

The Secret of Bright Butterfly Wings: LED Technology

By Ker Than



Optical image showing magnified colored wing scales of *Papilio nireus*. (credit: Peter Vukusic/University of Exeter)

Science was way behind nature in developing LED light technology, a new study finds.

The beautifully colored wings of African swallowtail butterflies manipulate light using engineering tricks similar to those found in digital displays. The butterflies have black wings with bright patches of green and blue, which they use to communicate across long distances. Microscopic scales covering the wings absorb ultraviolet light and then re-emit it.

The re-emitted light interacts with fluorescent pigments found on the butterflies'

wings to produce the vibrant green-blue color.

Researchers investigating how the scales work found that they have many similarities to digital devices known as light emitting diodes, also known as LEDs, which are found in everything from computer and television screens to traffic lights.

The first LEDs invented in the late 1960s weren't very bright. They produced a lot of light but most of it tended to either become trapped inside the device or to spread sideways and become diluted.

In the early 1990s, engineers came up with ways to get around these problems. They outfitted LEDs with tiny mirrors that could reflect and channel the light and made microscopic holes in them to help the light escape.

While studying the wings of swallowtail butterflies, researchers discovered that there were a lot of similarities between the scale coverings and LEDs.

The scales that cover the butterflies' wings contain tiny structures called "photonic crystals," which act very much like the microholes found in LEDs.

"[The scales] prevent the fluorescent light from being trapped inside the scales and from being emitted sideways," said Pete Vukusic of Exeter University, a researcher in the study.

The scales on the wing also have a specialized mirror underneath them, which act very much like the tiny mirrors found in LEDs.

The mirror reflects all the scattered fluorescent light it receives upward, giving the butterflies control over the direction in which the light is emitted.

The study was reported in the Nov. 18 issue of the journal *Science*.

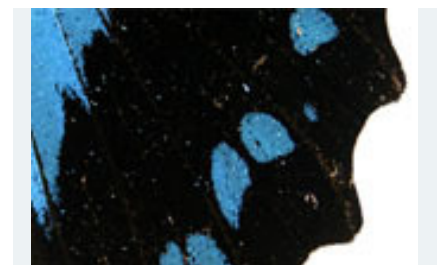
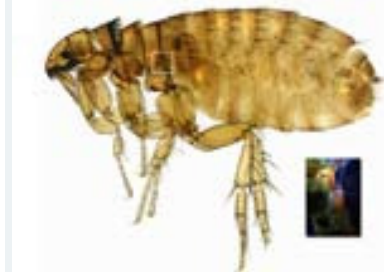


Image of colored banding on the dorsal wing surfaces of *Papilio hornimani*. (credit: Peter Vukusic/University of Exeter)

Insect's Amazing 'Rubber' Made in Lab

By Bjorn Carey



A flea relies on resilin to jump around. Inset shows resilin in a flea's jumping joints. (Credit: Chris Elvin / CSIRO)

A special type of protein enables insects to chirp, fly, and hop. Now, scientists have produced this same protein in the lab and say it could one day be used to repair human arteries.

The protein, called resilin, is like rubber. It can be squished up, storing energy for a quick release, and it remains extremely functional over an insect's lifetime.

Flies take advantage of the material's durability to flap their wings more than 720,000 times an hour. Froghoppers and fleas achieve a jump acceleration of more than 400 times gravity in just one

millisecond thanks to the quick release of energy from a tendon full of resilin.

While most insects use it for getting around, others, such as cicadas, moths, and some crustaceans, use it like a drum to make noise. And if incorporated into an insect's outer shell, resilin provides elasticity to an otherwise stiff structure. This is how termite queens manage to haul around a load of eggs.

Scientists at the Commonwealth Science and Industrial Research Organization in Australia took a copy of the resilin gene from a commonly used research fly, *Drosophila melanogaster*, and inserted it into the genome of *E. coli* bacteria. *E. coli* is the bacterial equivalent of a protein factory, and once the researchers had coaxed it into producing the protein, they exposed it to light to create the rubber-like molecule.

Resilin is one of the most resilient materials around – it can be stretched three times its original length without breaking – and it owes its

bounce-back ability to the special way its molecules are arranged.

Since it is structurally similar to elastin, the molecule that allows blood vessels to expand and contract, scientists think they may be able to use the manufactured resilin to repair stretched out, damaged blood vessels.

This study is detailed in the Oct 13 issue of the journal *Nature*.

The Real Spider-Man

By Robert Roy Britt



The fibers produced in insect cells, by Gat's team in a lab, are seen at right.

Uri Gat is no Peter Parker. Crime-chasing strands of silk fail to stream from his wrists when he thrusts them at tall buildings. But Gat, a biologist at the Hebrew University in Jerusalem, is as close to a real Spider-Man as they come. Gat and his colleagues have produced spider web fibers in a lab -- without spiders.

In a feat of genetic engineering that could one day result in tough new industrial materials and commercial products, Gat's team genetically engineered spider web silk. They did it by injecting the silk-making genes of a common garden spider into the cultured cells of a caterpillar.

While much more work is needed to perfect the process, with proper funding the silk could be commercialized within 10 years, Gat told *LiveScience*.

Spiders, being territorial, are impossible to domesticate. So commercial silk is typically harvested from cocoons of the silk moth. This silk is only one-third as strong and about half as elastic as what spiders produce.

Spider silk is the strongest natural fiber known. The most appealing type is the "dragline" that spiders use to move about and snag prey. Dragline silk -- what Peter Parker employs while swinging through the streets -- is six times stronger than steel and can be stretched to 50 percent of its length before it breaks.

In 2002, scientists at Nexia Biotechnologies produced spider silk proteins in cells from a mammal. The proteins were then spun into silky threads.

The Nexia research was supported by the U.S. Army, which is interested in producing dragline silk for better armor, tethers and bulletproof vests. It could also improve surgical threads, microconductors, optical fibers and the clothes on your back, says Gat, whose team moved a step closer to the goal by creating self-assembling spider web fibers.



A common spider web. (Credit: Current Biology magazine/Gat et al.)

Dragline silk is made primarily of two proteins, called ADF-3 and ADF-4. These are produced in a gland in the spider's abdomen, using the same amino acids that your body uses to produce skin and hair. Each protein is made by a specific gene.

Gat's team put these genes into a genetically engineered virus, then let the virus infect the cultured caterpillar cells. The cells produced silk proteins, and then spider fibers formed spontaneously in the Petri dish.

The fibers were identical to real draglines in chemical resistance and diameter -- about one-tenth the width of a human hair. And important aspects of natural silk production are now better understood.

The results are detailed in the Nov. 23 issue of *Current Biology*. Scientists at Oxford University and the Technical University of Munich contributed to the research.