Fabrication of Controlled Nanostructures

Part of: GS-III- Nanotechnology (PT-MAINS-PERSONALITY TEST)

Background

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).

About

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 MoS2 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 MoS2 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.