Applications of carbon Nanotube

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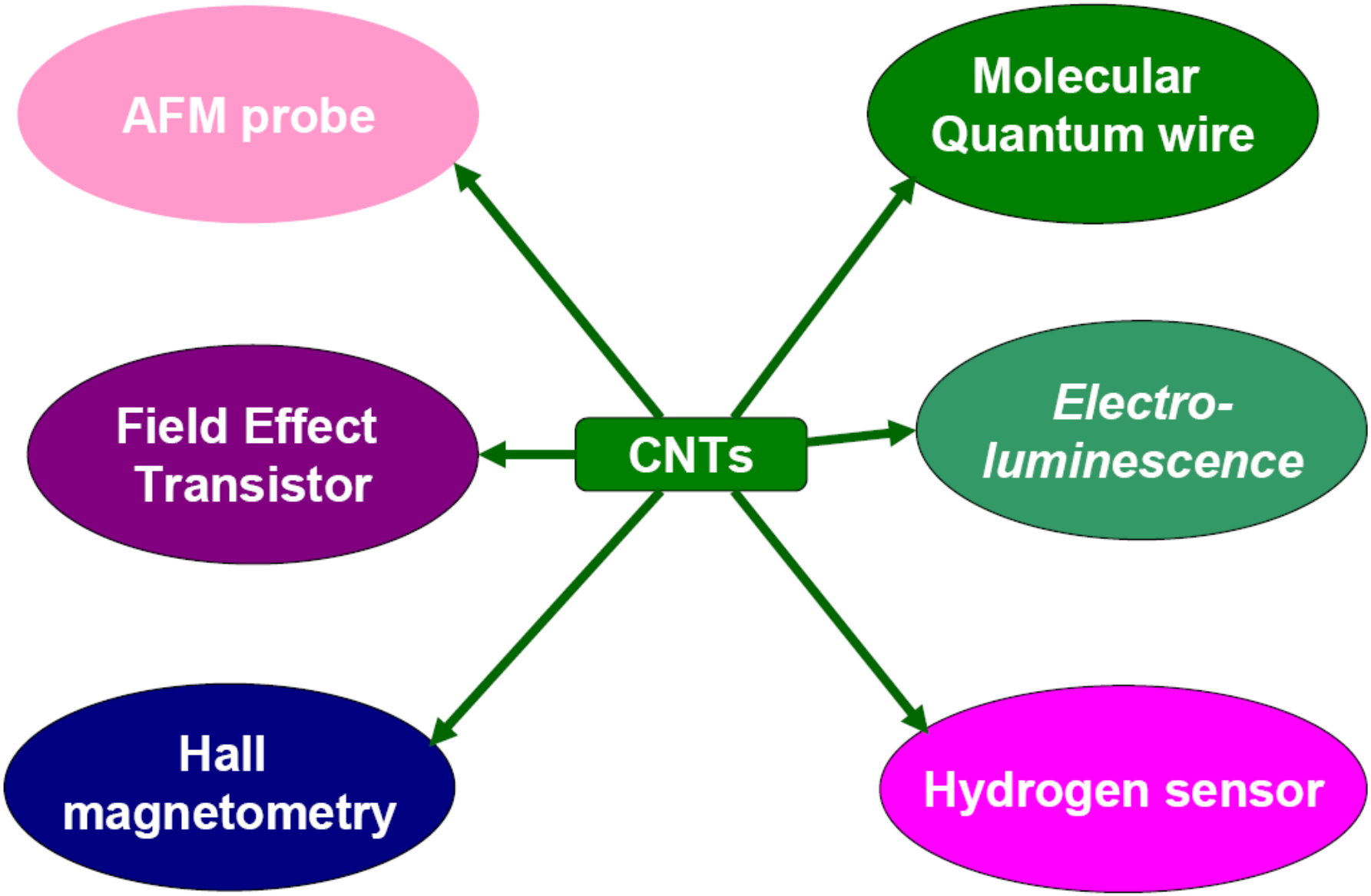
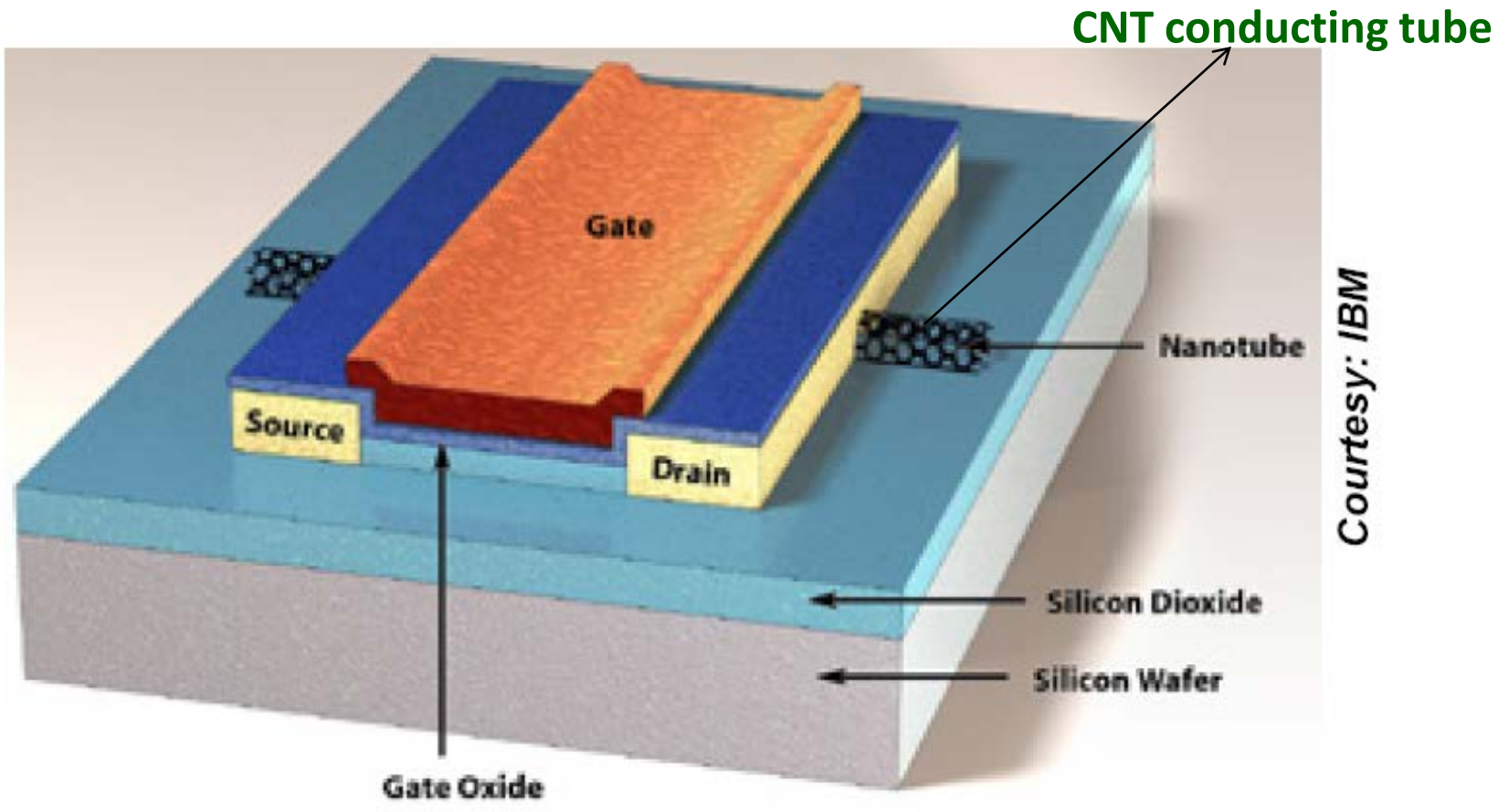
Applications of CNTs



