Carbon Nanoflorets

For Prelims: Carbon nanoflorets, **Carbon footprint.**

For Mains: Science and Technology- Developments and their Applications and Effects in Everyday Life, Achievements of Indians in Science & Technology.

Source: TH

Why in News?

Recently, researchers at IIT Bombay have created **carbon nanoflorets** capable of converting **sunlight into heat** with unmatched efficiency.

- This innovative development holds the potential to revolutionize sustainable heating solutions while minimizing the **carbon footprint.**

What are Carbon Nanoflorets?

- **About**:
  - The carbon nanoflorets, developed by researchers from IIT Bombay, demonstrate an impressive **light absorption efficiency of 87%.**
  - They can absorb multiple frequencies of sunlight, including infrared, visible light, and ultraviolet, in stark contrast to **traditional solar-thermal materials** that typically **absorb only visible and ultraviolet light.**
- **Designing Process of Carbon nanoflorets:**
  - A special form of silicon dust called DFNS (dendritic fibrous nanosilica) is heated in a furnace.
  - Introduction of Acetylene gas in the chamber facilitates carbon deposition, turning it black.
  - Then the black powder is collected and treated with a strong chemical that dissolves the DFNS away, leaving carbon particles behind, resulting in **spherical carbon beads with cone-shaped pits,** forming the carbon nanoflorets, resembling **marigold flowers** when observed under a microscope.

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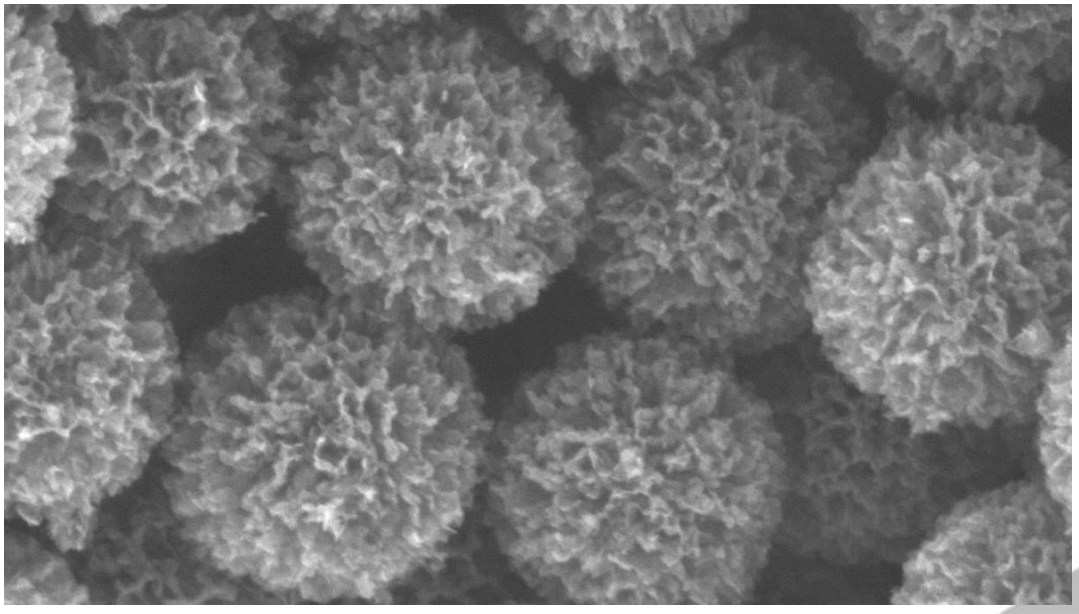
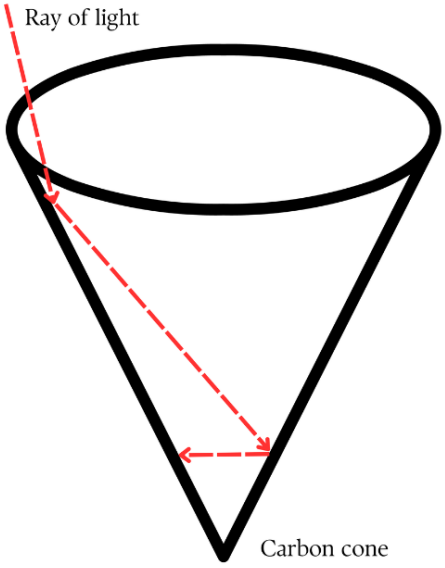


- **The Role of Unique Structure:**
  - The structure of the nanoflorets, composed of carbon cones, **minimizes light reflection and ensures maximum internal absorption.**
  - This distinctive design captures and **retains sunlight, converting it into thermal energy.**



A simple schematic diagram showing the path of sunlight insight a carbon nanofloret.

- **Minimal Heat Dissipation:**
  - The long-range disorder in the nanoflorets' structure ensures that heat generated within the material is **not carried over long distances.**
    - This characteristic reduces the dissipation of heat into the environment, allowing the nanoflorets to retain and utilize the generated thermal energy effectively.

What are the Applications and Commercial Potential of Carbon Nanoflorets?

- **Heating Water Efficiently**:
  - A one-square-meter coating of carbon nanoflorets can vaporize approximately five litres of water within an hour, surpassing the performance of **commercial solar stills.**
    - Carbon nanoflorets are ideal for water heating applications, offering a **sustainable**

and cost-effective solution that reduces reliance on **fossil fuels**.
        - Nanoflorets can be applied to diverse surfaces, such as paper, metal, and terracotta clay, making them versatile for various applications.
- **Eco-Friendly Heating:**
    - By utilizing nanofloret coatings, users can harness **solar energy** for heating their homes in an environmentally friendly manner, thereby reducing their carbon footprint.
- **Stability and Longevity:**
    - Coated nanoflorets exhibit exceptional stability with a minimum **lifetime of eight years.**
        - Researchers are continuing to assess their durability under various environmental conditions.