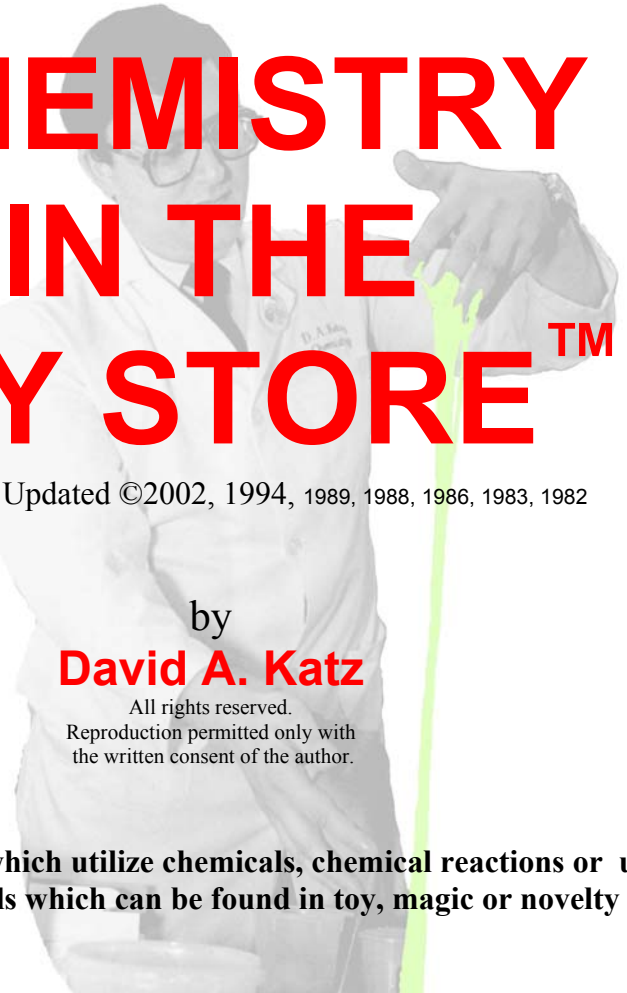


CHEMISTRY IN THE TOY STORE™

6th Edition, Updated ©2002, 1994, 1989, 1988, 1986, 1983, 1982

by

David A. Katz

A look at some toys which utilize chemicals, chemical reactions or unique properties of materials which can be found in toy, magic or novelty stores.

David A. Katz
Chemist, Educator, Science Communicator, and Consultant
133 N. Desert Stream Dr., Tucson, AZ 85745, USA
Voice/Fax/Message: 520-624-2207 Email: dakatz45@msn.com

PART II: Ballons, Rubber, Shrinky Dinks, Silly Putty, Slime and Related Polymeric Materials

BALLOONS/RUBBER

Another common item in toy stores are balloons. They are usually composed of rubber and come in a multitude of colors, shapes, and sizes. Natural rubber is a polymer of isoprene (2-methyl-1,3-butadiene) in the form of folded polymeric chains which are joined in a network structure (see Figure 6) and have a high degree of flexibility. Upon application of a stress to the balloon material, such as inflating it, the polymer chain, which is randomly oriented, undergoes bond rotations allowing the chain to be extended or elongated (see Figure 7). Upon removal of the stress, the chain will fold up to its previous configuration. The fact that the chains are joined in a network allows for elastomeric recoverability since the cross-linked chains cannot irreversibly slide over one another. That is, the rubber returns to its previous shape. The changes in arrangement are not constrained by chain rigidity due to crystallization or high viscosity due to a glassy state. Also, the polymeric material that makes up the balloon is porous, as evidenced by the balloon deflating over a period of time.

An interesting demonstration of some of the properties of the rubber material that composes the balloon is the needle-through-the-balloon trick. For this, one needs a large needle about 35-50 cm long (Needles about 45 cm [18 inches] long are available from magicians' supply stores or from an upholstery shop.) and some good quality balloons. The balloon should be inflated to about two-thirds its maximum size, and the end tied in a knot. Wipe the needle with a cloth containing a small amount of oil, allowing the needle to slide through the rubber easier. Starting at the end of the balloon, where the rubber is thicker and under less stress, slowly push the needle into the balloon. If the needle is sufficiently sharp and smooth, it will not tear the rubber, but will slide between the polymer chains, allowing them to stretch around the needle. The needle should then be pushed through the balloon until it comes through the other side near the knotted end. The needle can then be withdrawn or pushed completely through the balloon leaving two small holes where it passed through. (The rubber does not make a perfect seal in those spots.) After showing that the balloon is intact, the balloon is tossed into the air and popped with the needle to hide the small holes from the audience.

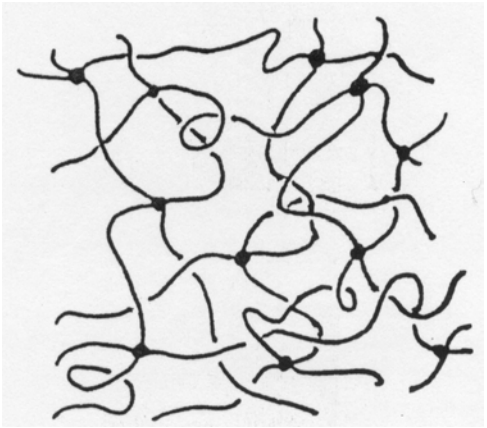
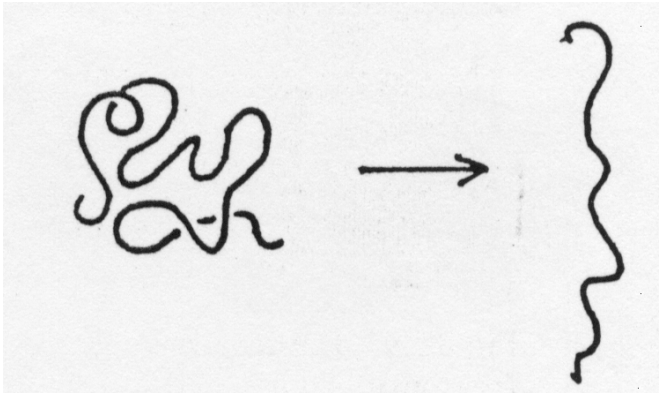


