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.