Research Experiences with Fluorescent Dyes for Teachers

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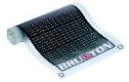
Background Information and Applications of Fluorescent Dyes

The sunlight that reaches earth is enough to power the world's energy usage. However, only about 25% of the sun's energy reaches the Earth's surface. And most of that limited solar energy cannot be utilized effectively, as most solar cells have efficiency rating of less than 20%. Also, the wavelengths used by solar panels are restricted to wavelengths between 300 and 700 nanometers (nm) that can be absorbed by silicon solar cells and wavelengths under 400 nm are often wasted as heat inside the solar or photovoltaic cell.

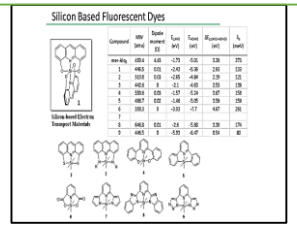


Fluorescent dyes can be used for converting light, as they have the ability to convert one high energy photon into two or more low energy photons. Electrons are excited by the photons and when they fall back down, they release two photons that have lower energy. With using fluorescent dyes, wavelengths under 400 nm can be converted to about 600 nm, which is visible light, and the silicon wafers can use more efficiently. In other words, research on fluorescent dyes can help make solar panels more efficient.

Research Goals

- To characterize fluorescent dyes that can be used in Light Emitting Diodes (LED)
- To learn how to use the Flourolog Instrument for characterization of fluorescence properties of various dyes

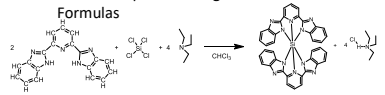
Vocabulary and Reference Data



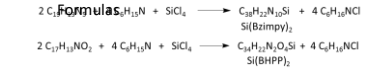
-Nanometers and Nanoseconds are tiny measurements that scientist use.
-Nao means 1 billionth of a meter or second, which written in exponents is 1×10^{-9} m or s.
-Absorption: How much light a substance takes in (Absorb).
-Emissions: How much light a substance gives off (Emit).
-Compounds: 2 or more elements chemically combined.
-Excitation: when light energy is applied to a molecule it is excited.
-Photons: light.
-Lifetime: A measure of the time a fluorophore spends in the excited state before falling back to the ground state by emitting a photon. The lifetimes of fluorophores are measured in units ranging from picoseconds to of nanoseconds.
Bioluminescence: the production and emission of light by a living organism.

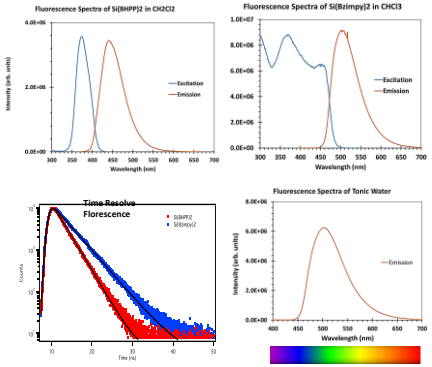
Obtained Data

Reaction Equation Using Structural Formulas



Reaction Equations Using Molecular Formulas





Fluorescence occurs when a source of energy excites molecules, making them release packets of light called photons. When you burn wood, you create light and heat energy. The heat energy causes light energy and the heat energy causes the molecules that make up the wood to speed up. When the molecules speed up, they hit each other with more frequency. If the molecules are excited enough, the heat will transfer energy to some of the molecule's electrons.

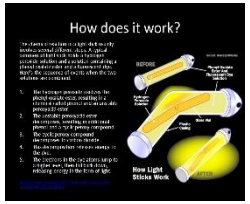
When this happens, an electron will be boosted to a higher energy level (This is the excited state). When the electron's energy level eventually falls back down to its original level (This is the relaxed state) it gives up some of its energy in a form of light. A glow stick does the same thing, but it uses a chemical reaction to excite the fluoresc… …ply ultra-vio… …can be conv…

NC Standards

Standards included in this Curriculum Unit include:
8.P.2.2 Explain the implications of the depletion of renewable and nonrenewable energy resources and the importance of conservation.
8.P.1.1 Classify matter as elements, compounds, or mixtures based on how the atoms are packed together in arrangements.
8.P.1.2 Explain how the physical properties of elements and their reactivity have been used to produce the current model of the Periodic Table of elements.
8.P.1.3 Compare physical changes such as size, shape and state to chemical changes that are the result of a chemical reaction to include changes in temperature, color, formation of a gas or precipitate.
8.P.1.4 Explain how the idea of atoms and a balanced chemical equation support the law of conservation of mass.

Lab Activities and Materials

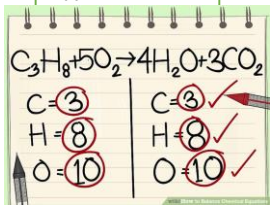
Glow Stick Lab



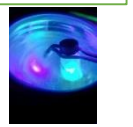
Tonic Water with Quinine Lab

These labs are related to the NC 8th Grade Science Standard 8.P.1.4, in which students compare physical changes such as size, shape and state to chemical changes that are the result of a chemical reaction to include changes in temperature, color, formation of a gas or precipitate.
The glow stick activity demonstrates the release of energy and proves that a chemical reaction occurs. The quinine in the tonic water, which turns blue when observed under sunlight or UV light, however, proves that a physical change occurred when it is removed from the sunlight and UV light.

Balancing Equations Lab



The Balancing Equations Lab is related to the NC 8th Grade Science Standards 8.P.1.4, as students are expected to explain how the idea of atoms and a balanced chemical equation support the Law of Conservation of Mass (LCM).
The reaction, shown in the form of an equation above, demonstrates The
LCM and can be used in a lesson plan to identify elements and prove that the equation is balanced, thus proving the LCM.



Acknowledgements