



AN ENLIGHTENING EXPERIENCE

Gaia Roati, IS Sobrero Casale Monferrato, Italy

Have you ever heard about *lophine*? It works similar to Luminol, the substance widely used in TV series such as C.S.I. to detect blood stains.

Both are chemiluminescent organic compounds which can emit mysterious light as you might know from glow sticks. We (Fig. 1) had the unique chance to have a very close look at lophine (while the synthesis of *luminol* is more difficult and dangerous). Everything started thanks to the collaboration of our chemistry teacher Elisabetta Gaita with the Università del Piemonte Orientale Avogadro of Alessandria. Our aim was to synthesize lophine, which chemists call 2,4,5-triphenylimidazole. Wearing the classic white coats and protective goggles we enthusiastically started work under the supervision of the scientists Katia Sparnacci and Guido

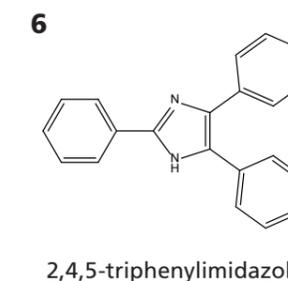
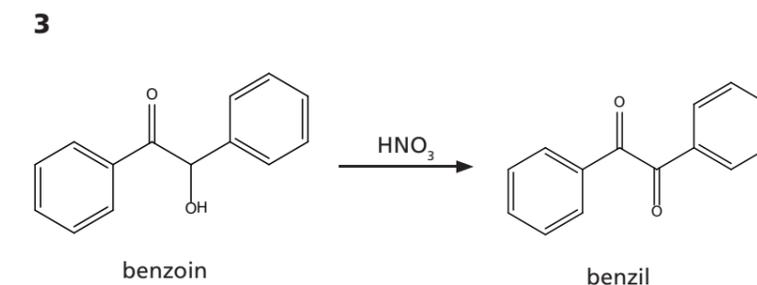
Panzarasa. The first step was the synthesis of benzil by oxidation of benzoin with nitric acid (HNO_3). This reaction needs heat and produces red-brown fumes of NO_2 (Fig. 2,3) until a bright yellow solid is obtained when the liquid product has cooled down. This product is not very pure, so it must be dissolved in ethanol until a clear liquid is formed, that has to be recrystallized by putting it in ice. During our work we had to use a Buchner funnel to separate the solid component from the liquid. The second step was the synthesis of lophine by condensation of benzil with benzaldehyde (Fig. 4), which we accomplished by heating a solution of benzil and benzaldehyde in glacial acetic acid. The product was obtained as a cream-white solid upon addition of aqueous ammonia, recovered by vacuum filtration and air-dried. We were very excited when we tested our own lophine. We dissolved it in ethanol and went into a darkroom. To observe the chemiluminescence,

a basic solution of hydrogen peroxide ($\text{NaOH}+\text{H}_2\text{O}_2$) was added to the ethanolic solution of lophine followed by a diluted solution of sodium hypochlorite (commercial bleach): A yellow-green light was emitted by the mixture which was visible in the dark (Fig. 5). This experience was so impressive that a follow-up project was set up by our teacher and by professor Nadia Semino from the Marconi Institute of Tortona. Now it was our turn to teach our fellow students all about chemiluminescence and make them produce such glowing stuff themselves.

The results were presented at the European Science on Stage Festival 2013 in Slubice (Poland) and you can also find an interactive poster at www.sobrero.it/liceo/clil.htm

SOURCES

- K. Nakashima (2003). Lophine derivatives as versatile analytical tools. *Biomedical chromatography* 17, 83-95.
- E. Welsh (2011). What is chemiluminescence? *Science in School* 19, 62-68. "practical instruction of our teachers" http://en.wikibooks.org/wiki/Analytical_Chemiluminescence/Lophine_and_pyrogallol



GLOSSARY

Lophine

(2,4,5- triphenylimidazole; Fig. 6) Nitrogenous organic base that exhibits lemon yellow chemiluminescence when it reacts with oxygen in presence of a strong base (such as NaOH). Is one of the few long-lasting chemiluminescent molecules. It forms dimers that have photochromic properties (can reversibly change colour in presence of electromagnetic radiation such as light). Lophine is also used as an analytical reagent for trace metal ion detection and in biomedical science, since some of its derivatives can detect organic substances in biological materials.

Luminol

($\text{C}_8\text{H}_7\text{N}_3\text{O}_2$) Chemical substance that exhibits a blue chemiluminescence when mixed with an appropriate oxidizing agent. It is used to detect blood since the iron contained in blood acts as a catalyst (makes the process faster) in the oxidation reaction.

Chemiluminescence

A type of luminescence in which the electrons are excited due to a chemical reaction.

Luminescence

The production of light, usually at low temperatures, due to the movement of electrons of the compounds involved from higher levels to lower ones.

Oxidation

Interaction between oxygen molecules and other substances; more generally it is the loss of electrons (increase in oxidation state) by a molecule, atom, or ion.

Buchner funnel

Laboratory instrument, that is used for filtration through filter paper using vacuum suction.

Condensation

Formation of chemical bonds between different molecules, usually resulting in loss of water.

Organic compounds

Molecules that consist mainly of carbon but can have additional elements like nitrogen, oxygen and hydrogen (C, N, O, H).

Crystallization

Formation of solid crystals due to precipitation from a liquid solution.

Figure 1 Our high school student group in the lab with the supervisors.

Figure 2 Red-brown fumes of NO_2 .

Figure 3 Reaction of benzoin to benzil.

Figure 4 Synthesis of lophine by condensation of benzil with benzaldehyde.

Figure 5 Chemiluminescent emission from an ethanolic solution of lophine in presence of hydrogen peroxide and bleach.

Figure 6 Chemical structure of lophine.

Benzil

Organic molecule very common in nature as substituent in more complex compounds

Benzoin

Organic compound, forms white crystals.

NOTE: WHEN DEALING WITH CHEMICALS YOU MUST OBSERVE UTMOST CAUTION TO NOT HARM YOURSELF, OTHERS, OR THE ENVIRONMENT. THE EXPERIMENT DESCRIBED HERE MUST BE CONDUCTED UNDER SUPERVISION OF TEACHERS!