Figure 10. Schematic sketch of a typical elastomeric network



.Figure 11. Elastic deformation of a rubber chain.

Rubber latex, available at craft stores, hobby shops, or from Flinn Scientific, Inc., can be used to make a rubber ball. Dilute 20 mL of latex with 20 mL water, stir and add 20 mL of vinegar. Wash the rubber mass under water in a small bucket, squeezing and turning it to shape it into a ball.

A novel application of rubber is in Stretch Armstrong™ marketed by Cap Toys (originally manufactued by Kenner Toys) (See Figure 12) and Drastic Elastic™ from Just Toys, Inc. These consist of action figures approximately 15 inches high that can be stretched up to four or five feet in length. According to a representative from Cap Toys, the skin of the Stretch Armstrong™ figure is composed of rubber latex. The body is filled with a material made from a boiled corn syrup with some moisture removed so that it forms a gel with some flow characteristics and with some memory properties. Thus, when stretched and released, the figure returns to its original shape by elastomeric recovery of the rubber skin.

Other variations of Stretch Armstrong™ are Vac-Man™, marketed by Cap Toys, and Electronic Stretch Screamers!™ marketed by Manley Toy Quest. Vac-Man™ is a stretchable figure with a tgough rubber body filled with ground up corn cobs. Vac-Man™ comes with a hand operated vacuum pump and has a valve in one ear where the pump connects. While stretching Vac-Man™, one can pump the air out of the inside of its body effectively "freezing" it in its stretched position. A release valve allows air to reenter Vac-Man's™ body. An Electronic Stretch Screamers!™ is similar to Stretch Armstrong™ and Vac-Man™, but only the upper torso of the body stretches. That section is of the body is filled with solid particle-type filler and an electronic "voice box". When stretched, a Electronic Stretch Screamers!™ will scream or speak a message.

Figure 12. A Stretch Armstrong™ action figure.

SHRINKY DINKS*

Shrinky Dinks* consist of sheets of plastic, usually with pictures of cartoon characters, dolls, or designs printed on them. They have also been available in 8 inch by 10 inch blank sheets. Colored pencils or permanent markers are used to color the preprinted pictures or to draw pictures or diagrams on the blank sheets and then the pictures can be cut out or cut into any desired shape. The material is placed in a 163°C (325°F) oven and within 4 minutes will shrink to about 1/3 its size with all dimensions in the same ratio as the unshrunk piece.

Shrinky Dinks* is a bioriented polystyrene film (See Figure 13) that has been extruded under stress. Upon heating to 163°C (325°F), the film exhibits what is called a "memory effect", softening and shrinking to its original pre-stressed size. The material will shrink to 1/3 its size and will become about 9 times thicker.

Shrinky Dinks* sheets are available in both frosted and clear sheets. Both are composed of the same material. Frosting is accomplished by rubbing the sheet with fine sandpaper. This makes the surface suitable for writing or drawing on it with colored pencils. The newest version of Shrinky Dinks® comes with its own oven for shrinking the plastic sheet.

Other versions of shrinking plastic sheets now includes a shrinking sheet that can go through a Laser or InkJet printer. This material is sold by Flinn Scientific.

Many plastic items that have been softened and stretched or blown into other shapes also exhibit a memory effect. Some examples are 2-Liter plastic soda bottles, and some plastic lids used on containers for deli-style foods in the markets.

