

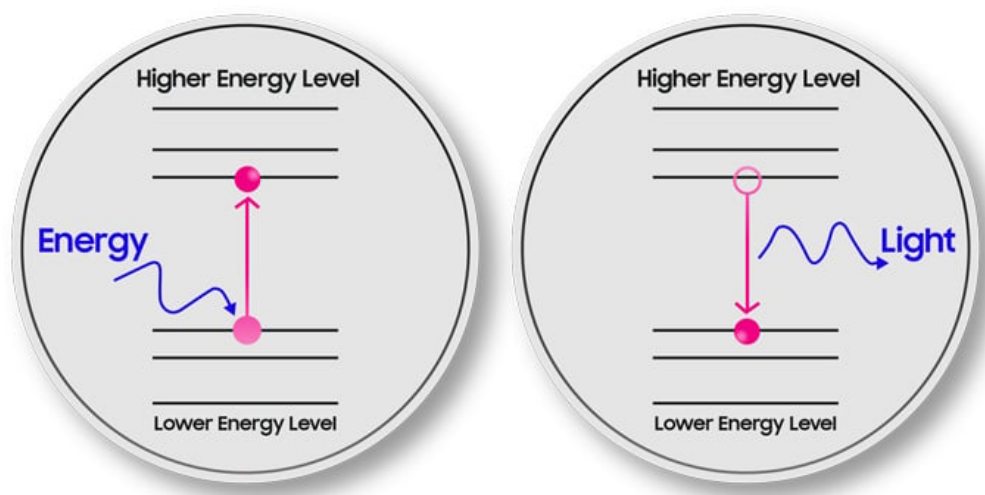
## Significance of Quantum Dots

### Why in news?

Nobel Prize for Chemistry 2023 has been awarded to Alexei I. Ekimov, Louis E. Brus, and Moungi G. Bawendi for the discovery and synthesis of quantum dots.

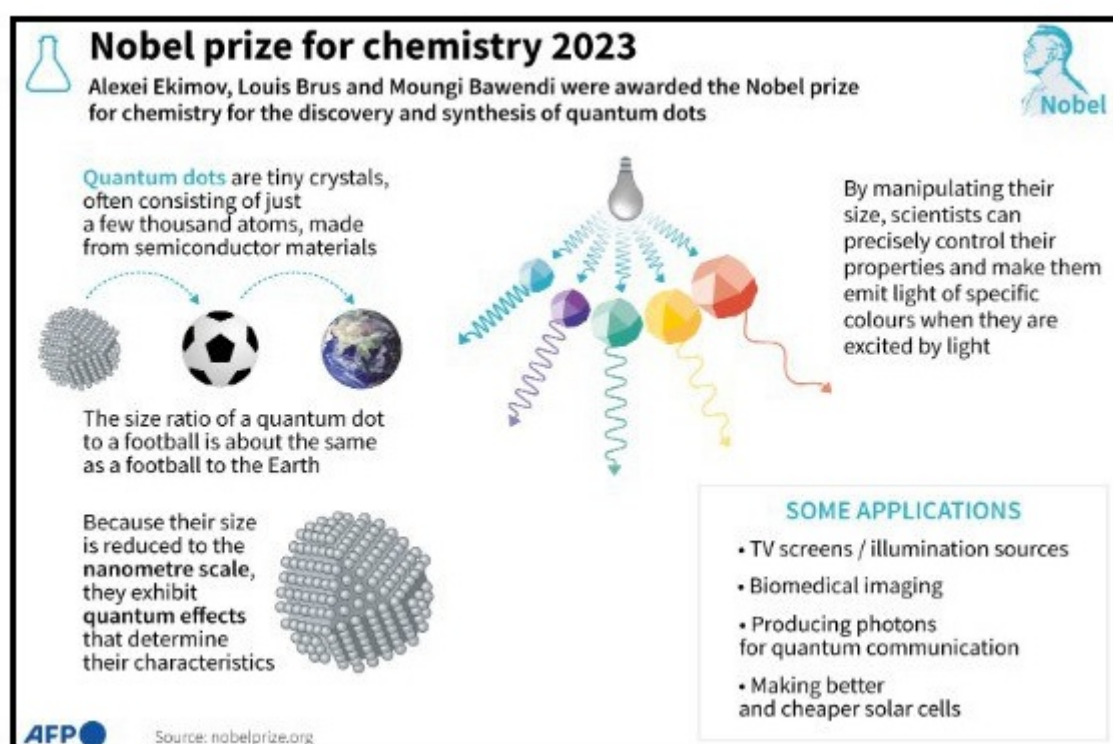
### What is a Quantum dot?