Carbon Nanotube FET

Carbon Nanotube can be used as a **conducting channel** in Field emission Transistor

Usase of CNT conducting channel result the device with low power consumption



Field Emission properties of CNTs

Prototype devices using the superior field emission properties of nanotubes have been demonstrated.

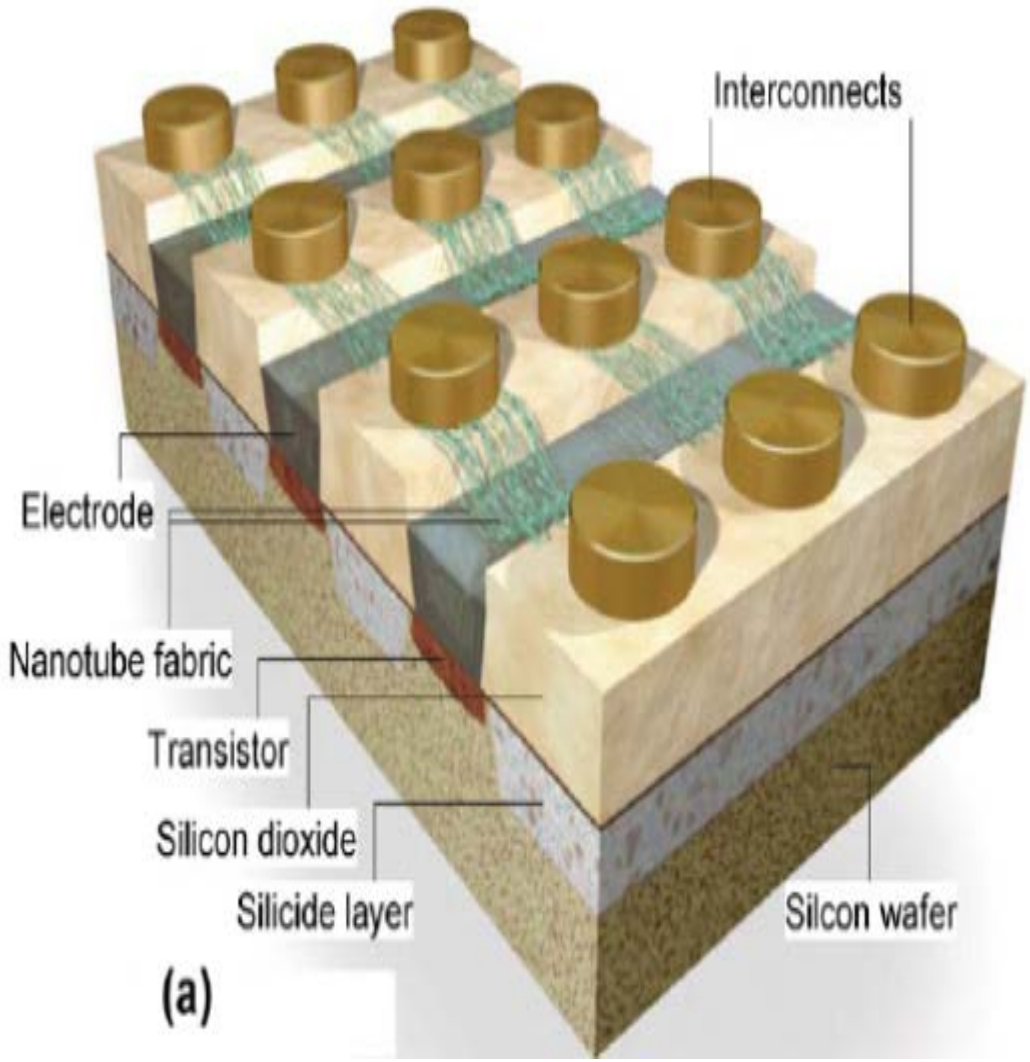
These devices include x-ray tubes, scanning x-ray sources, flat panel displays, and lamps.

There are many reasons for the excellent field emission properties of CNTs. The first reason is the inertness and temperature stability of the CNT tips for long periods of operation compared with the metal and diamond tips; due to their covalent bonding structure, nanotubes do not suffer from electro-migration.