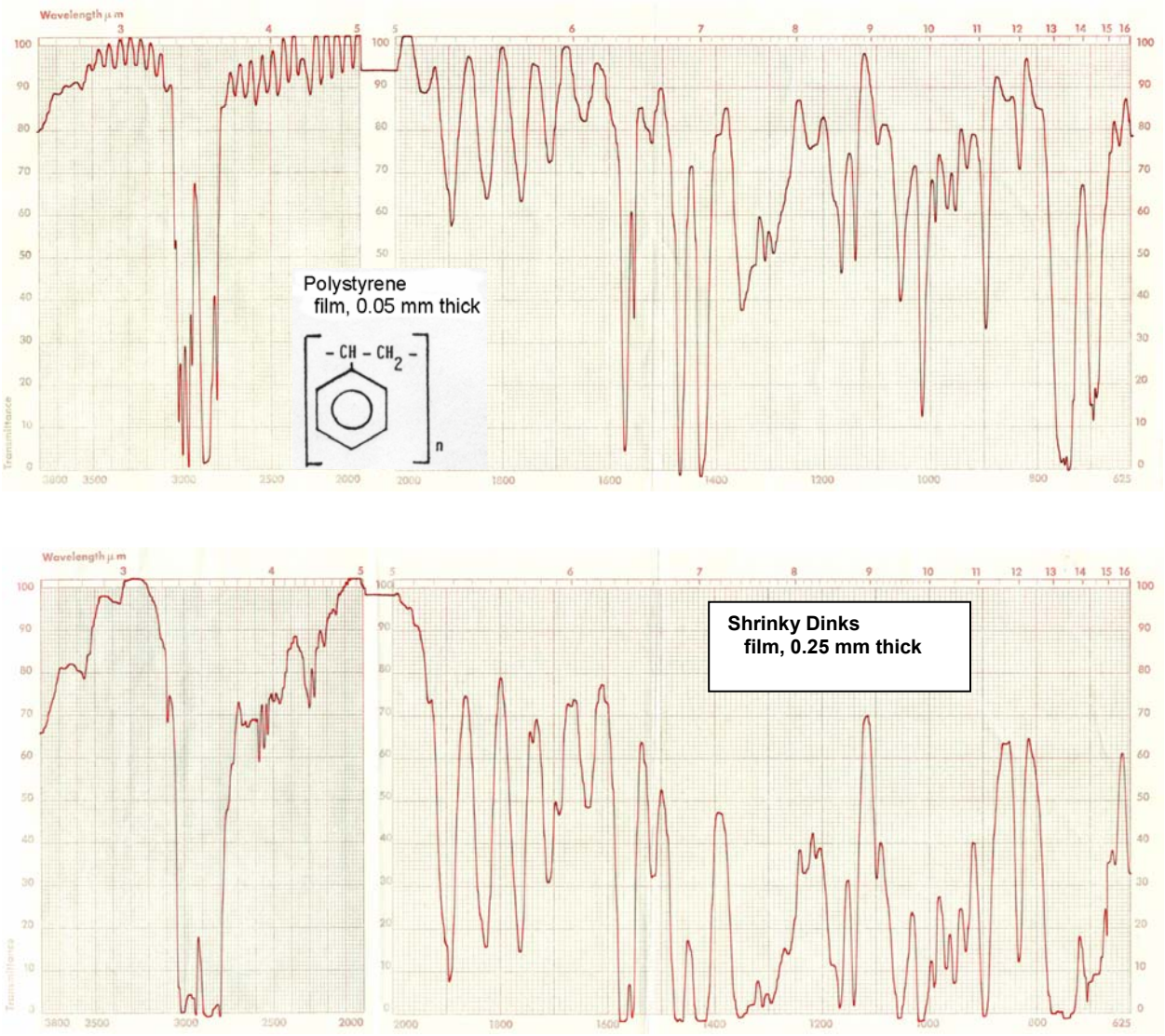
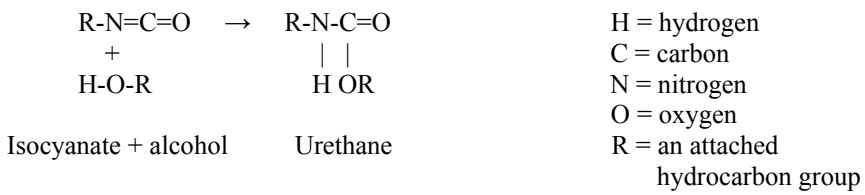


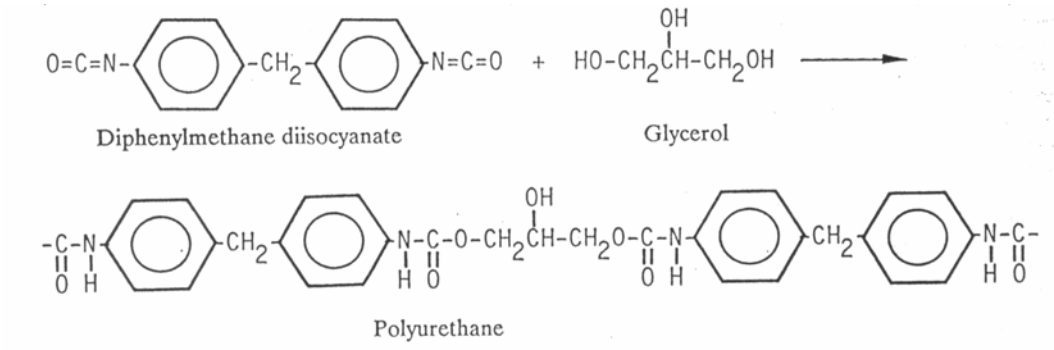
Figure 13. The infrared spectrum of polystyrene film (top). The infrared spectrum of Shrinky Dinks* (bottom). All infrared spectra were run on a Pye Unicam SP1000 Infrared Spectrophotometer.

CRAFT CAST* (POLYURETHANE FOAM)

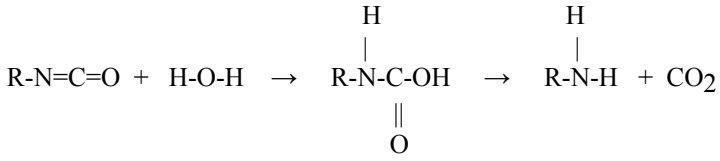
Craft Cast* is a two-part liquid material that, when mixed in equal amounts, produces a rigid polyurethane foam that can be used to make mushrooms, castings of objects, for insulating and soundproofing, or other craft uses. Part A consists of a polymeric diol or triol (glycerin is usually used), a blowing agent, a silicone surfactant, a catalyst, and a Freon (trichlorofluoromethane). Part B contains a polyisocyanate (diphenylmethane diisocyanate). Upon mixing, a polymerization reaction occurs in three directions leading to a large molecule that is rigidly held into a three-dimensional structure. At the same time, the small amount of water present causes a decomposition of some of the isocyanate and the evolution of carbon dioxide which results in the foaming. The freon, which boils at 23.7°C (75°F), is vaporized by the heat of the reaction and also contributes to the foaming. The carbon dioxide and Freon bubbles create pores in the viscous mixture as the foam sets into a rigid mass. The cell size and structure of the foam is controlled by the silicone surfactant. A generalized reaction scheme is:



