Last Updated: Friday, 18 November 2005, 10:27 GMT



# Butterfly wings work like LEDs

**When scientists developed an efficient device for emitting light, they hadn't realised butterflies have been using the same method for 30 million years.**

**"The way light is extracted from the butterfly's system is more than an analogy - it's all but identical in design to the LED"**

Pete Vukusic, University of Exeter

Fluorescent patches on the wings of African swallowtail butterflies work in a very similar way to high emission light emitting diodes (LEDs).

These high emission LEDs are an efficient variation on the diodes used in electronic equipment and displays.

The University of Exeter, UK, research appears in the journal Science.

In 2001, Alexei Erchak and colleagues at the Massachusetts Institute of Technology (MIT) demonstrated a method for building a more efficient LED.

Most light emitted from standard LEDs cannot escape, resulting in what scientists call a low extraction efficiency of light.

## Ingenious design

The LED developed at MIT used a two-dimensional (2D) photonic crystal - a triangular lattice of holes etched into the LED's upper cladding layer - to enhance the extraction of light.

And layered structures called Bragg reflectors were used to control the emission direction. These high emission devices potentially offer a huge step up in performance over standard types.

Pete Vukusic and Ian Hooper at Exeter have now shown that swallowtail butterflies evolved

SEE ALSO:
Space designs from ants and squirrels
28 Oct 05 | Technology

RELATED INTERNET LINKS:
Science
University of Exeter
The BBC is not responsible for the content of external internet sites

TOP SCIENCE/NATURE STORIES NOW
Japan's asteroid touchdown fails
Butterfly wings work like LEDs
Climate target a 'bit optimistic'
Dinosaurs had appetite for grass
RSS | What is RSS?

an identical method for signalling to each other in the wild.

The butterflies use the fluorescent patches to signal each other

Swallowtails belonging to the *Princeps nireus* species live in eastern and central Africa. They have dark wings with bright blue or blue-green patches.

The wing scales on these swallowtails act as 2D photonic crystals, infused with pigment and structured in such a way that they produce intense fluorescence.

Pigment on the butterflies' wings absorbs ultra-violet light which is then re-emitted, using fluorescence, as brilliant blue-green light.

**Performance-enhancing bugs**

Most of this light would be lost were it not for the pigment being located in a region of the wing which has evenly spaced micro-holes through it.

Two components of the scales enhance light emission

This slab of hollow air cylinders in the wing scales is essentially mother nature's version of a 2D photonic crystal.

Like its counterpart in a high emission LED, it prevents the fluorescent colour from being trapped inside the structure and from being emitted sideways.

The scales also have a type of mirror underneath them to upwardly reflect all the fluorescent light that gets emitted down towards it. Again, this is very similar to the Bragg reflectors in high emission LEDs.

"Unlike the diodes, the butterfly's system clearly doesn't have semiconductor in it and it doesn't produce its own radiative energy," Dr Vukusic told the BBC News website "That makes it doubly efficient in a way.

"But the way light is extracted from the butterfly's system is more than an analogy - it's all but identical in design to the LED."

Dr Vukusic agreed that studying natural designs such as this could help scientists improve upon manmade devices.

"When you study these things and get a feel for the photonic architecture available, you really start to appreciate the elegance with which nature put some of these things together," he said.

E-mail this to a friend Printable version

LINKS TO MORE SCIENCE/NATURE STORIES

Select Go

News Alerts E-mail services Mobiles/PDAs Headlines for your site

Help Privacy and Cookies Policy News sources About the BBC Contact us