Triboluminescence!

What happens when you crush a Wint-O-Green Lifesaver in a dark room?

***** Here's the short explanation (from *Earth & Sky.com*):**

Wint'O'Green Lifesavers produce an example of what's called triboluminescence. It's a two step process. Step one happens when sugar crystals break -- they tend to split along planes with positive charges on one side and negative on the other. As the pieces of candy move apart, the charges want to get back together, so they jump across the air like tiny lightning bolts.

Because WintOGreen Lifesavers are naturally fluorescent, now step two can take place. The "lightning bolts" give off invisible ultraviolet light -- which cause the fluorescent Lifesavers to give off their own visible fluorescent light. You may have seen something like this in mineral displays under black lights. The black light shines in the ultraviolet, causing the minerals to fluoresce, or glow. In the case of WintOGreen Lifesavers, the fractured sugar crystals generate the ultraviolet -- and the wintergreen molecules absorb it. the result is that, as you chomp your candy, sparks fly.

***** Here's a more in-depth explanation (from *About.com*):**

Candy Triboluminescence: Glow-in-the-dark fun!

For several decades people have been playing in the dark with triboluminescence using wintergreen-flavored Lifesavers candy. The idea is to break the hard, donut-shaped candy in the dark. Usually a person looks in a mirror or peers into a partner's mouth while crunching the candy to see the resulting blue sparks.

Triboluminescence is light produced while striking or rubbing two pieces of a special material together. It is basically light from friction, as the term comes from the Greek tribein, meaning "to rub," and the Latin prefix lumin, meaning "light". In general, luminescence occurs when energy is input into atoms from heat, friction, electricity, or other sources. The electrons in the atom absorb this energy. When the electrons return to their usual state, the energy is released in the form of light.

The spectrum of the light produced from the triboluminescence of sugar (sucrose) is the same as the spectrum of lightning. Lightning originates from a flow of electrons passing through air, exciting the electrons of nitrogen molecules (the primary component of air), which emit blue light as they release their energy. Triboluminescence of sugar can be thought of as lightning on a very small scale. When a sugar crystal is stressed, the positive and negative charges in the crystal are separated, generating an electric potential. When enough charge has accumulated, the electrons jump across a fracture in the crystal, colliding with and exciting electrons in the nitrogen molecules. Most of the light emitted by the nitrogen in the air is ultraviolet, but a small fraction is in the visible region. To most people the emission appears bluish-white, although some people discern a blue-green color (human color vision in the dark is not very good).

The emission from wintergreen candy is much brighter than that of sucrose alone because wintergreen flavor (methyl salicylate) is fluorescent. Methyl salicylate absorbs ultraviolet light in the same spectral region as the lightning emissions generated by the sugar. The methyl salicylate electrons become excited and emit blue light. Much more of the wintergreen emission than the original sugar emission is in the visible region of the spectrum, so wintergreen light seems brighter than sucrose light.

Triboluminescence is related to piezoelectricity. Piezoelectric materials generate an electrical voltage from separation of positive and negative charges when they are squeezed or stretched. Piezoelectric materials generally have an asymmetric (irregular) shape. Sucrose molecules and crystals are asymmetric. An asymmetric molecule changes its ability to hold electrons when squeezed or stretched, thus

altering its electric charge distribution. Asymmetric, piezoelectric materials are more likely to be triboluminescent than symmetric substances. However, about a third of known triboluminescent materials are not piezoelectric and some piezoelectric materials are not triboluminescent. Therefore, an additional characteristic must determine triboluminescence. Impurities, disorder, and defects are also common in triboluminescent materials. These irregularities, or localized asymmetries, also allow for electrical charge to collect. The exact reasons why particular materials show triboluminescence can be different for different materials, but it is probable that crystal structure and impurities are primary determinants of whether or not a material is triboluminescent.

Wint-O-Green Lifesavers aren't the only candies that exhibits triboluminescence. Regular sugar cubes will work, as will just about any opaque candy made with sugar (sucrose). Transparent candy or candy made using artificial sweeteners will not work. Most adhesive tapes also emit light when they are ripped away. Amblygonite, calcite, feldspar, fluorite, lepidolite, mica, pectolite, quartz, and sphalerite are all minerals known to exhibit triboluminescence when struck, rubbed, or scratched. Triboluminescence varies widely from one mineral sample to another, such that it might be unobservable. Sphalerite and quartz specimens that are translucent rather than transparent, with small fractures throughout the rock, are the most reliable.

There are several ways to observe triboluminescence at home. If you have wintergreen-flavored Lifesavers handy, get in a very dark room and crush the candy with pliers or a mortar and pestle. Chewing the candy while watching yourself in a mirror will work, but the moisture from saliva will lessen or eliminate the effect. Rubbing two sugar cubes or pieces of quartz or rose quartz in the dark will also work. Scratching quartz with a steel pin may also demonstrate the effect. Also, sticking/unsticking most adhesive tapes will display triboluminescence.

For the most part, triboluminescence is an interesting effect with few practical applications. However, understanding its mechanisms may help explain other types of luminescence, including bioluminescence in bacteria and earthquake lights. Triboluminescent coatings could be used in remote sensing applications to signal mechanical failure. One reference states that research is underway to apply triboluminescent flashes to sense automobile crashes and inflate air bags.

Additional Reading (web):

- Chemiluminescence Movie - This is a QuickTime movie of solution-phase chemiluminescence using hydrogen peroxide and a peroxylate ester.
- Impurities give crystals that special glow - Wu's article summarizes Sweeting's research on triboluminescence and discusses why some materials are triboluminescent.
- Triboluminescence - This is a brief description of how Wint-O-Green Lifesavers emit triboluminescence. There is a photograph of the blue light.
- Wintergreen Candy and other Triboluminescent Materials - Linda Sweeting at Towson University provides this in-depth look at triboluminescence.