The actual reaction of the diphenylmethane diisocyanate to form polyurethane with glycerol is:



The generalized reaction forming the carbon dioxide is:



Part B, which contains diphenylmethane diisocyanate (MDI), is toxic as well as an irritant to the skin and eyes. It may also cause an allergic response. This material should only be used with good ventilation.

A variation of the polyurethane foam is a product called String Confetti manufactured in France. This is an aerosol spray producing instant streamers of colored foam that utilizes a propellant as a blowing agent. The String Confetti material becomes hardened on exposure to air.

SILLY PUTTY®

Silly Putty® is a silicone polymer that comes packaged in small egg-shaped containers and is usually pink in color. Some forms of Silly Putty® contain phosphorescent material (usually zinc sulfide) that will allow it to glow in the dark. Silly Putty is also available in a range of fluorescent colors.

Silly Putty® was first made in 1941, by chemists working for General Electric, as an unsuccessful attempt to prepare a synthetic rubber based on silicon, the element present in sand (silicon dioxide). Although this "bouncing putty" had no industrial value, a salesman who frequented the laboratory would give out samples of this unusual material to his clients. Eventually, Silly Putty® was marketed as a toy.

Silly Putty® is a non-Newtonian fluid which has dilatant properties. That is, instead of its viscosity (measured resistance to flow) being dependent only on temperature, as described by Sir Isaac Newton in his Law of Fluid Friction, the viscosity can be altered by shearing it through stirring, pouring, or spreading. Thus, Silly Putty® tends to dilate (or expand) when sheared resulting in an increased viscosity under stress. Some other examples of stress-thickening fluids are quicksand, wet sand on the beach, some printers' inks, starch suspensions, and Slime®.

Silly Putty® has some unique properties:

a) Under low stress, such as slowly pulling the Silly Putty® apart, the putty flows forming thin strands.
b) Under high stress, such as a sharp pull, the putty breaks.
c) If rolled into a ball and dropped, the putty will bounce.
d) If the ball of putty is placed on a table top and hit with the hand, the ball will hardly be deformed. If hit with a hammer, the putty will shatter. Yet, if it is squeezed gently, the ball will flatten.
e) If the putty is stuffed through a tube, it will swell as it emerges from the open end. This is known as die-swell. (This works well with freshly prepared putty as the putty tends to harden with age.)

When Silly Putty® is prepared in the laboratory, initially, it is a clear, colorless to slightly yellow material. Within one week it cures to a white solid with properties closer to the commercial Silly Putty® which contains fillers to make it stiff. As it is used, it will pick up foreign matter and become gray in color slowly improving its properties.

An interesting property of Silly Putty® is that it picks up pictures from many newspapers or the comic sections. This is a function of the older type of ink used in newspapers. The ink is composed of mineral oil and carbon black or colored pigments. These inks do not dry readily as demonstrated by rubbing a finger over them. When Silly Putty® is placed on the newsprint, the pigment is transferred to the excess silicone oil in the putty.

SLIME®

Slime® and Nickelodeon Green Slime, products of the Mattel Toy Corporation, are reversible cross-linking gels made from Guar gum. The cross-linking is accomplished by the addition of sodium borate, $Na_2B_4O_7$, commonly called borax. Like Silly Putty®, Slime® is a non-Newtonian fluid that is dilatant. Its properties are also similar:

a) Pull slowly and the Slime® will flow and stretch. If careful, you can form a thin film.
b) Pull sharply (high stress) and the Slime® breaks.
c) Pour the Slime® from its container then tip the container upward slightly, the gel will self siphon.
d) Cut the pouring stream with a scissors.
e) Put a small piece of Slime® on a table top and hit it with the hand, there is no splashing or splattering. Throw a small piece onto a hard surface, it will bounce slightly.
f) Stuff the Slime® through a tube, die swell occurs as it emerges.

Guar gum, the main component of Slime®, is a vegetable gum from the guar plant, *Cyamopsis tetragonolobus*, a leguminous plant which resembles a soybean plant. It is composed of a straight chain of D-mannose with a D-galactose side chain at approximately every other mannose unit (see Figure 14). The mannose-galactose ratio is about 2:1, and the molecular weight of guar is approximately 220,000-250,000. It is used as a protective colloid, stabilizer, thickening and film forming agent for cheese, salad dressing, ice cream, and soups; as a bind and disintegrating agent in tablet formulations; in suspensions, emulsions, lotions, creams, and toothpastes.

