of the Cassie-Baxter equation in terms of *d*, *h* and *s*.

(b) Find the apparent contact angle of the surface according to the Wenzel and Cassie-Baxter equation under the following conditions (i) as oxidized silicon (ii) surface coated with PTFE to give a contact angle of 114°.

(c) What is the critical contact angle to make the surface superhydrophilic if $d = 50\ \mu m$, $h = 10\ \mu m$ and $s = 150\ \mu m$. (6+8+2)



12. Mention two unique properties of magnetic nanomaterials and mention one application for each. (4)

13. Compare SPR and LSPR? (4)

superparamagnetisim: srong magnetism in prsencen of magnetic field , targeted drug delievry using external magnetic field
control agent for magnetic resosncance imaging

LSPR : resonance of conduction electron within the localised nano particle.
SPR: over the continus metial surface and dielectric medium