The second reason is a low threshold voltage for cold field emission from nanotube tips. Other advantages are low temperature of operation, ultra small response times, low power and small size.

Nanotube memory

- Another exciting application of the CNT electromechanical response has been the development of a new CNT memory.
- This memory uses a silicon platform while nanotubes form the channel to store information.
- The channel consists of aligned nanotubes lying between a source and drain (interconnects in figure) and the channel is capacitively coupled to a gate electrode.
- The nanotube array is suspended either with or without contact with the electrode depending on the voltage of the electrode.
- Binary 0 and 1 states are determined by whether or not the nanotube fabric makes contact with the electrode. Binary 0 is represented by the state where there is a ~ 13 nm gap between the nanotube fabric and electrode as shown in figure. The application of a voltage to the electrode pulls the nanotube fabric down such that it makes contact with the electrode and this state represents binary 1 (figure).



Nanoprobes and sensors

- Because of their flexibility, nanotubes can also be used in scanning probe instruments.
- Since MWNT tips are conducting, they can be used in STM and AFM instruments.
- Advantages are the improved resolution in comparison with conventional Si or metal tips and the tips do not suffer from crashes with the surfaces because of their high elasticity.
- However, nanotube vibration, due to their large length, will remain an important issue until shorter nanotubes can be grown controllably.
- Nanotube tips can be modified chemically by attachment of functional groups.

1. Electronic Devices

   Nanotube TV's

   Nano-wiring

2. High Strength Composites

   100 times as strong as steel and 1/6 the weight

3. Conductive Composites

4. Medical Applications

   Encase drug into nanotube capsule for more predictable time release

- **Because of this, nanotubes can be used as molecular probes, with potential applications in chemistry and biology.Other applications are the following:**
- **A pair of nanotubes can be used as tweezers to move nanoscale structures on surfaces.**
- **Sheets of SWNTs can be used as electromechanical actuators, mimicking the actuator mechanism present in natural muscles.**
- **SWNTs may be used as miniaturised chemical sensors. On exposure to environments, which contain NO_2, NH_3 or O_2, the electrical resistance changes.**

4. Composite materials

- Because of the stiffness of carbon nanotubes, they are ideal candidates for structural applications.
- For example, they may be used as reinforcements in high strength, low weight, and high performance composites.
- Theoretically, SWNTs could have a Young's Modulus of 1 TPa.
- MWNTs are weaker because the individual cylinders slide with respect to each other.
- Ropes of SWNTs are also less strong.
- The individual tubes can pull out by shearing and at last the whole rope will break.

5. Templates

- Because of the small channels, strong capillary forces exist in nanotubes.
- These forces are strong enough to hold gases and fluids in nanotubes.
- In this way, it may be possible to fill the cavities of the nanotubes to create nanowires.

1. Nanotechnology Applications in Medicine

- **Because of their small size, nanoscale devices can readily interact with biomolecules on both the surface of cells and inside of cells.**