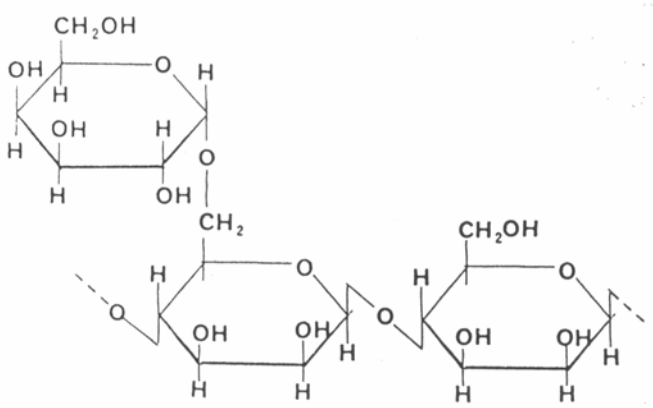


Figure 14. The Structure of guar. The mannose units are ß-(1-4) linked and the single D-galactose units are joined to this chain by à-(1-6) linkages

Slime-type materials are also available as Weird Ball Sludge® (in Lucky Yellow, Putrid Purple, and Ghastly Green colors) from Mel Appel Enterprises, Inc., as purple Ecto-Plazm® from Kenner Parker Toys Inc, as Living Nightmare® Body Fluids from Fun World, as Teenage Mutant Ninja Turtles Retromutagen Ooze from Playmates Toys, as Toxic Crusaders™ Toxic Waste™ from Playmate Toys, as Dinosaur Ooze™ from Imperial Toys, and other similar materials.

Slime®, originally sold as a separate toy, was incorporated into a number of toy kits by Mattel. One of these was the Slime Pit® which was used with Masters of the Universe® toy action figures to turn them into Slime monsters. Other variations of this toy include the Teenage Mutant Ninja Turtles Flushomatic™ High-Tech Toilet Torture Trap! and the Hot Wheels Attack Pack™ Slime-inator™ Vehicle. (See Figure 15)

Another application of Slime® was Glow-In-The Dark Alien Blood® in Mattel's Mad Scientist® Dissect-An-Alien® Kit. This version of Slime® contained a phosphorescent material (zinc sulfide) that glows in the dark after being exposed to light. In the Dissect-An-Alien® Kit, a plastic alien with a clear, colorless body cavity (see Figure 16) is packed with plastic body organs such as a Stumukus, Mad Bladder, Spleenius, and Liverot, among others, and the Alien Blood® is used to fill in open spaces around the organs. Later, when the alien is dissected, body parts are removed dripping in Alien Blood®.

Mattel also marketed Alien Blood® Monster Kits. These were plastic creatures filled will Alien Blood® which oozed from their eyes, mouth, or nose when they were squeezed.

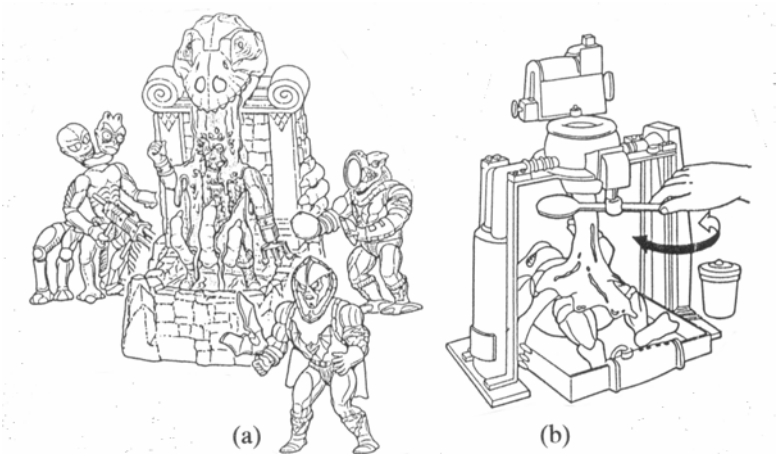


Figure 15. a) A Slime Pit® with Masters of the Universe action figures and b) The Teenage Mutant Ninja Turtles Flushomatic™.

Figure 16. Dissect-An-Alien

Another toy is The Glooper Game® which consists of a gun-type of device that shoots small, single globs of gloop, a Slime-type of material, up to 25 feet (only up to 10 feet in this author's tests). For this toy, the gloop is contained in non-reloadable cartridges.

A material similar to Slime® can be made from a polyvinyl alcohol solution or water soluble polyvinyl alcohol bags and borax. This material is a colorless reversible cross-linking gel that has the same properties as Slime. This material can be colored by using food coloring. Polyvinyl alcohol is a water soluble polymer. Thin films of polyvinyl alcohol are one of the materials being studied for use as a environmental degradable packaging material.

NICKELODEON™ GAK™ SPLAT

Nickelodeon™ Gak™ Splat, a product of Mattel, Inc., is a non-Newtonian fluid made from guar gum, that has properties between Silly Putty and Slime . Gak™ is thick and will stretch and break like Silly Putty , but it will

flow and is cold to the touch like Slime . The Gak™ can be twisted and squeezed and different colors can be mixed. It is stored in an amoeba shaped plastic container and will make rude noises when stuffed in the Splat.

A variation of Gak™ called Solar Gak™ is available that changes color in light and fades rapidly in the shade. Solar Gak™ is available in blue, green, and purple. The best color change is obtained with direct sunlight as opposed to light from incandescent or fluorescent lamps. At this writing, the identity of the material causing the color change is not known.

There are several Gak™ toys available. A Gak™ Inflator which is used to pump Gak™ up into bubbles and then burst it. A Gak™ Vac which sucks Gak™ up and spits it out. A Gak™ Copier in which Gak™ is used to transfer drawing made with a water soluble felt-tip pen from a small white-board or paper to itself and then to another sheet of paper.

A variation of Gak™, called Flubber™ is available from Cap Toys. Slightly stiffer than Gak™, Flubber™ appears to be marketed specifically for producing loud, gross, anti-social noises when it is pushed into its container.

