Fabrication of Controlled Nanostructures

Why in News

Recently, the researchers at the **Institute of Nano Science and Technology** (INST) **Mohali** have found a route to fabricate precisely controlled nanostructures of desired geometry and location on 2D materials, through a rapid one-step low power laser writing process.

- INST, Mohali is an **autonomous institute** under the **Department of Science and Technology** (DST).

Key Points

- INST developed a **hybrid Surface-Enhanced Raman Spectroscopy** (SERS) **platform of Molybdenum disulfide** (MoS2, an inorganic compound) **nanostructure** decorated with **gold NanoParticles** (AuNPs).
    - SERS is a **commonly used sensing technique** in which inelastic light scattering by molecules is greatly enhanced when the molecules are adsorbed onto corrugated metal surfaces such as silver or gold nanoparticles (NPs).
    - It enhances the Raman scattering light from molecules, thus leading to effective analysis of the molecules.
- **Direct laser writing** (3D printing for microscopic world) was used to engineer the artificial edges on the surface of MoS_2 which **created localized hotspots with precision and control.**
    - A focused laser beam of meagre power of a **conventional Raman spectrometer** was used which enables the superior deposition of AuNPs along the artificial edges.
    - Nanostructuring was done on the 2D MoS_2 sheet.
- The hybrid SERS platform offers **controlled formation of localized hotspots for ultrasensitive and reproducible detection of analytes** (substances whose chemical constituents are being identified and measured).
- **Significance:**
    - This research will open a new avenue for the development of commercialized **SERS substrates** (a silicon wafer coated with a metal like gold or silver) with a localized detection capability of analytes.
        - SERS detection has been emerging as a powerful **tool for the detection of a variety of analytes** due to its very **high sensitivity and fingerprinting recognition capabilities.**
    - This will also shed new light in the SERS sensing of biological and chemical molecules.
    - The technology can be used in combination with an antibody for the spectroscopic detection of various **biomarkers** (an objective measure that captures what is happening in a cell or an organism at a given moment).

Raman Effect

- It is a phenomenon in **spectroscopy** discovered by the eminent **physicist Sir Chandrasekhara**

Venkata Raman on **28th February 1928.**

- In his honour, 28th February is celebrated as **National Science Day** in India.

- In **1930,** he got a **Nobel Prize** for this remarkable discovery and this was the **first Nobel Prize for India in the field of Science.**
- Raman effect is the **inelastic scattering of a photon by molecules** which are excited to higher vibrational or rotational energy levels. It is also called **Raman scattering.**
    - In simpler words, it is a **change in the wavelength of light that occurs when a light beam is deflected by molecules.**
    - When a beam of light traverses a dust-free, transparent sample of a chemical compound, a small fraction of the light emerges in directions other than that of the incident (incoming) beam.
    - Most of this scattered light is of unchanged wavelength. A small part, however, has wavelengths different from that of the incident light and its presence is a result of the Raman Effect.
- The Raman effect **forms the basis for Raman spectroscopy** which is used by chemists and physicists to **gain information about materials.**
    - **Spectroscopy** is the study of the interaction between matter and electromagnetic radiation.

Source: PIB