Nano materials:

Nano scale materials are defined as a set of substances where at least one dimension is less than approximately 100 nanometers. A nanometer is one millionth of a millimeter – approximately 100,000 times smaller than the diameter of a human hair. Nano materials are of interest because at this scale unique optical, magnetic, electrical, and other properties emerge. These emergent properties have the potential for great impacts in electronics, medicine, and other fields.

Nanotechnologies involve designing and producing objects or structures at a very small scale, on the level of 100 **nanometres** (100 millionth of a millimetre) or less. **Nanomaterials** are one of the main products of **nanotechnologies** – as nano-scale particles, tubes, rods, or fibres. **Nanoparticles** are normally defined as being smaller that 100 **nanometres** in at least one dimension.

As **nanotechnology** develops, **nanomaterials** are finding uses in healthcare, electronics, cosmetics, textiles, information technology and environmental protection.

Detailed assessments may include the following:

1. Physical properties:

- Size, shape, **specific surface area**, and ratio of width and height

2. Chemical properties:

- Molecular structure
- Composition, including purity, and known impurities or additives

Application of nanomaterials

❖ **Nanomaterial Applications using Carbon Nanotubes**

Researchers are improving dental implants by adding nanotubes to the surface of the implant material. They have shown that bone adheres better to titanium dioxide nanotubes than to the surface of standard titanium implants , Carbon nanotubes are being developed to clean up oil spills.

❖ **Nanomaterial Applications using Graphene**

Applications being developed for graphene include using graphene sheets as electodes in ultracapacitors which will have as much storage capacity as batteries, replacing indium in flat screen TVs and making high strenght composite materials.

❖ **Nanomaterial Applications using Nanocomposites**

Applications being developed for nanocomposites include a nanotube-polymer nanocomposite used to replacement of broken bones, making a graphene-epoxy nanocomposite with very high strenght-to-weight ratios, The anodes made of the

silicon-carbon nanocomposite make closer contact with the lithium electrolyte, which allows faster charging or discharging of power.

❖ Nanomaterial Applications using Nanofibers

Applications being developed for nanofibers include stimulating the production of cartilage in damaged joints, piezoelectric nanofibers that can be woven into clothing to produce electricity for cell phones or other devices, carbon nanofibers that can improve the performance flame retandant in furniture

Toxicity of Nanoparticles :

- ***Aluminum oxide***:

aluminum oxide NPs (<50 nm) cause genotoxic effects in the form of DNA damage .

- ***Gold*** :

The variation in toxicity with respect to different cell lines has been observed in human lung and liver cancer cell line.

- ***Copper oxide*** :

it was accumulated in the kidney

- **silver:**

silver NPs have been detected in various organs, including lungs, spleen, kidney, liver, and brain.

- ***Zinc oxide*** :

DNA damage, alteration in mitochondrial activity in human hepatocytes, and embryonic kidney cells.

- ***Iron oxide*** :

Magnetic iron oxide NPs have been observed to accumulate in the liver, spleen, lungs, and brain .

- ***Titanium oxide*** :

titanium dioxide NPs (5-200 nm) possess toxic effects on immune function, liver, kidney, spleen, myocardium, glucose, and lipids homeostasis .

Phase change materials:

Phase change materials or latent heat storage material is the most efficient used method to store thermal energy. Energy per unit mass is stored during phase changes from solid to liquid, and released during freezing at a constant temperature. The energy absorbed by the material allows increasing the vibrational energy states of the constituent atoms or molecules. During melting, the atomic bonds loosen and consequently the material changes its state from solid to liquid. However, during solidification, the material transfers energy and, consequently, the molecules lose energy and order themselves in solid state.

The application of PCM has grown incrementally in various industries, such as the solar cooling and solar power plants, photovoltaic electricity systems, electronic industry, waste heat recovery systems, solar dryers in agricultural industry, domestic hot water, pharmaceutical products and preservation of food, and space industry. Apart from the preceding utilizations, PCM improves energy performance and thermal comfort in buildings. Therefore, PCM applications could be a powerful tool in designing net zero energy buildings. PCM must be put in specific containers that depend on the thermal storage application. The content of PCM depends on the specific thermal storage application. For example, in the case of building integrated latent heat storage, PCM can be contained in a porous matrix (wood, concrete, plasterboard, etc.).

PCMs can broadly be arranged into two categories:

A - Organic PCMs:

Paraffin (C_nH_{2n+2}) and fatty acids ($CH_3(CH_2)_{2n}COOH$) Organic Thermal Salt can be Aliphatic or Other Organics. Organic materials used as PCMs tend to be polymers with long chain molecules composed primarily of carbon and hydrogen. They tend to exhibit high orders of crystallinity when freezing and mostly change phase above 0°C. Examples of materials used as positive temperature organic PCMs include waxes, oils, fatty acids and polyglycols.

- **Advantages**

1. Freeze without much super cooling.2. Ability to melt congruently. 3. Compatibility with conventional material of construction. 4. Chemically stable. 5. Recyclable.

- **Disadvantages**

1. Low thermal conductivity in their solid state. 2. Volumetric latent heat storage capacity is low. 3. Flammable.

B - Inorganic PCMs:

Salt hydrates (MnH2O) Inorganic Thermal Salts are generally Hydrated Salt based materials. Academicians are likely to misguide you into using pure hydrated salts like Sodium Sulphate Decahydrate .

- **Advantages**

1. High volumetric latent heat storage capacity. 2. Availability and low cost. 3. Sharp melting point. 4. High thermal conductivity. 5. High heat of fusion. 6. Non-flammable.

- **Disadvantages**

1. Change of volume is very high. 2. Super cooling is major problem in solid–liquid transition. 3. Nucleating agents are needed and they often become inoperative after repeated cycling.