Gak™ and Flubber™ will dry out during use. To extend the life of these materials, dip them in water before storing them overnight in their air-tight containers.

OOZ BALL™

An Ooz Ball®, a product of Ritam International, Ltd., is an elastic non-Newtonian fluid that comes packed in a small plastic pod called The Pod of Intergalactic Ooze®. A representative from Ritam International explained that it was composed of thirteen ingredients using a talcum powder base. There is some polymerization in the Ooz Ball®, but all ingredients are water soluble.

The Ooz Ball®, if pulled slowly, can be stretched to "hundreds of feet" forming thin strands. It can also be stretched to form a thin web. If dropped, an Ooz Ball® will bounce, but if left sitting on a surface, it quickly settles into puddle.

During use, an Ooz Ball® will dry out and should be re-moistened using a few drops of water or oil-free moisturizer. Since it absorbs water very slowly, it should be held for a few seconds under the faucet and then stored in its pod for several hours or overnight.

SUPER LIQUID (MOON BLOB)

Super Liquid, also known as Moon Blob, is composed of a material called poly(ethylene oxide) or Polyox. This material is a water-soluble polymer that is nonionic and depending on the specific polymer, has a molecular weight between one-hundred-thousand and five million. The structure of the resin is

$$(\text{-O-CH}_2\text{-CH}_2\text{-})_n$$

A water solution of poly(ethylene oxide) is a non-Newtonian fluid (see discussion under Silly Putty) in which the viscosity decreases under stress. These types of fluids are called thixotropic liquids. Some examples are margarine, catsup, mayonnaise, and ball-point pen ink.

Poly(ethylene oxide) solutions are also elastic. Thus, depending on the type of stress applied, the polymer molecules can be compressed or expanded. This is often referred to as a viscoelastic fluid.

Some of the properties of Polyox solutions are:

a) A 0.75% solution will self-siphon if the upper container is tipped upward while pouring.
b) A 0.75% solution is elastic and will stretch up to about 1 meter (about 3 feet) if quickly pulled upward. Upon release the liquid will snap back into its container without splashing.
c) A 1% solution poured into a funnel will exhibit die-swell as it emerges from the from the bottom of the funnel.
d) A 2% - 2.5% solution will exhibit elastic recoil if stirring in a circular motion is suddenly stopped. The liquid will recoil into its upper container if a pouring solution is cut with a scissors about 5 cm below the lip of the container.
e) A 2% - 2.5% solution will climb up a straight stirring rod turning at a speed of about 5 revolutions per second. This is known as the Weissenberg effect:
f) A 0.01% solution will reduce friction of liquid flow through a tube or pipe using a head of water about 1 meter with a piece of capillary tube 8 cm long by 1 mm bore attached to the liquid supply.

MAD SCIENTIST® MONSTER LAB®

The Mad Scientist® Monster Lab® from Mattel, Inc., allowed the user to "make disgusting, gross monsters...then sizzle the flesh off their bones!" The set included a plastic Monster Vat, plastic monster "Bones", Green Monster Flesh®, Secret Froth Formula, and Powdered Flesh Remover for dissolving monsters.

The green Monster Flesh® Compound is modeling material, similar in texture to Play Doh® (manufactured by Kenner Products), but not as water soluble since it is composed of silica gel rather than flour. The Monster Flesh® is mixed with Secret Froth Formula (sodium bicarbonate or baking soda) and molded onto a monster skeleton. The monster is then placed in a plastic tank containing a water solution of Monster Flesh® Remover (citric acid, - commonly sold as sour salt in the supermarket). The reaction between the sodium bicarbonate and citric acid - produces sodium citrate and carbon dioxide resulting in bubbles of gas ("sizzle") and breaking apart of the Monster Flesh® into small pieces. Lemon juice or vinegar can be substituted for the citric acid.

TERMINATOR™ 2 BIO-FLESH REGENERATOR

The Terminator™ 2 Bio-Flesh Regenerator, from Kenner , based on the movie Terminator 2: Judgment Day™, allows the user to mold and destroy their own Terminator™.

The user is supplied with two Terminator™ Endoskeleton Action Figures which are placed in a mold, slipped into a plastic base unit, and then injected with Bio-Flesh to produce Terminators™. The Bio-Flesh "skin" can be torn off the Terminators™ in "battles".

Terminator™ 2 Bio-Flesh is the material that a dentist may use in making a mold of a patient's teeth. It is composed of potassium alginate (a seaweed derivative), silica in the form of diatomaceous earth and cristobalite (a silicon dioxide mineral), tetrasodium pyrophosphate (to provide cross linking to form a gel-type material), and some coloring material.

SUPER BALL®/STUPID BALL

A Super Ball® is a highly resilient ball which was originally manufactured by the Wham-O Mfg. Co. Similar products are marketed under names such as High-Bounce Ball or similar names by other manufacturers.

A Super Ball® is a ball or sphere having extremely high resilience factor in excess of 90% and a high coefficient of friction. These two qualities cause the ball to react in an extraordinary and unpredictable manner when bounced or struck. Thus, any spin applied to the ball will be accentuated when it rebounds from a hard surface.

