



# **UNIVERSITY OF ROME "LA SAPIENZA"**

## **NANOTECHNOLOGIES ENGINEERING**

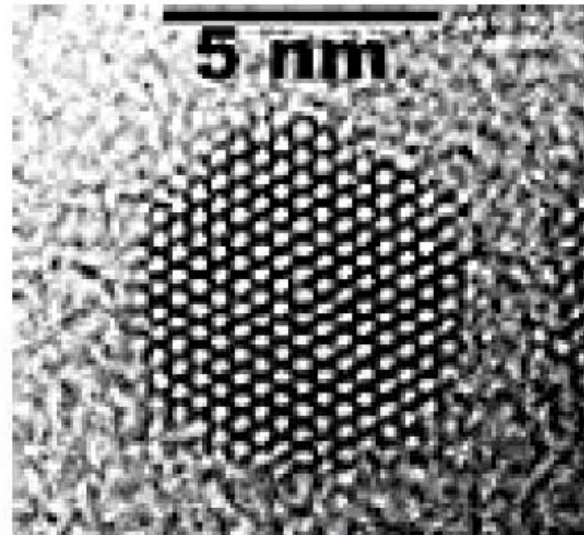
# **QUANTUM DOTS**

## QUANTUM DOTS

Optoelectronic properties of fine particles are a function of their size, habit, shape and composition.

Once the particle is smaller than the Bohr radius (10nm) electrons results confined, and their energy bands becomes discrete (as for single atoms): their energy gap increases.

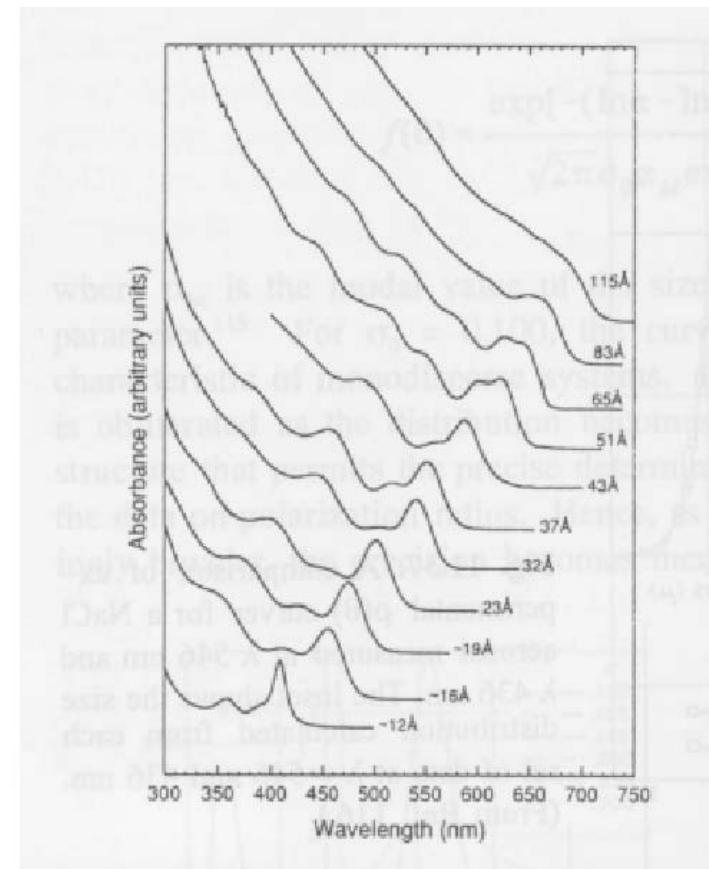
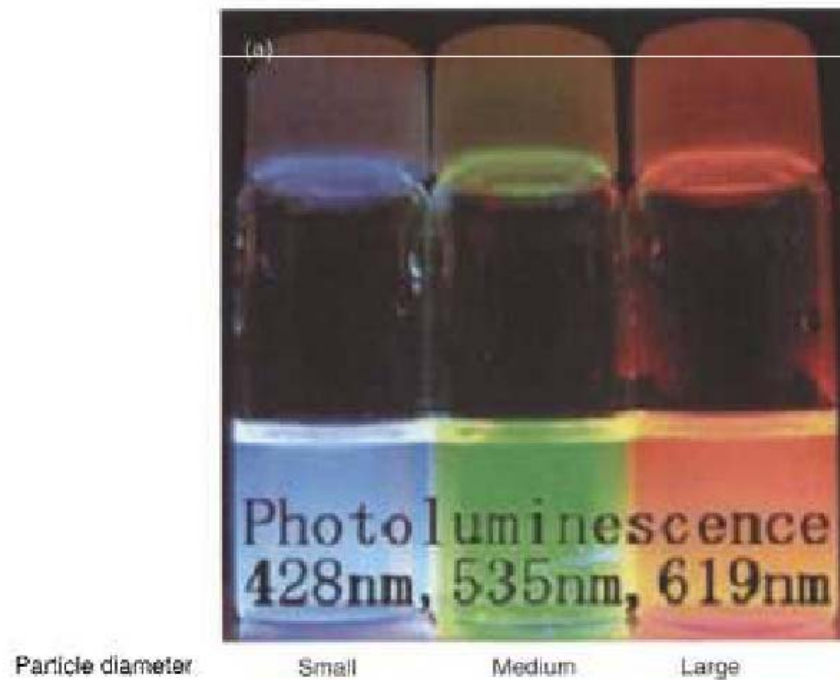
By changing size, it is possible to obtain a wide range of energy bands and therefore use them in new applications.



