IIT-M Team Makes Mineral Nanoparticles with Water Droplets

Source: TH

Why in News?

Recently a study published in the journal Science has revealed that **microdroplets of water** possess the ability to break down **minerals into nanoparticles.**

Note: Properties of Microdroplets:

- Water microdroplets are significantly **smaller than typical raindrops**, being just a thousandth the size of a raindrop.
- These **microdroplets exhibit more eagerness** to participate in **chemical reactions** compared to bulk water due to their **densely packed nature.**
- Microdroplets can engage in chemical reactions **much faster, up to a million times** quicker than in bulk water.
- They act as **excellent carriers of electric charge.**

What are the Key Highlights of the Study?

- **Experimental Findings:**
  - The study demonstrated that microdroplets **could break down minerals** such as **silica (SiO_2) and alumina (Al_2O_3) into nanoparticles.**
  - This was achieved **by applying a high voltage to mineral microparticles** suspended in water, causing them to break into nanoparticles within 10 milliseconds.
  - The breakup of mineral microparticles into nanoparticles may be due to the **protons squeezing into crystal layers**, the electric fields produced by charged surfaces, and the surface tension of the microdroplets.
- **Potential Applications:**
  - This process of nanoparticle formation has **significant implications for agriculture,** such as converting unproductive soil into productive land by supplying silica nanoparticles.
    - Plants absorb silica in the form of nanoparticles to help them become taller.
  - It also has **relevance to the origins of life**, as microdroplets might mimic proto-cells, potentially playing a role in early biochemical reactions.
  - Future investigation may look into whether water microdroplets naturally react with minerals in atmospheric processes, potentially forming nanoparticles through 'microdroplet showers'.

What are Nanoparticles?

- The **International Organization for Standardization (ISO)** defines **nanoparticles(NPs)** as

nano-objects **with all external dimensions in the nanoscale,** where the lengths of the longest and the shortest axes of the nano-object do not differ significantly.

- If the dimensions differ significantly (typically by more than three times), terms such as **nanofibers or nanoplates** may be preferred to the term NPs.
- NPs can be of different shapes, sizes, and structures. They can be **spherical, cylindrical, conical, tubular,** hollow core, spiral, etc., or irregular.
    - The size of NPs can be anywhere from 1 to 100 nm. If the size of NPs gets lower than 1 nm, the term atom clusters is usually preferred. NPs can be **crystalline with single or multi-crystal solids,** or amorphous. NPs can be either loose or agglomerated.
- NPs can be uniform, or can be composed of several layers.
- **Classification:** Based on their composition, NPs are generally placed into three classes namely organic, carbon-based, and inorganic.
- **Applications: In medicine, pharma, electronics, agriculture, food industry, etc.**

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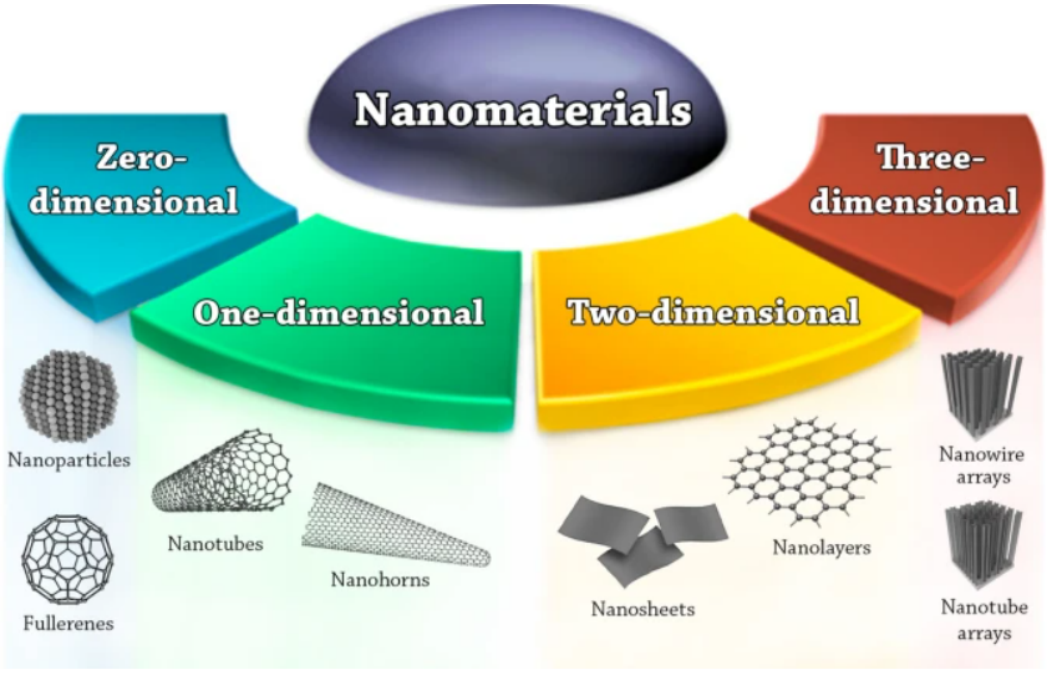

Water Droplets vs Water Vapour		
Feature	**Water Droplets**	**Water Vapour**
Physical State	Liquid	Gas
Visibility	Visible	Invisible
Formation	Condensation of water vapour	Evaporation of water
Examples	Rain, fog, mist, dew, clouds	Air on a humid day, steam

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims:

Q. With reference to "water vapour", which of the following statements is/are correct? (2024)

1. It is a gas, the amount of which decreases with altitude.
2. Its percentage is maximum at the poles.

Select the answer using the code given below :

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

Ans: (a)

Q. Consider the following statements: (2022)

1. Other than those made by humans, nanoparticles do not exist in nature.
2. Nanoparticles of some metallic oxides are used in the manufacture of some cosmetics.
3. Nanoparticles of some commercial products which enter the environment are unsafe for humans.

Which of the statements given above is/are correct?

(a) 1 only

(b) 3 only

(c) 1 and 2

(d) 2 and 3

Ans: (d)

Q. There is some concern regarding the nanoparticles of some chemical elements that are used by the industry in the manufacture of various products. Why? (2014)

1. They can accumulate in the environment, and contaminate water and soil.
2. They can enter the food chains.
3. They can trigger the production of free radicals.

Select the correct answer using the code given below:

(a) 1 and 2 only

(b) 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

Ans: (d)