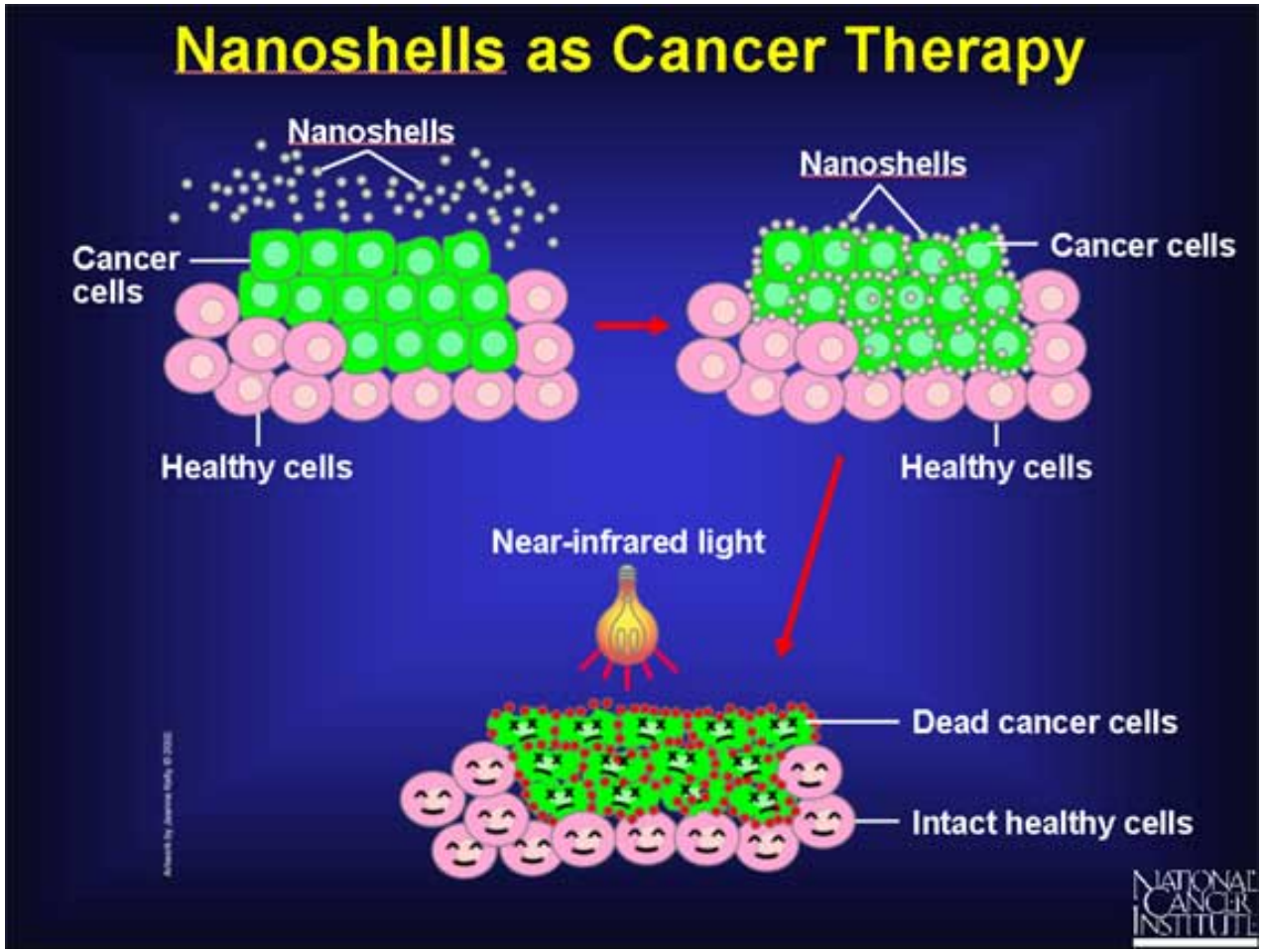
- **By gaining access to so many areas of the body, they have the potential to detect disease and the deliver treatment.**

- **Nanoparticles can can deliver drugs directly to diseased cells in your body.**
- **Nanomedicine is the medical use of molecular-sized particles to deliver drugs, heat, light or other substances to specific cells in the human body.**

- **Quantum dot- that identify the location of cancer cells in the body.**
- **Nano Particles - that deliver chemotherapy drugs directly to cancer cells to minimize damage to healthy cells.**
- **Nanoshells - that concentrate the heat from infrared light to destroy cancer cells with minimal damage to surrounding healthy cells.**
- **Nanotubes- used in broken bones to provide a structure for new bone material to grow.**

Nano shells as Cancer Therapy

Nano shells are injected into cancer area and they recognize cancer cells. Then by applying near-infrared light, the heat generated by the light-absorbing Nano shells has successfully killed tumor cells while leaving neighboring cells intact.

