THE ELECTRIC LIFE SAVER EFFECT

Wintergreen-candy research is sparking new interest in triboluminescence

By JANET RALOFF

Kids have been familiar with this spark-in-the-dark magic for years. First you lure a friend inside a closet. Closing the door, you wait five minutes or so — for the friend's eyes to adapt to the dark — then pop a few Wint-O-Green Life Savers into your mouth and begin chomping away. If all goes well, the friend is treated to tiny bright flashes emanating from your mouth.

Children have referred to this display as the electric Life Saver effect. To physicists it's just one of the more prosaic examples of triboluminescence (SN: 6/6/87, p.360) — light emitted by the friction between two materials. But to Linda M. Sweeting, it suggests a possible answer to some vexing questions about why certain crystals emit light as they're crushed. Her newest research, reported last month in Toronto at the Third Chemical Congress of North America, not only explains the candy spectacle but also indicates a possible general mechanism behind triboluminescence — a phenomenon first reported by Francis Bacon some 400 years ago.

It's long been known that sugar crystals emit light when crushed. In fact, spectra collected during the 1920s identified the source of sugar's light as miniature discharges of static electricity — essentially microlightning. The triboluminescence of wintergreen candy has also been known for a long time, although various problems have limited its spectral characterization. Sweeting, a physical organic chemist at Towson (Md.) State University decided to learn once and for all just what causes Wint-O-Green Life Savers and pink (wintergreen) Necco Wafers to flash when crushed.

For her experiments, she teamed up with Reginald F. Pippin III, a Towson undergraduate, and Patrick F. Moy, a chemist at EG&G PAR in Princeton, N.J. They began by crushing the commercial wintergreen candies with a glass rod in a Pyrex test tube. But "we had difficulties," Sweeting recalls, because a binder in the candy made it stick to the sides of the test tube. This scattered the candy's emissions, dramatically limiting how much light could reach the detector.

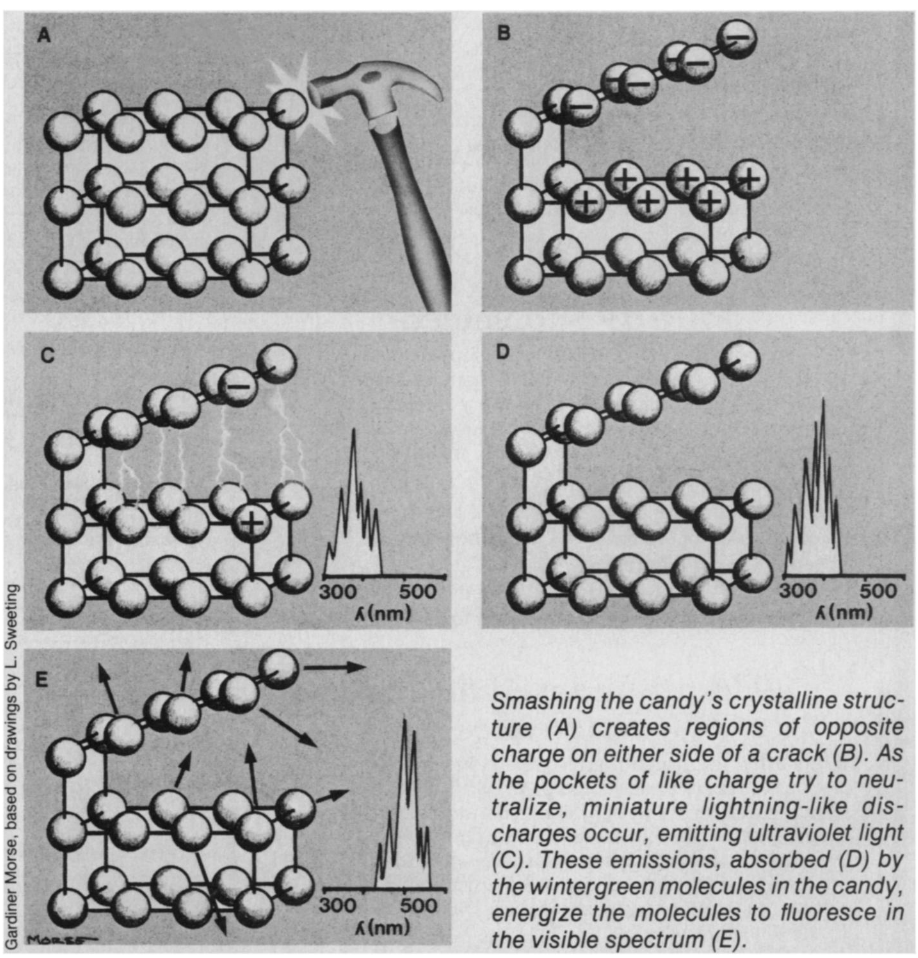
So Sweeting concocted imitation candies by mixing wintergreen flavoring with sugar. This time, when she smashed her candy with a glass rod, its intense spectra were readily detected by an array of more than 1,000 photocells. These emissions were then analyzed by a spectrometer.

