CHEMISTRY IN THE TOY STORE
Part 3: Lightsticks, Thingmaker, Magic Sand, Magic Rocks, Scratch and Sniff Stickers

Lightsticks

A lightstick is a device that produces a "cool light" by means of a chemical reaction. The reaction is similar to the one that produces light in a firefly, but the chemicals involved are different.

A lightstick is a two-component system consisting of dilute hydrogen peroxide in a phthalic ester solvent contained in a thin glass ampule that is surrounded by a solution containing a phenyl oxalate ester and the fluorescent dye 9,10-bis(phenylethynyl)anthracene. When the glass ampule is broken by bending the lightstick, the hydrogen peroxide and the phenyl oxalate ester react. During the reaction energy is transferred to the dye molecules, and light is produced.

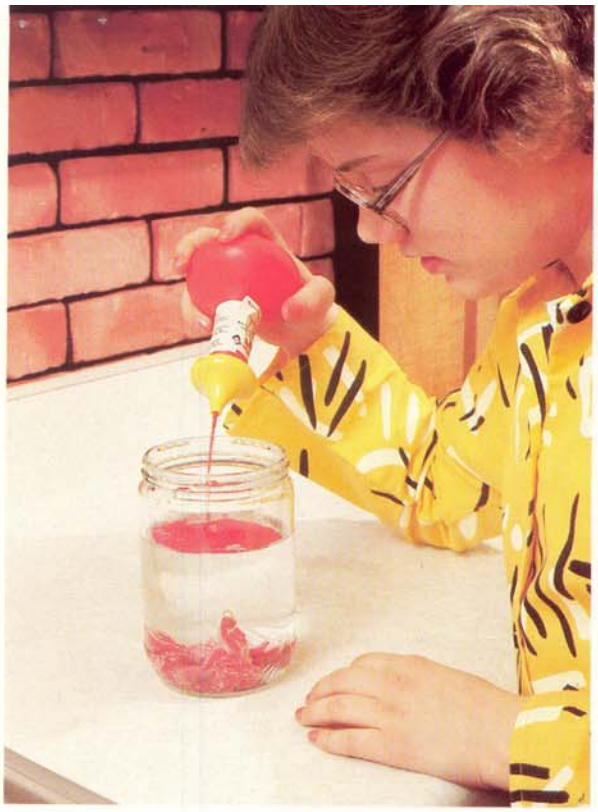
Lightsticks are used as emergency lights, earrings, necklaces, and bracelets. They are also used to light up balls for nighttime playing.

Thingmaker II

Thingmaker II®, a former product of Mattel, was a molding set that utilized colored material called Goop for making rings, necklaces, pencil holders, flowers for small arrangements, and other articles. Another version was used to make assorted insects.

To be made usable the Goop compound should be placed in the Thingmaker II, where it is heated by a 25-watt light bulb for about one hour

Goop is poured into Thingmaker II to make flowers and other ornamental objects. The mixture is heated by a 25-watt light bulb for about one hour before it is poured into the molds.



Magic Sand, silicon dioxide that has been treated with a colored dye and coated with finely divided hydrophobic silicon, is poured into a jar of water (far left). Its water repellency allows the particles to stay together as a separate phase and to form intricate patterns in water (center). When removed from the water (above), it is completely dry. A similar material has found many industrial applications.

Wham-O a Kransco Group Company; photos, Cameramann International, Ltd.

until it is softened, and then poured into molds. The Goop is described as a lightly cross-linked gelatin with color and bacteriostats (agents that inhibit the growth of bacteria without destroying them) that uses glycerin as a plasticizer. It takes about 15 minutes for the Goop to cool and set before it can be removed from the mold and used for its intended purpose. If exposed to the atmosphere, the molded Goop tends to shrink owing to loss of water.

Goop can be made in a kitchen or a laboratory by dissolving four envelopes of gelatin, such as Knox-brand unflavored gelatin, in 225 milliliters of warm water with 25 milliliters of glycerin. If the resulting gel is too hard or too soft, the quantity of gelatin should be reduced or increased until the proper consistency has been obtained. Food color can be added to produce various colors. The resulting gel should be stored in an airtight container to prevent drying out or growth of mold. When the homemade Goop is going to be used, the container should be set in hot water until the gel becomes liquid. Removal of the Goop from the molds can be facilitated by lubrication of the mold with a thin layer of vegetable oil (a spray-type vegetable oil works well).

Magic Sand

Magic Sand®, originally produced by Wham-O Manufacturing Co., is sand (silicon dioxide) that has been treated with a colored dye and coated with finely divided hydrophobic silicon. This coating allows Magic Sand to be placed in water to form underwater towers or columns and designs and then to be removed and found to be completely dry. Because of

this water repellency the particles of Magic Sand will stay together as a separate phase in the water, similar to the phase separation of a polar and a nonpolar liquid such as vinegar and oil.

