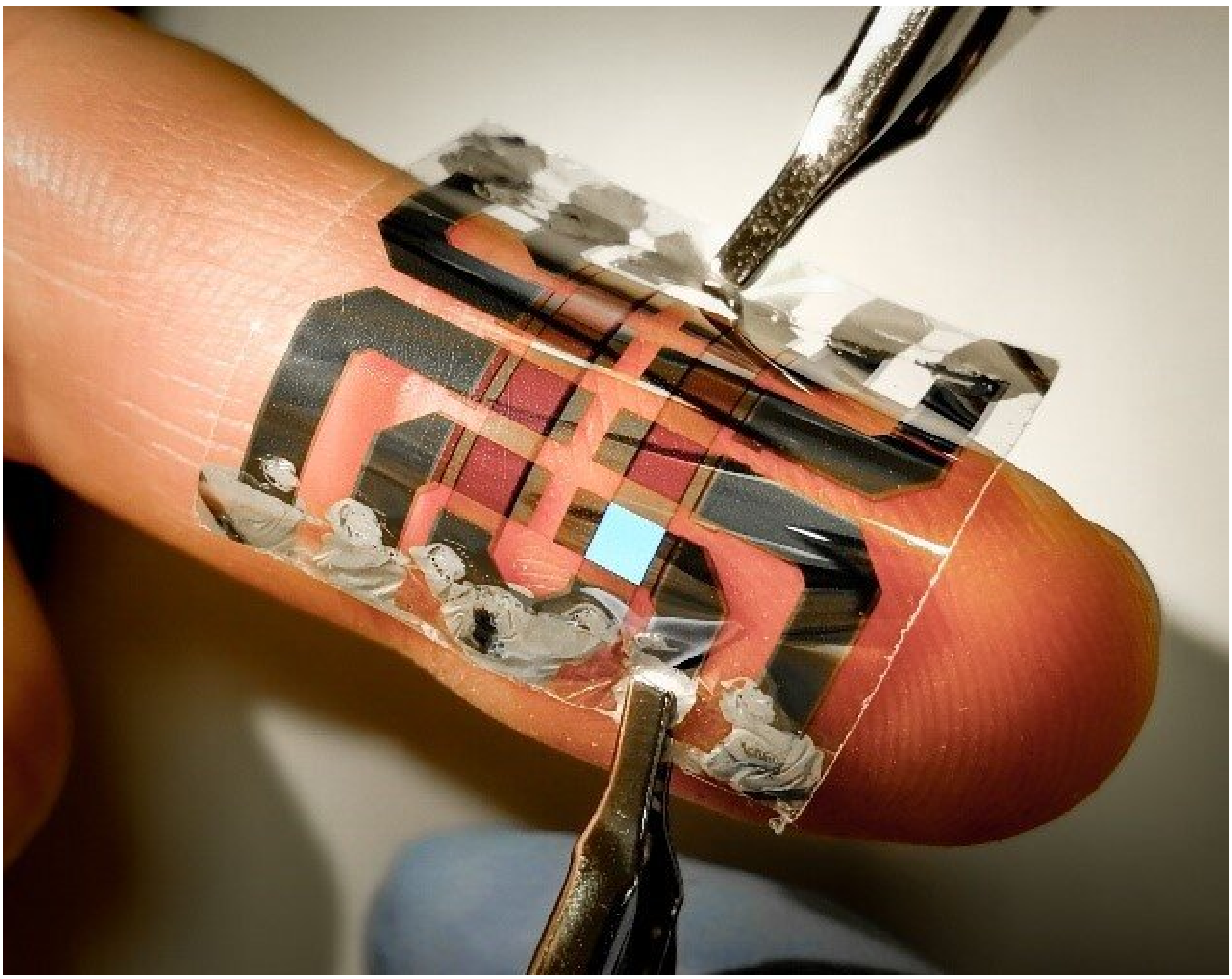
The lightest light – the future of digital displays and brain science

December 7 2020



Flexible, ultra-lightweight and highly durable organic LEDs promise new forms of wearable displays. Credit: University of St Andrews

A team of scientists from the University of St Andrews has developed a new way of making the most durable, lightweight and thinnest light source available so far, which could revolutionize the future of mobile technologies and pave the way for new advances in brain science.

Writing in two separate papers and published in *Nature Communications* today (Monday 7 December), the new research into the development of organic LEDs, led by the School of Physics and Astronomy at the University of St Andrews, has implications not only for the future designs of mobile phones and tablets but could also play a key role in neuroscience research and clinical technologies used to help patients who suffer from neurological diseases.

