

GFP as a Light Source

Abstract: Electrical engineers have begun experimenting with the Green Fluorescent Protein, GFP, produced from the jellyfish *Aequorea*. GFP is being tested in the use of organic light emitting diodes (OLEDs). They are hoping that replacing crystalline semiconductors with GFP will produce more efficient and less costly LEDs that are currently being used in flat screen portable computer displays.

Diodes and semiconductors:

A diode is an electronic device that allows the passage of current in only one direction. The most commonly used diodes used today are semiconductor diodes. A semiconductor can be a solid or liquid material that can conduct electricity at room temperature more easily than an insulator, but less well than a metal. The common semiconductors include chemical elements and compounds such as silicon, germanium, selenium, gallium arsenide, zinc selenide, and lead telluride. A semiconductor works by exciting their outer orbital, or valence electrons, by increasing the temperature or exposing to light. Once the electrons are out of their bonds, holes are left behind and a current can now be carried. Another method to create these holes is to add impure mixtures, called "doping" the semiconductor.

Light Emitting Diodes –LEDs

A light emitting diode (LED), is a device that emits visible light or infrared radiation when an electric current passes through it. LEDs are made of semiconductors mixed with phosphors, substances that absorb electromagnetic radiation and reemit it as visible light. The process, known as electroluminescence, works as follows:

1. Electrical current passes through the diode.
2. The electrons in the semiconductor are boosted to a higher orbital.
3. These electrons fall back to lower orbits, and the atom emits infrared irradiation.
4. The radiation strikes a phosphor atom and the electrons in the phosphor atom jump to higher orbits.
5. Finally, the phosphor atom emits visible light as the electrons fall back to their lower orbit.

LEDs have been employed in touch screens that are used in information stations and automatic teller machines. They are also used in numerical displays such as those on electronic digital watches and pocket calculators.

Using GFP in Organic Light Emitting Diodes-OLEDs:

Electrical engineers have begun to look at the bioluminescent properties of the jellyfish *Aequorea* as a source of light to use in their LEDs. They are experimenting with the Green Fluorescent Protein, GFP, in order to design better LEDs. Currently, researchers are using crystalline semiconductors such as gallium arsenide or indium phosphide in their LEDs. A researcher at the University of Southern California, Mark Thompson, and his colleagues made a GFP-like molecule, seeded them onto a matrix of organic molecules, creating an organic LED (OLED). They were testing to see if the GFP-like molecules would help convert energy from the matrix into light. Eventually, after much trial and error, they were able to produce both green and orange LEDs.

This new light emitting device technologies will work optimally for flat panel displays, such as portable computer displays. OLEDs are thought to be much simpler and cheaper to make than their non-organic counterparts. Currently they are not as efficient as the existing devices, but should improve with further research and development.

References:

Jellyfish protein inspires LED design *Scientific American* December 8, 2000.

Progress with Light-emitting polymers. Bernius et al *Advanced Materials* vol.12 issue 23 p1737-1750.

<http://www.usc.edu/dept/chemistry/faculty/thompson.htm>

Web site of the USC professor that is currently making OLEDs with GFP.

<http://www.intel.com/education/teachtech/learning/chips/introduction.htm>

Intel's Education web site on how silicon chips are made.

Glossary for GFP as a Light Source**diode**

An electronic device that allows the passage of current in only one direction.

doping

Adding a small amount of impurity into a semiconductor.

electromagnetic waves or radiation

Are made up of oscillating electric and magnetic fields that can travel through many substances. Particles that make up the waves are called photons. They consist of many frequencies. At the high frequencies are the gamma rays and X rays, followed by ultraviolet, then the visible light. At the lower frequencies are the infrared radiation waves and microwaves. Within the lower frequencies are the radio waves.

green fluorescent protein (GFP)

A protein found in jellyfish that fluoresces, or emits a green visible light when excited by UV light with a wavelength of 395 nanometers. It can function as a biological marker when co-expressed with other proteins. The structure of the protein is cylindrical with the glowing component, an amino acid complex called a *fluorophore*, in the middle of it.

light

Consists of electromagnetic waves of specific frequencies and wavelengths. Light is often drawn as a ray. The ray shows the path taken by the light waves, the direction in which the energy is being carried.

light emitting diode-LED

A device that emits visible light or infrared radiation when an electric current passes through it.

semiconductor

A solid or liquid material that can conduct electricity at room temperature more easily than an insulator, but less well than a conductor (i.e. metal). Its ability to conduct electricity increases as you increase the temperature or the amounts of impurities you add to the system. They are widely used in electronic circuits.