The Super Ball® has a specific gravity of 1-1.3 (The specific gravity of water is 1.0). It is composed of about 100 parts polybutadiene, 0.5 to 15 parts sulfur vulcanizing agent, and 5 to 15 parts of filler such as hydrated silica, carbon black or lithium oxide. The sulfur vulcanizing agent is added in excess of that in products such as automobile tires (which contain about 3 parts sulfur) to produce cross-linking between polybutadiene chains resulting in the high resiliency. The ball is molded at a pressure of between 500 and 3,000 p.s.i. for 10 to 30 minutes at a temperature of 285-340°F (140-171°C). This produces the Super Ball® with the properties described above. In addition, it has been found that these balls also exhibit an ability to conserve energy. That is, when bounced, the ball will dissipate very little of the energy imparted to it in the form of heat.

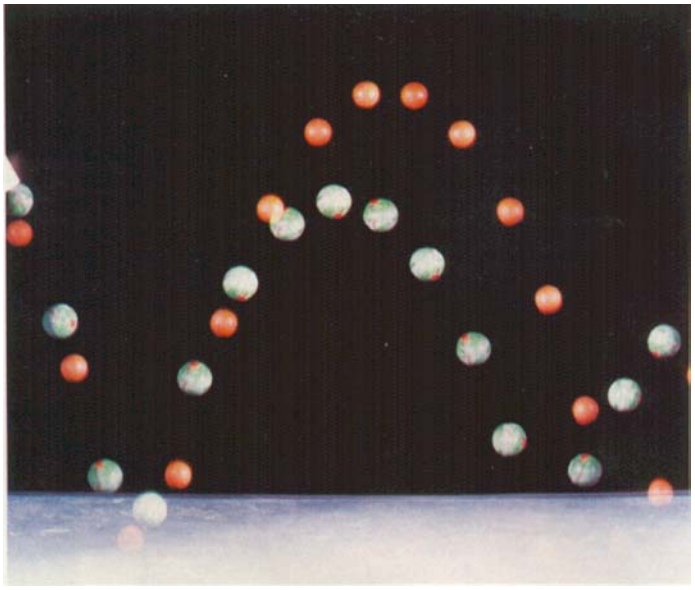


Figure 17. A Super Ball® bounces higher than an ordinary rubber ball.

The Stupid Ball was first made by Phillips Petroleum Co. from their Solprene® Elastomer. Non-bounce balls may be composed of several different materials. Common materials used are a block co-polymer of poly(styrene-butadiene) or a block co-polymer of poly(vinyl-butadiene). This material has a specific gravity that is higher than that of a smart ball (one sample had a specific gravity of 1.17 compared to a Super Ball® at 1.03) and a structure that has a low resiliency and absorbs energy. Thus, when the ball is dropped, it does not bounce.

These properties make the Stupid Ball material useful for a number of applications. The poly(styrene-butadiene) co-polymer is used in automobile tires where it helps to absorb some of the bumps encountered on the highway. This type of material has also found use in lining the ballistic containers used by bomb squads (these look like big trash cans). Should a bomb explode, this material will absorb a significant amount of energy.

A BAD CASE OF WORMS®, MAGIC OCTOPUS AND WALL WALKERS

A Bad Case of Worms®, marketed by Mattel Toy Corp., consisted of a small plastic case, resembling a suitcase, containing two yellow colored plastic “worms”. Worms are a soft, limp plastic that is tackified (made sticky). The plastic is also washable so that the surface can be restored without losing the tackifier. The plastic is an isoprene polymer, similar to the Stupid Ball material described earlier, manufactured by Shell Petroleum Co.

Similar to A Bad Case of Worms®, are the Magic Octopus and various Wall Walkers in the shape of spiders, other insects, bats, and skeletons. These are sticker than the Worms, and have better adhesion to surfaces. Some may contain excess plasticizer and leave an “oily” residue on the surface that may be difficult to remove.

To use a Worm or a Wall Walker, one throws it against a smooth, clean surface, such as a wall, to which it will stick. After a while, the Worm or Wall Walker will slowly release from the wall and “crawl” down the wall. The rate of motion will depend on the cleanliness of both the wall and the Wall Walker’s surface. Once the Wall Walker no longer adheres to a surface, it is washed with soap and water to restore its tackiness.

There are also small automobile-type vehicles called Tacky Wacky® Vertical Racers. These have a Wall Walker-type of material for a roller that allows the Tacky Wacky® to race down a vertical race track made of coated paper. Other variations are the Wacky Tacky™ Acrobat or the Magic Wall Stunter™ which have hands and feet composed of the Wall-Walker-type of material that allows them to tumble down a wall.

Variations of the Magic Octopus and Wall Walkers are the Frog and the Snapper Hand. These are highly tackified and stretchy soft rubber bands shaped as a Frog's tongue attached to a frog shaped handle or a band with a hand shaped end. These are cast out like a fishing line toward a small object which will stick to the tacky end and be retrieved when the band snaps back. There is also another variation called Boogers™ from the planet Nose from Toy Headquarters, Inc. Packed in plastic nose-shaped Nose Cones, these green colored creatures will stick to walls and other surfaces.

Different plastics are used to make Wall Walkers. They may be composed of an isoprene polymer (a synthetic rubber), styrene-butadiene copolymer, or a poly(styrene-butylene-ethylene) copolymer along with tackifiers, and coloring materials. In some cases, wall walkers glow in the dark. This is due to the addition of a phosphorescent zinc sulfide.

GLUE BALL®

A Glue Ball®, manufactured in Taiwan for Hyman Products Inc., consists of two very sticky half spheres that can be used independently or stuck together as a single ball. The Glue Ball® can be stretched, squeezed, or squashed and it will return to its original shape. It will stick to many surfaces such as windows, doors, or walls and will "walk" down a vertical surface. Similar toys are sold under the name of Smartball™, Tacky Wacky Wall Roller™, Jelly Ball, and others.