The Magic Sand is an application of an invention from Cabot Corp., Boston, that originally was used for the removal of oily contaminants from water systems. A similar material is a fumed silicon dioxide, called Cab-O-Sil®, marketed by Cabot Corp., which is used for many applications such as thickening, suspension of solids, and optical clarity in products such as coatings, adhesives, cosmetics, inks, plastics, and rubbers. It is also used to promote the free flow of dry powders.

Magic Sand is prepared by treating an inland sand (which has grains with rounded edges for better flow characteristics) with an organohalosilane such as dimethyldichlorosilane, $(CH_3)_2SiCl_2$. In the reaction the surface of the sand becomes coated with a thin monolayer film of $(CH_3)_2(OH)Si\text{-}O\text{-}$, which repels water. Materials such as paper, wood, glass, silk, and porcelain can also be coated with a water-repellent film by simply exposing them to the vapor of organohalosilanes.

Magic Rocks

Magic Rocks, also known as a "chemical garden," consist of small "rocks" colored white, blue, green, red, purple, and orange or yellow. When placed in the "growing solution," the rocks grow and form colored columns. After growth is complete, the solution can be replaced by water so that the garden can be maintained for decoration.

Craft House, Toledo, Ohio; photo, Cameramann International, Ltd.

A "chemical garden" has been grown from Magic Rocks. These are small chunks of differently colored chemical salts such as calcium chloride (white), copper(II) sulfate (blue), cobalt(II) chloride (red), iron(III) chloride (yellow or orange), and nickel(II) nitrate (green). When the salts are placed in a solution of sodium silicate in water, the chunks grow to form colored towers. After the growth is complete, the solution can be poured off and replaced by water.

Magic Rocks consist of a sodium silicate solution in water, Na_2SiO_3 (the growing solution), and small chunks of various chemical salts. Some commonly used salts and their colors are: calcium chloride (white), lead(II) nitrate (white), copper(II) sulfate (blue), cobalt(II) chloride (red), iron(III) chloride (yellow or orange), nickel(II) nitrate (green), and manganese(II) chloride (pink or purple). The salts are kept stable by being dispersed in an alum or aluminum hydroxide. Attempting to dissolve the colored "rocks" in water or dilute acid results in a gelatinous precipitate.

To make a chemical garden one should mix 100 milliliters of sodium silicate solution (available from chemical supply companies and some hobby shops) with 400 milliliters of water in a 600-milliliter beaker or glass. Enough sand should be added to form a thin layer on the bottom of the container. Then crystals or chunks of any of the above salts should be placed in the solution, though not so many at once that cloudy solutions and heavy precipitates result. After the garden is grown, it can be saved by siphoning off the sodium silicate solution and replacing it with water.

Smelly Patches and scratch-and-sniff stickers

Smelly Patches are cloth patches backed with a heat-activated adhesive that can be applied to clothing or other objects. They are also marketed in the form of scratch-and-sniff stickers.

Smelly Patches contain a picture of a fruit such as apples, grapes, or strawberries and also smell like the fruit that is pictured. The smell is a result of natural fragrances or esters that are microencapsulated onto the surface of the Smelly Patch. Microencapsulation is a process in which substances such as inks or dyes, adhesives, cosmetics, pharmaceuticals, or fragrances are contained in microscopic capsules, 20 to 150 microns in diameter, that can be broken mechanically, electrically, or chemically to release the contents. The microcapsules consist of different materials, depending on the substance packaged and the method by which it is to be released. Gelatin is widely used as an encapsulating agent. The advantage of microencapsulation is that the capsules remain stable and inert until broken down.

Flavors and fragrances may utilize a single ester or a mixture of esters and other substances. Some esters that smell like common materials are listed below. Esters are made by mixing an alcohol with an organic acid in the presence of concentrated sulfuric acid, which catalyzes the reaction.

Common esters used for flavors and fragrances

ester	smells like	prepared from
isoamyl acetate	bananas	isoamyl alcohol and acetic acid
ethyl butyrate	pineapples	ethanol and butanoic acid
benzyl acetate	peaches	benzyl alcohol and acetic acid
n-propyl acetate	pears	n-propyl alcohol and acetic acid
benzyl butyrate	flowers	benzyl alcohol and butanoic acid
methyl butyrate	apples	methanol and butanoic acid
isobutyl propionate	rum	isobutyl alcohol and propionic acid
octyl acetate	oranges	octanol and acetic acid
methyl anthranilate	grapes	methanol and 2-aminobenzoic acid