Nobel Prize in Chemistry 2023

For Prelims: Nobel Prize in Chemistry 2023, Quantum Dots, <u>Quantum technology</u>, <u>Nanomaterials</u>, <u>LEDs.</u>

For Mains: Applications of Quantum Dots.

Source: IE

Why in News?

The Royal Swedish Academy of Sciences awarded the Nobel Prize in Chemistry 2023 to Moungi G Bawendi, Louis E Brus, and Alexei I Ekimov for their groundbreaking discovery and synthesis of quantum dots.

How did Scientists Discover Quantum Dots?

- Background:
 - Traditionally, **all pieces of a pure element**, regardless of size, were believed to have **identical properties** due to the uniform distribution of electrons.
 - However, about forty years ago, scientists discovered that nanoparticles on the nanoscale, **typically 1 to 100 billionths of a meter in size**, exhibited distinct behaviors different from their larger counterparts of the same element, **challenging this conventional belief.**
- The Nobel Laureates' Contributions:
 - Alexei Ekimov: In around 1980, Alexei Ekimov was the first to observe the anomalous behavior in Copper Chloride nanoparticles.
 - He successfully manufactured these nanoparticles, showcasing their distinctive properties.
 - Louis Brus: American scientist Louis Brus made a similar discovery involving Cadmium Sulphide nanoparticles.
 - Like Ekimov, he could create these nanoparticles with altered properties.
 - Moungi Bawendi: Moungi Bawendi, who initially collaborated with Louis Brus, later played a pivotal role in simplifying the production methods for nanoparticles with unique characteristics.
 - His work paved the way for efficient and controlled manufacturing of nanoparticles displaying desired deviant behaviors.
 - Factor Responsible for Distinctive Properties of Nanoparticles:
 - The unconventional behavior of small nanoparticles is a result of the emergence of quantum effects.
 - Despite nanoparticles being considerably larger than individual atoms, a crucial insight emerged in the 1930s, that when particles are reduced to the nanoscale, quantum effects can come into play.
 - This is primarily because, under such conditions, electrons within atoms find themselves confined within a limited space.

- Typically, electrons move within a relatively spacious area outside the nucleus of an atom.
- However, as particle size drastically decreases, <u>electrons</u> experience increasing constraints, leading to the manifestation of these peculiar quantum effects.
- This profound understanding, as observed and demonstrated by the Nobel Laureates, Ekimov and Brus in their laboratories, resulted in the creation of nanosized particles with distinct behaviors compared to their larger counterparts of the same element.
 - These remarkable nanoparticles, possessing unique properties, came to be known as **quantum dots.**
- Feature of Quantum Dots: Quantum dots are nanoscale particles, typically ranging in size from 1 to 100 nanometers. These minuscule structures possess unique properties that are governed by their size.
 - Notably, the size of quantum dots determines the colour of light they emit, with smaller dots emitting blue light and larger ones shining in yellow and red.

Note

- Quantum Effect: Quantum refers to the fundamental behavior of matter and energy at the smallest scales, where classical physics no longer applies.
 - Quantum effects are the phenomena that occur at the quantum level, where particles like electrons exhibit **behaviors such as superposition and entanglement**, which are distinct from classical physics.
- Quantum Technology: <u>Quantum technology</u> harnesses the unique properties of quantum mechanics to create innovative tools and applications, including quantum computing, quantum cryptography, and quantum sensors, with the potential to revolutionize various fields.

What can be the Applications of Quantum Dots?

- Display Technology: Quantum dots can enhance the quality of displays, such as <u>LED</u> lamps and television screens, by emitting clear and vibrant light.
- Medical Imaging: They can illuminate tumor tissue during surgery, aiding surgeons in precise removal.
 - Their nanoscale size makes them ideal for use in **tiny sensors.**
- Flexible Electronics: Quantum dots hold promise for flexible electronics, paving the way for innovative and adaptable devices.
- Slimmer Solar Cells: Quantum dots could lead to more efficient and compact solar cells, improving renewable energy solutions.
- Encrypted Quantum Communication: Quantum dots might play a role in developing secure <u>quantum communication</u> technologies, protecting sensitive information.

Who are the Other Recent Nobel Laureates in the Field of Chemistry?

- **2022**
 - Carolyn R. Bertozzi, Morten Meldal and K. Barry Sharpless "for the development of click chemistry and bioorthogonal chemistry"
- **2021**
 - Benjamin List and David MacMillan "for the development of asymmetric organocatalysis"
- **2020**
 - Emmanuelle Charpentier and Jennifer A. Doudna "for the development of a method for <u>genome editing"</u>
- **2019**
 - John B. Goodenough, M. Stanley Whittingham and Akira Yoshino "for the development of <u>lithium-ion batteries"</u>

- **2018**
 - Frances H. Arnold "for the directed evolution of enzymes"
 - George P. Smith and Sir Gregory P. Winter "for the phage display of peptides and antibodies"

The Vision

Reference to Other Announcements of the Nobel Prizes 2023: Physics , Physiology or Medicine

PDF Refernece URL: https://www.drishtiias.com/printpdf/nobel-prize-in-chemistry-2023