Her data show the photoluminescent wintergreen absorbs the "lightning," emitted when the sugar is crushed, and then reemits it. And the greater the proportion of wintergreen in Sweeting's sweets, the greater the visible light show.

The lightning is produced when an asymmetric crystal — such as sugar — is cracked. These cracks create pockets of like charge, some positive and some negative. When the pockets get large enough, the system tries to neutralize itself. Essentially, electrons jump through the air to the pockets of positive charge. Along the way, those electrons collide with nitrogen molecules in the air, exciting their electrons into fluorescing. The same thing, on a much grander scale, occurs when the charge differential between clouds and the ground gets large enough to initiate lightning.

Though it's a fluorescent material, wintergreen won't glow unless it's irradiated with light at the proper wavelength. And it just so happens that the energy radiated by the sugar's discharge matches the wavelength of the wintergreen's absorption band.

Because much of the sugar-lightning's



Smashing the candy's crystalline structure (A) creates regions of opposite charge on either side of a crack (B). As the pockets of like charge try to neutralize, miniature lightning-like discharges occur, emitting ultraviolet light (C). These emissions, absorbed (D) by the wintergreen molecules in the candy, energize the molecules to fluoresce in the visible spectrum (E).

spectral energy is in the ultraviolet, it's not visible to the eye. But the wintergreen's fluorescence is in the visible part of the spectrum. So the more wintergreen there is, Sweeting found, the higher the proportion of sugar-lightning emissions that will be shifted to visible light.

Although she investigated the unexplained candy-flashing phenomenon "just because it was there," Sweeting later realized her findings point toward "something that could be important"—what lies behind the triboluminescence of other perplexing crystals.

Many asymmetric crystals create an electrical voltage when squeezed, pressed or crushed. Ones that don't—and many are triboluminescent — interest Sweeting. "Substituted anthracene," a molecule with appendages of carbons and oxygens coming off its three rings, creates one such crystal. What particularly intrigued Sweeting was that although it was triboluminescent, there was no sign of what might be energizing its glow. Microlightning, the most obvious explanation, was conspicuously absent.

Sweeting now says "the theoretical importance of the candy experiments is that it gives us a way to estimate how big the lightning would be, if it were there [in the substituted-anthracene case]." Using the formula she computed from the wintergreen candy as a gauge, she estimated the percentage of lightning that would have been needed to energize these anthracene-based compounds into glowing. And her calculations suggest it "would be on the order of 0.005 percent [of their triboluminescent display]—way too little to see with current technologies."

So the fact that she didn't see lightning in the substituted anthracene's triboluminescence no longer means it's not there. And that's sweet news to one who has been hunting it so long. □

Continued from p.75

atric diagnoses, including antisocial personality (marked by rebelliousness, family and social problems and law breaking), anxiety, depression and schizophrenia.

For now, though, a direct connection between heredity and alcoholism is a "missing link," says anthropologist Dwight B. Heath of Brown University in Providence, R.I. The question of who is at risk is a sticky one, notes Heath, who studies cultural and social influences on alcohol use. It may be true, he explains, that half of hospitalized alcoholics have alcoholic relatives and one out of four sons of alcoholics become alcoholics themselves, but this says nothing about any individual's risk of alcoholism.

"Certainly there are more sons of alcoholics who do not have drinking problems than who do, just as there are many problem drinkers who have no alcoholic relatives," says Heath. "No one is genetically predestined to become an alcoholic. Even if the genetic missing link were eventually found, the interaction of various environmental factors is certainly crucial if alcoholism is to occur in an individual." □

Next: Alcoholism as learned behavior