**1. What is the typical size range of Carbon Nanotubes (CNTs)**

* **Size Range**: We get the typical range of Carbon Nanotubes between 1 nm to 100 nm.
* **Types**: There are two main types of CNTs:
  + **Single-Walled Carbon Nanotubes (SWCNTs)**: Typically 1-2 nm in diameter.
  + **Multi-Walled Carbon Nanotubes (MWCNTs)**: These are composed of multiple concentric layers of carbon atoms and can have diameters of 5-20 nm or more.

**2. How much nano-materials are used in drug delivery and medical purpose?**

From the pivot table we get total 5 nano-materials which are used in drug delivery and medical purpose.

* **Amorphous Silica Nanoparticles** : These have been explored for drug delivery due to their ability to encapsulate drugs and their potential for targeted delivery.
* **Iron Oxide Nanoparticles**: These nanoparticles are used to deliver drugs, particularly in cancer therapy. They help in protecting drugs from degradation and ensuring controlled release.
* **Gold Nanostars**: Used in diagnostics, imaging, and as drug carriers for cancer therapies.
* **Magnetic Nanoparticles**: These nanoparticles are used to drug delivery and to the manufacture of Magnetic Resonance Imaging.
* **Silica Nanoparticles**: Mesoporous silica nanoparticles (MSNs) are particularly useful for targeted drug delivery and controlled release.

**3. What are the nano materials having largest average band gap energies?**

From the analysis I observed that Aluminium Oxide (Al2O3) nanoparticle have the largest band gap energies. As the properties of nano particles proportional to it`s band gap energies, so it can be said that Al2O3 shows a better performance as a nanomaterial. The other nanoparticles which have larger band gap energies are:

* + **Aluminum Nitride (AlN)**: Has a band gap around **6.2 eV**.
* **Graphene Oxide**: Though graphene itself is a semimetal, graphene oxide (GO) can show larger band gaps when oxygenated, making it a material of interest for electronic applications.

**4. Which number of nanomaterials are Ferromagnetic?**

We get total 2 nanomaterials which show the ferromagnetic property ,i.e, they have permanent magnetic alignment even after the applied magnetic field is removed. These nanoparticles are:

* **Cobalt (Co) Nanoparticles**: Exhibiting high magnetization, these are used in applications like data storage and as catalysts.
* **LaO7.SrO3.MnO3**: These are used for their ferromagnetic properties in sensors, actuators, and magnetic storage.

**5. Which conductivity is mostly showed by the nano particles? Find the highest conductive nanoparticle by using chart.**

From the chart we obtain that the conductivity of 10-7 is shown by most of nanomaterials. The high conductive nanoparticles are:

* **Graphene**: Graphene is the material that exhibits the highest electrical conductivity among known nanomaterials. It has a **sp² hybridized carbon lattice** that allows for nearly frictionless electron flow.
  + **Conductivity**: Graphene has a **very high electrical conductivity**, comparable to that of copper, with values around **60 × 10⁶ S/m**.
* **Carbon Nanotubes (CNTs)**: They also exhibit excellent electrical conductivity, though not as high as graphene, with conductivity values depending on whether they are metallic or semiconducting CNTs.

**6.What materials are used for UV protection?**

* **Zinc Oxide (ZnO) Nanorods**: Widely used in sunscreens and cosmetics for its broad-spectrum UV-blocking properties. It provides protection against both UVA and UVB radiation.

**7. Which number of Nano-materials are often used in solar cell?**

In this data table, there are 3 nanomaterials which are often used in solar cell. These are:

* **TiO2 Nanoparticles**: This thin-film material is used in solar cells due to its high efficiency in converting sunlight into electricity.
* **Quantum Dots (QDs)**: Quantum dots of materials like **cadmium selenide (CdSe)** and **cadmium telluride (CdTe)** are utilized in solar cells for their tunable electronic properties.
* **Zinc Selenide(ZnSe) Quantum Dots**: These have been explored to enhance the efficiency of silicon-based solar cells, offering higher surface area for light absorption.

**8. Which Nano particle is comparatively cheap to use commercially?**

From the pivot chart it is obtained that 3 Nano particles (named: Bismuth Ferrite(BiFeO3), Iron Oxide Nanoparticles and Yttrium Oxide(Y2O3)) are available only for 50$ per gram. So they are comparatively cheap to manufacture any device commercially.

**9. Make a list of metal-based Nanoparticles and show their electrical conductivity.**

There are 7 carbon-based Nanoparticles in this data set.

|  |  |
| --- | --- |
| **Nanoparticles** | **Conductivity(S/m)** |
| Carbon Nanotubes | 1000-2000 |
| Fullerene | 10-4 |
| Graphene Foam | 102 |
| Graphene Nano plates | 102 |
| Graphene Nano ribbons | 102 |
| Graphene Oxide | 102 |

* **Note**: The electrical conductivity of metals is heavily influenced by factors like temperature and nanoparticle morphology.

**Conclusion:**

Nanomaterials exhibit a vast range of properties that can be harnessed for diverse applications across industries, from drug delivery in medicine to photovoltaic technologies for clean energy. Materials like graphene and CNTs are particularly notable for their exceptional electrical conductivity, while others like ZnO and TiO₂ are widely used in UV protection. The continuous exploration and development of these materials promise to revolutionize many areas of technology, including electronics, energy, and healthcare.

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