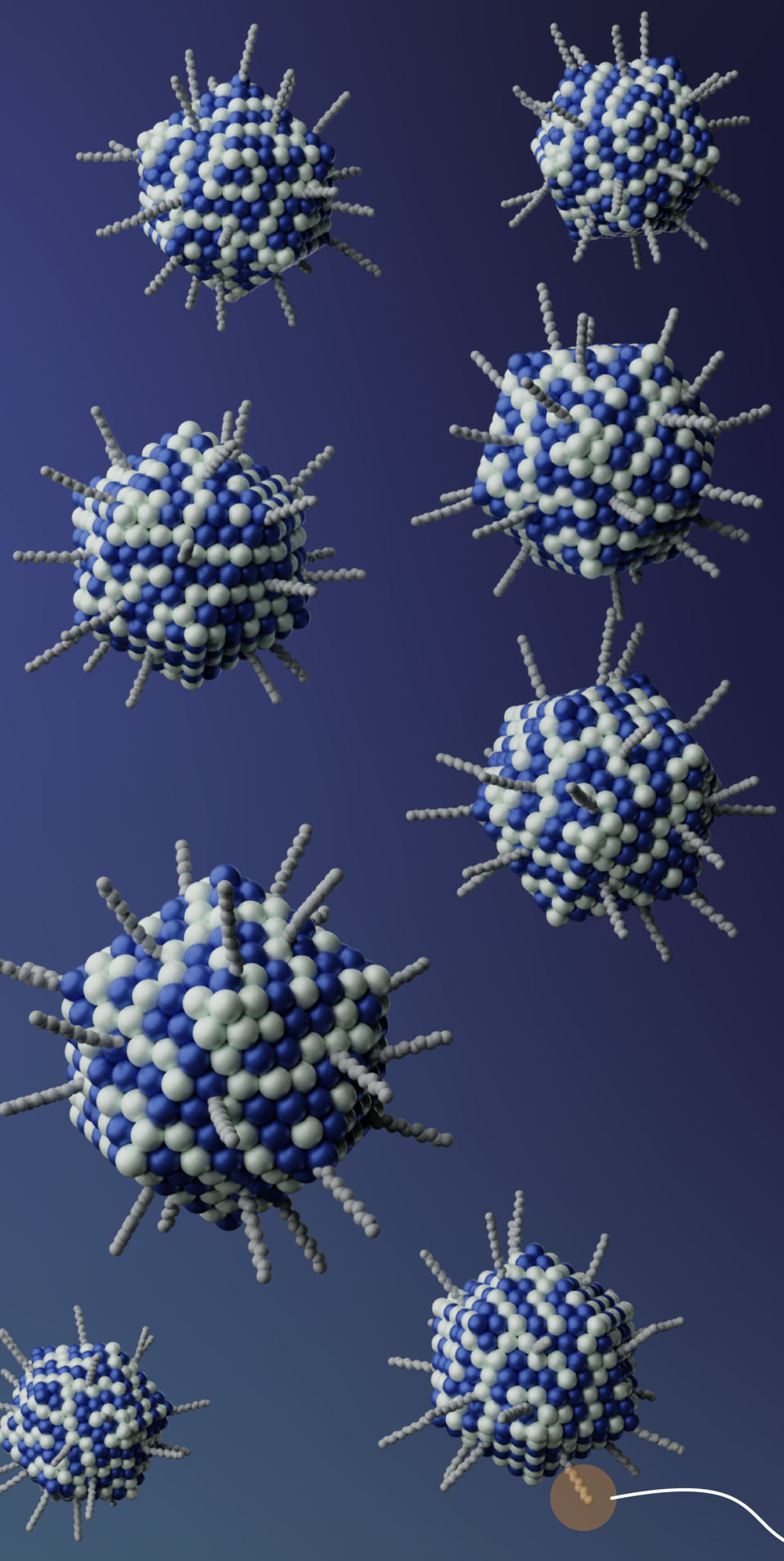
QUANTUM DOTS

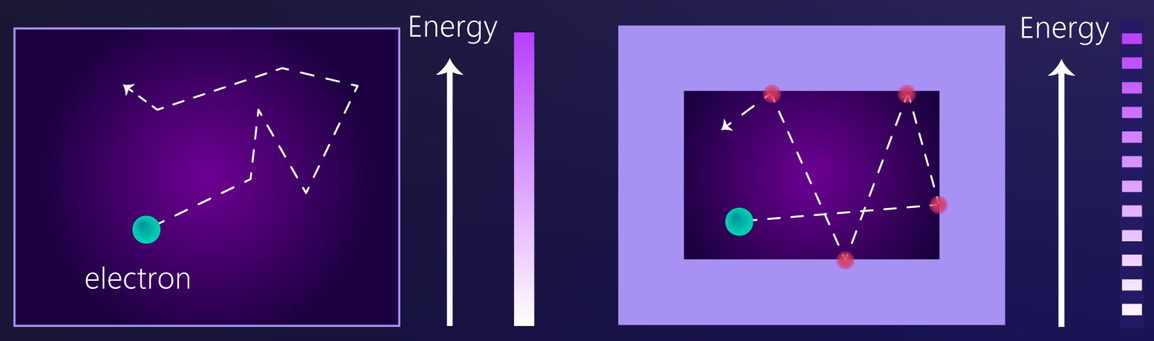
Nanomaterials for Clean Energy Project

Quantum dots are nanoscale particles, typically between 2 and 10 nanometers in diameter. Thousands of quantum dots could fit across the width of a human hair. They are made from semiconductor materials and have unique optical and electronic properties due to their size and quantum confinement effects.



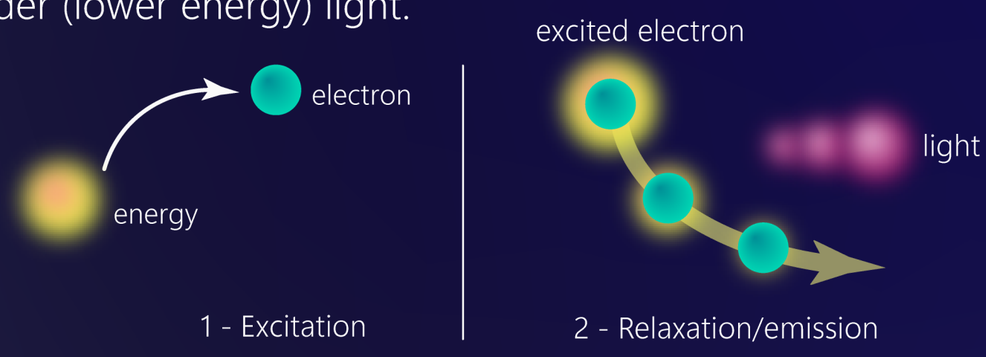
QUANTUM CONFINEMENT EFFECTS

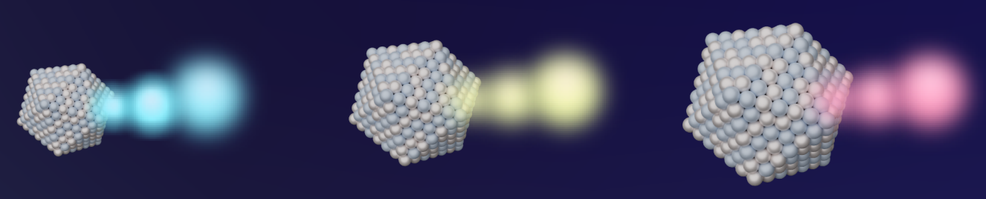
These effects describe how an electron's behavior changes when it is squeezed into a tiny space, like in a quantum dot. Just like you would move differently in a small room compared to a wide field, the electron's energy levels become distinct, not continuous. Because of this effect, the size and shape of the quantum dot control these energy levels, which is key for electronics and photonics.