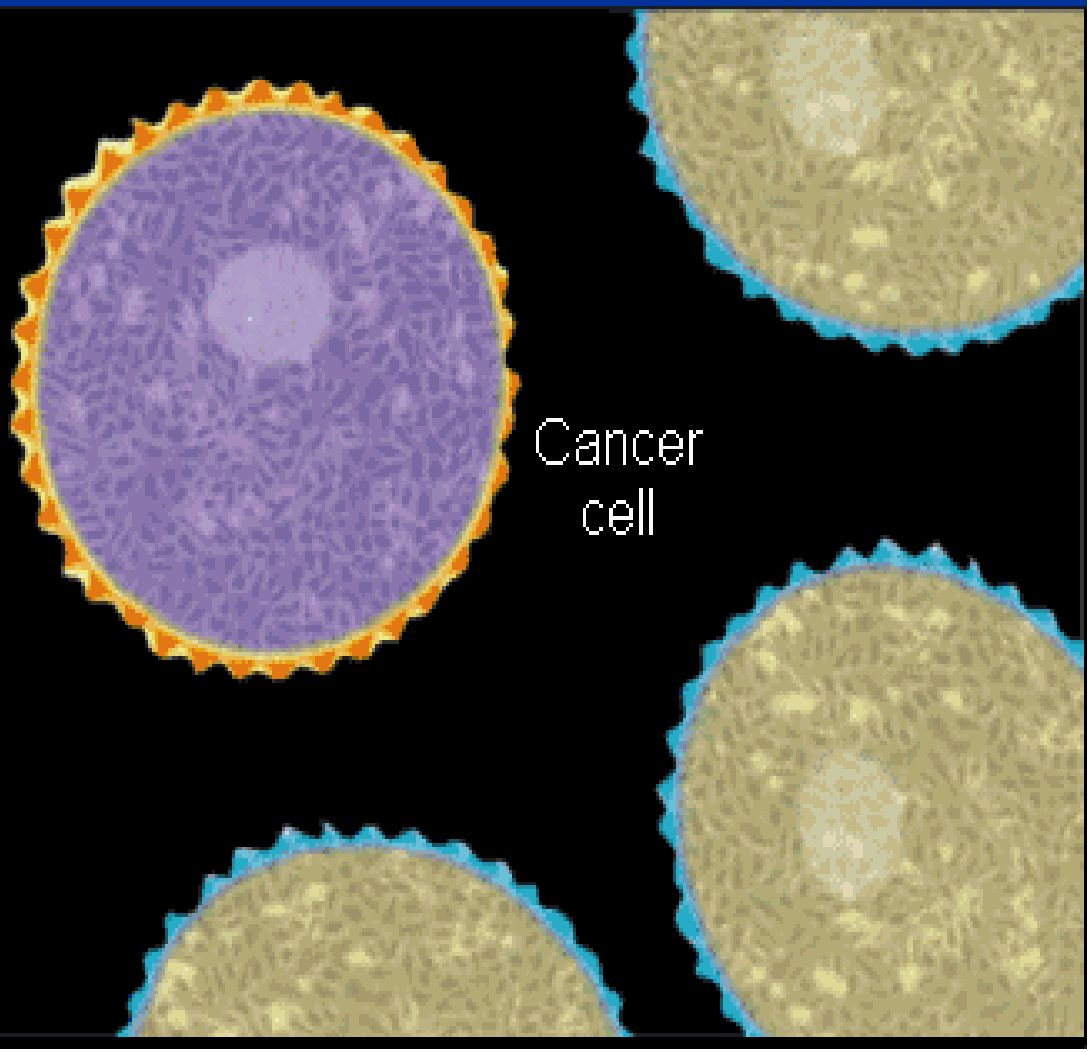


Nanoshells

Nanoshells kill tumor cells selectively

Nanoparticles

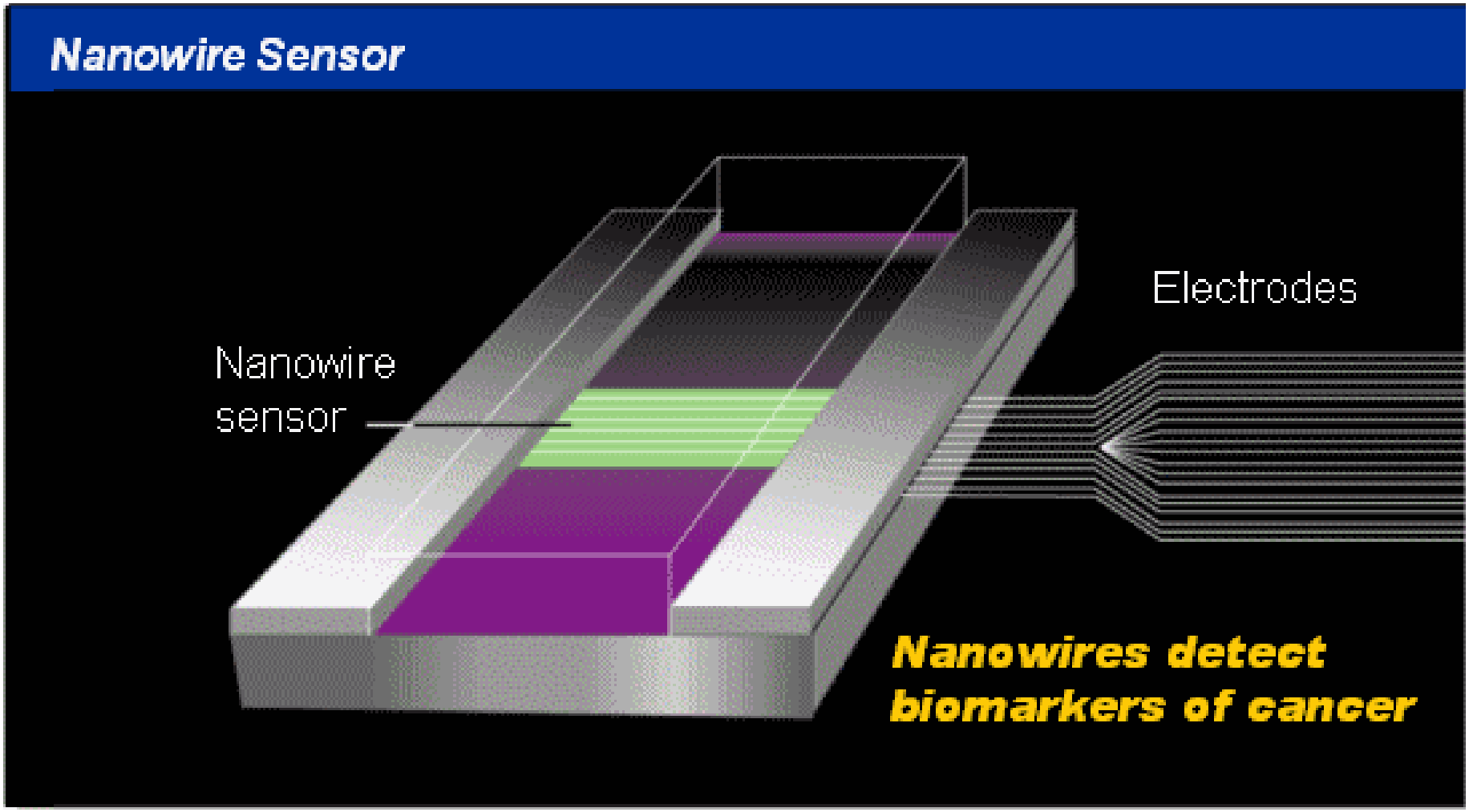
Nanoparticles used for molecular imaging of malignant lesions



Nanowires – used as medical sensor

- In this diagram (next page), Nano sized sensing wires are laid down across a micro fluidic channel. As particles flow through the micro fluidic channel, the Nanowire sensors pick up the molecular identifications of these particles and can immediately relay this information through a connection of electrodes to the outside world.
- These Nanodevices are man-made constructs made with **carbon, silicon Nanowire**.
- They can detect the presence of altered genes associated with cancer and may help researchers pinpoint the exact location of those changes

Nanowire Sensor




THANKYOU