*TEM image of a quantum dot. It is seen the distribution of atoms. Copyright Quantum Dot Corporation, Hayward, CA, USA.*

# SEMICONDUCTORS

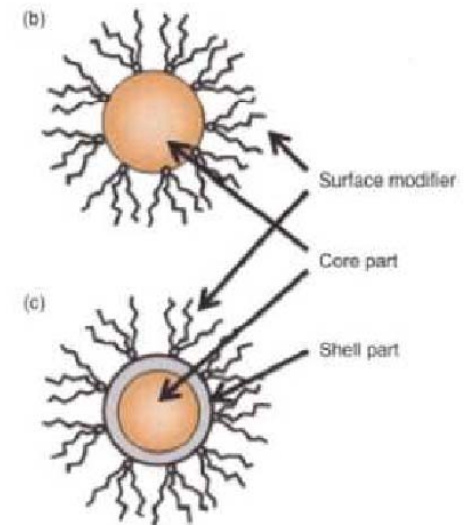
CdS, CdSe and CdTe have semiconductive characteristics. Different CdSe particles from 1nm to 11nm have different adsorption spectra.



## PREPARATION

1. By pyrolysis using metal-organic reactants in absence of oxygen at 300°C and determining size by controlling the growth rate (temperature).
2. By microemulsions of water in oil.

The particles are nowadays produced with a coating of surfactant to avoid agglomeration. This coating leads to different wettability of the particles at different pH values, and may be used in the framework of medical applications or biosensors.



## QUANTUM DOTS FOR RAM

A very thin layer of these particles under constant radiation will reach a maximum of fluorescence. If kept perfectly at dark, as soon as irradiation starts again, this maximum is immediately reached again.

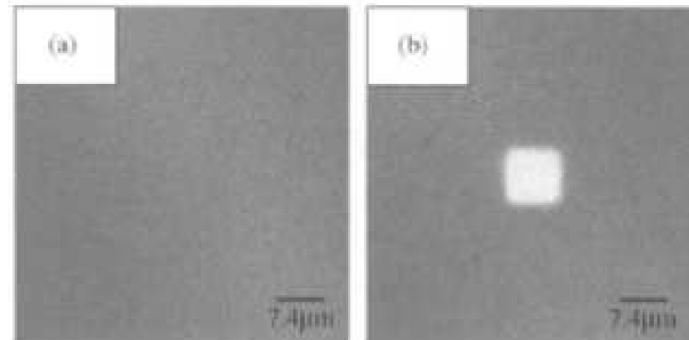
→ Quantum dots maintain memory of past irradiation processes.

This memory can be used for RAM architectures. If the quantum dot under radiation immediately exhibits maximum fluorescence, this behaviour may correspond to the specific value of the bit. On contrary, if it keep dark under radiation (since some time is required to reach fluorescence) the opposite value to the bit may be assigned.

Advantageous are access times (10ns) and the possibility to use flexible supports.

Core-shell CdSe in ZnS nanoparticles of 4nm are used. At first a 0,6nW irradiation was adopted on a small portion of the surface (writing). Fluorescence was homogeneous.

In a second step, the same irradiation was used as a flash. A small portion of quantum dots were written thus brighten up immediately (reading).



Recently it was demonstrated that:

To every quantum dot more bit states (not only binary) may be assigned due to different fluorescence.

→ Quantized computers

Unfortunately, at best, information is kept for months (and should be for years).

To avoid memory loss, the use of protective coatings are under investigation.