LIGHT EMISSION

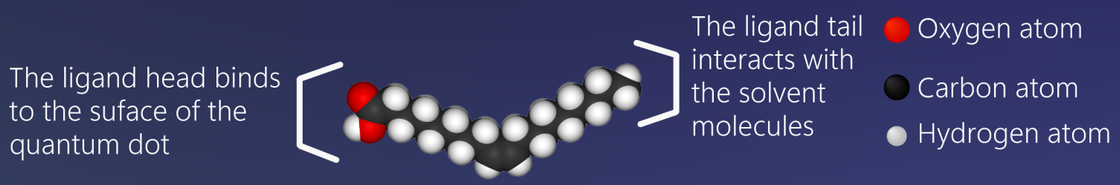
Quantum dots can emit light in different colors. When energy (from light or electricity) is given to these dots, it gets absorbed by the electrons in the dot. These excited electrons then drop back to their original energy level, releasing the extra energy as light. The color of the light depends on the size of the dot - smaller dots give off bluer (higher energy) light, while larger dots emit redder (lower energy) light.





COMPOSITION

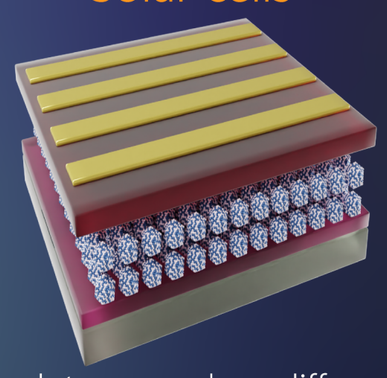
A quantum dot can be made of one, two, or more elements. These elements arrange in a specific way to construct the structure, shape, and size of the quantum dot. Typical types of quantum dots are cadmium selenide, cadmium telluride, indium phosphide, lead sulfide, and lead selenide. Quantum dots can be dispersed in solution, similar to dissolving salt or sugar in water. The surface of a quantum dot is covered by ligands, which are molecules that help stabilize the quantum dot in solution. Below is a typical ligand called oleate.



CLEAN ENERGY APPLICATIONS

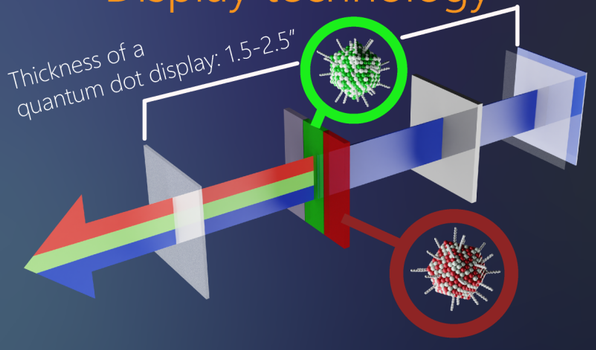
Quantum dots are versatile tiny tools in clean energy. Their ability to absorb different colors of sunlight and customizable properties make solar panels more efficient, generate energy from sunlight, and make better displays.

Solar cells



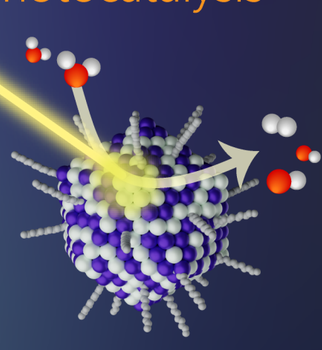
Quantum dots can soak up different colors of sunlight and create more power-packed particles, helping solar cells to use more of the sun's energy and work better.

Display technology



Quantum dots make screens for TVs and smartphones brighter and more colorful while using less energy, resulting in stunning displays and longer battery life.

Photocatalysis



Quantum dots can act like tiny solar-powered factories. When they absorb light, they can help break down abundant molecules to create more useful molecules.

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