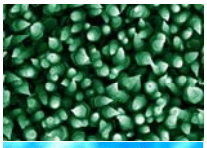
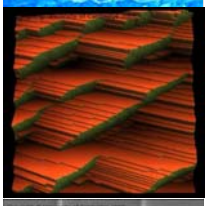
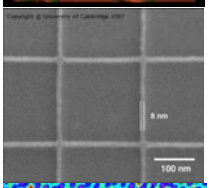
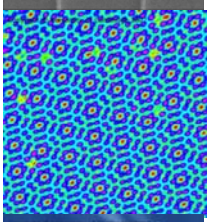
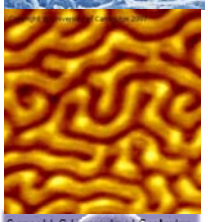
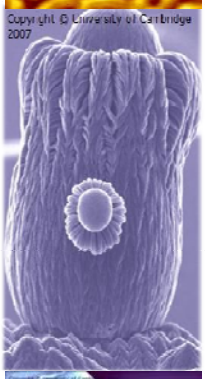
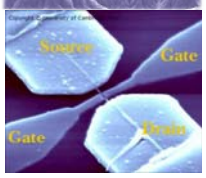
Energy and the Environment





Nanotechnology has enabled advances in energy conversion and storage, and has decreased its consumption.

With the world reliant on cheap plentiful energy supplies, and dwindling stocks of fossil fuels, nanotechnology can play a huge part in helping to reduce energy consumption and increase energy production. This is being achieved through the development of advanced energy sources, creation of new composite materials, improvements in battery technologies and development of devices which have a lower power consumption.

Additionally, nanotechnology can help with current environmental problems, making use of nanocatalysts, filtration devices or antibacterial coatings.

Dye-sensitised solar cells:

converting sunlight to electricity on the molecular level.

Traditional solar cells

Traditional Si-based solar cells are built by placing high purity crystals on top of each other in a sandwich structure.

Advantages:

•Exhibit good efficiencies

Disadvantages:

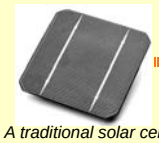
•Expensive.

•Need a lot of production energy to produce a solar cell.

•Only absorb energy within a limited range.

Solutions:

1. Development of silicon nanocrystals, engineered to absorb more solar energy
2. Biomimetric approaches, mimicking the natural photosynthetic process.



A traditional solar cell

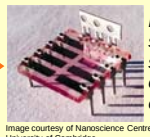


Image courtesy of Nanoscience Centre, University of Cambridge

Nanostructured solar cells offer one solution to providing cheap, plentiful energy supplies.

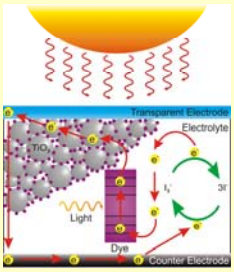
Dye-sensitised solar cells ("Grätzel Cells")

•Dye molecules (which strongly absorb light and act as a molecular antenna) are anchored onto a nanostructured semiconducting surface.

•The nanostructured seminconductor has an enormous internal surface area, to maximise light absorption and reduce the size of the cell.

•The light is captured by the dye molecules rather than by the semiconductor matrix. This means that a greater spectral range can be used in the cell.

The processes occurring in this type of cell mimic the natural photosynthetic process.



Schematic illustration of a generic dye-sensitized solar cell (source: M. R. Jones, Wikipedia Commons)

Nanotechnology and the Environment

In many areas of the world, especially the developing world, there are many environmental problems. Nanotechnology could offer a cheap, simple solution to some of these. Some examples are:

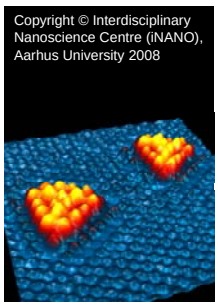
•**Nanocatalysts** – e.g. removal of sulfur from crude oil.

•**Nanofilters** e.g. removing bacteria/viruses from drinking water

•**Desalination** - turning seawater into drinking water.

•**Increasing land productivity** – e.g. using nanoporous material to improve water retention or the amount of nutrients in the soil.

•**Antibacterial coatings** – e.g. using nanoparticles of silver in coatings and textiles to kill bacteria.



A nanocatalyst used for cleaning up sulphur from crude oil. The image shows two molybdenum-disulfide nanoclusters each consisting of 15 Mo atoms and 42 S atoms .

Access to safe drinking water is a huge problem for many communities. Products such as the Lifesaver bottle use nanofilters to remove viruses and bacteria.

Reduction in Energy Consumption

Energy consumption can be reduced through various strategies:

•**Composite materials** (mixing nanomaterials with conventional materials):

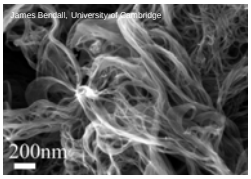
- Improving thermal insulation.
- Reducing fuel consumption e.g. in transportation by decreasing vehicle weight or reducing frictional drag.

•**Improved heating and lighting systems**

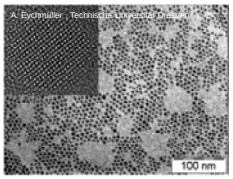
- Replacing conventional filament light bulbs with novel light emitting devices made with quantum dots.

•**Batteries**

- Longer lifetimes and improved charge retention



Carbon nanotubes can be made into composite materials. They are a sixth of the weight of steel but can be ten times stronger



Nanomaterials such as quantum dots (semiconductor nanoparticles) can be used in new low-power-consumption light emitting devices

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