- **Quantum dots**- Quantum dots are man-made nanoscale crystals that exhibit unique optical and electronic properties, including the ability to transport electrons and emit light of various colors when exposed to UV light.
- The quantum dot change based on the nature of their properties.
- **Quantum theory**- The motion and behaviour of very small particles are radically different, and strange, when compared with any familiar object in normal human experience.
- Such strange behaviour at the sub-atomic level is described by the hugely successful Quantum Theory.
- **Nanoparticles**- They are much larger compared with atoms.
- It was theorised in the 1930s that when the size of particles was reduced to nanoscale, it could give rise to quantum effects.
- **Effect of light on a quantum dot** - When light is shined on a quantum dot, it absorbs and then re-emits it at a different frequency.
  - **Smaller dots**- Emits bluer light
  - **Larger dots**- Emits redder light
- This happens because light shone on the dot energises some electrons to jump from one energy level to a higher one, before jumping back and releasing the energy at a different frequency.



## What did the Nobel laureats do?

- **Alexei Ekimov** – He added different amounts of copper chloride to a glass before heating it to different temperatures for different durations, tracking the dopants' structure and properties.
- They found that the glass's colour changed depending on the size of the copper chloride nanocrystals
- **Louis Brus**- He and his colleagues prepared similar crystals in a liquid solution, rather than in a glass.
- These crystals also interacted with light differently depending on small variations in their size.
- **Moungi Bawendi** – He devised a simple way to make quantum dots with just the right properties using hot-injection method.



## What are the applications of quantum dot?

- **Display**- An array of quantum dots can be a TV screen by receiving electric signals and emitting light of different colours.
- **Semiconductor**- If one of the energy levels an electron jumps between in a quantum-dot atom is the conduction band, the dot can operate like a semiconductor.
- **Photovoltaics**- The solar cells made with quantum dots are expected to have a thermodynamic efficiency as high as 66%.
- **Light Emitting Diodes (LEDs)**- Visible quantum dots-based LED is considered as a next generation display technology after OLED-displays (Organic LEDs) as it exhibits high colour purity, high luminance and lower power consumption.
- **Photodetectors**- They can be used in photodetectors for detecting both infrared and visible light.
  - **IR Photodetectors**- It finds application in night vision cameras, atmospheric

spectroscopy for gas detection, biomedical imaging, quality control and product inspection.

- **Visible light photodetectors**- They are used in image sensors for transforming the incoming light into electronic signals.
- Quantum dots can also be used in surveillance, machine vision, industrial inspection, spectroscopy, and fluorescent biomedical imaging.
- **Medical diagnostics**- It can highlight a tumour that needs to be removed, for targeted drug delivery and other therapeutic measures.
- It is also used in DNA hybridization, receptor mediated endocytosis, monitoring of parasite metabolism, real time visualization of tissue and cellular structures, and diagnostics application.
- **Biological tissues**-They are also used to map biological tissues by biochemists.
- **Markers**- It can be used as security markers on currency and documents as an anti-counterfeit measure.
- It can be used as fluorescent markers to tag and track objects.

## References

1. [The Hindu- Significance of quantum dots in nanotechnology](#)
2. [Indian Express- Quantum dots Nobel Prize for Chemistry 2023](#)