The Glue Ball® is made of a gel composed of an intimate melt blend admixture of poly(styrene-ethylene-butylene-styrene) triblock copolymer with high levels of plasticizing oil. The resulting transparent gel will not tear or crack under stretching or compression and has the property of elastic memory recovering and retaining its original molded shape after extreme deformations such as high velocity impact and stress conditions.

During use, the Glue Ball® will pick up dirt and other materials on its surface. Its original texture can be restored by washing it with soap and water.

A variation of the Glue Ball®, called Living Ice®, was available in Mattel's Monster Lab® or separately in toy stores. This was a mixture of approximately one-third poly(styrene-ethylene-butylene-styrene) triblock copolymer with two-thirds plasticizing oil. This gel is not as elastic as a Glue Ball®, tearing apart easily at room temperature, but it does reversibly cross-link, joining together without evidence of tearing. Living Ice® is not tackified.

Living Ice® can be used like Slime® if warmed in the hands or under warm water. It becomes gooey and can be stretched. If thrown against a smooth surface such as a window, it will stick to the surface. If cooled in a refrigerator or freezer, Living Ice® will bounce like a rubber ball.

SUPER ELASTIC BUBBLE PLASTIC

Super Elastic Bubble Plastic is manufactured by the Wham-O Mfg. Co., with similar materials usually referred to as "plastic bubbles" made by other companies.

Plastic bubbles are composed of polyvinyl acetate (See Figure 18 and 19), acetone, pigments and plastic fortifiers. In use, a small amount of the plastic material is placed on the end of a plastic straw and a bubble is formed by blowing through the straw. When the bubble is of sufficient size, it can be pinched off from the straw and saved. During the process, the acetone evaporates from the plastic leaving a polyvinyl acetate film.

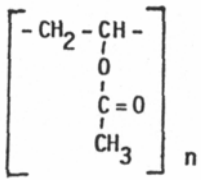


Figure 18. A polyvinyl acetate structural unit

SAFETY NOTE: Plastic bubble material is flammable and should not be used near flames. In high concentrations, acetone vapors are toxic, causing dizziness, narcosis (a "high") and coma. Plastic bubbles should be used with adequate ventilation.

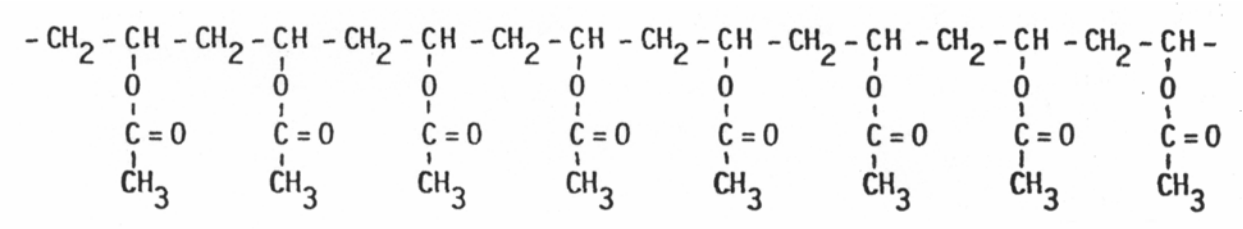


Figure 19. Polyvinyl acetate

MAGIC EGG / GROW CREATURE

The Magic Egg, also called Water Wonder Creatures and Grow Creatures, was named for its egg-shaped plastic container that contained a small plastic creature that swells up to 200 times its original size when placed in water. The creature is composed of a superabsorbant material is commonly called a "Super Slurper".

Superabsorbants were originally developed by the United States Department of Agriculture in 1966. This material consisted of a graft copolymer of hydrolyzed starch-polyacrylonitrile (polyacrylonitrile is commonly known as Acrilan, Orlon, or Creslan). The intended use was for additives for drilling fluid in off-shore secondary oil recovery operations and as agricultural thickeners. These materials were followed by synthetic superabsorbants that are polyacrylic and polyacrylonitrile based. Some of these materials are capable of absorbing up to 2000 times their weight of distilled water.

The Magic Egg creature is composed of a starch-hydrolyzed polyacrylonitrile superabsorbant mixed with glycerin or ethylene glycol. The resulting firm gel has a rubbery texture and is very strong and resilient. This material can absorb about 300 to 400 times its weight in distilled water. The process is reversible and, on standing in air, the Magic Egg creature will shrink almost to its original size on drying. It can be grown and dried many times.

A recent application of "Super Slurper" is in the liners of Pampers® disposable diapers. Under this application, the polymer gel can absorb up to 90 times its weight in liquid.

Another toy that utilizes superabsorbant material was Mad Scientist® Glowing Glop® from Mattel, Inc. This set contains packets of Instant Glop® (3 grams of super slurper), and Powdered Light, a phosphorescent material (3 grams of zinc sulfide), that are mixed with water to make an instant Glowing Glop®. The glop is actually a gel-like material consisting of beads of superabsorbant filled with water. The superabsorbant used is capable of absorbing over 800 times it weight of distilled water. It can be found in nursery supply stores under the names of Water Lock or Water Grabber.

Another type of superabsorbant material is a sodium polyacrylamide material sold under the name of Soil Moist in nursery supply stores or Ghost Crystals by Flinn Scientific. Ghost crystals form larger “chunks” of the superabsorbant gel.