Using a combination of organic electroluminescent molecules, metal oxide and biocompatible polymer protection layers, the scientists created organic LEDs that are as thin and flexible as the everyday cling film we use at home. The new light sources developed will have future implications for digital displays and can be used to make lighter and thinner displays for phones and tablets; displays that are big when we look at them, but that can be folded or rolled up when not in use.

In the longer term, these new LEDs could also see use in treatments for neurological diseases in which light-gated proteins are deployed to modulate brain activity in patients.

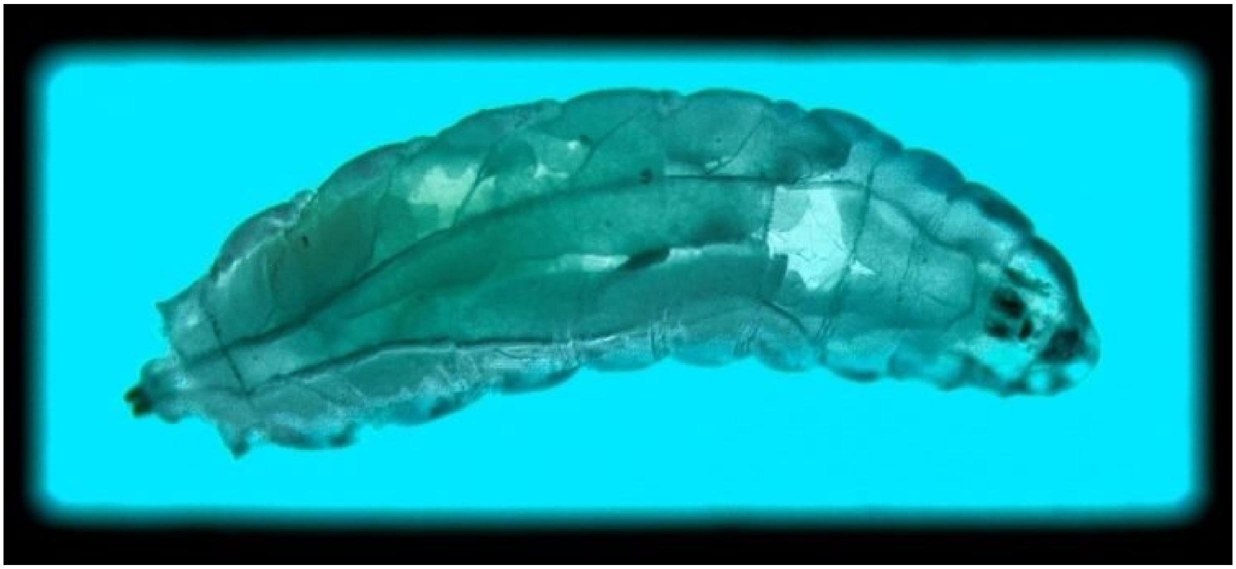
The flexible and ultra-lightweight organic LEDs developed at the University of St Andrews survive under harsh conditions, including under water, immersed in organic solvents, and even in aggressive gas plasmas. Credit: University of St Andrews

Earlier attempts to develop ultra-thin organic LEDs found they struggled with poor stability in air and moist environments. However, the new LEDs were found to be extremely robust with tests showing they can survive under water for weeks and withstand exposure to solvents and gas plasmas. The LEDs can also be bent around the edge of a razor blade thousands of times and still function perfectly—a simple experiment that highlights their extreme durability.

The robustness, extreme form factor and mechanical flexibility of the new light sources opens several possibilities for future use and applications beyond mobile technologies. For instance, they might be integrated into work surfaces, packaging and clothing as self-emissive indicators without adding weight and volume to the product. Furthermore, their stability under high humidity and in water makes them ideally suited for wearable applications requiring skin-contact and for use as implants in biomedical research.

Lead scientist for both studies, Professor Malte Gather from the School of Physics and Astronomy, said: "Our organic LEDs are very well suited to become new tools in biomedical and neuroscience research and may well find their way into the clinic in the future."

Working with Dr. Stefan Pulver from the School of Psychology and Neuroscience in a separate study, the scientists used light from an array of miniature organic LEDs and a neuroscience method called optogenetics to direct the locomotion of fly larvae in a highly controlled fashion.



Light-induced stimulation of the sensory neurons in a fly larva using organic LEDs can be used to study the basis of locomotion. Credit: University of St Andrews

Delivering light to specific body segments of crawling fly larvae allowed the researchers to stimulate and silence sensory neurons in a reliable manner. Depending on when and where light was delivered, larvae started to crawl forward or backward, with the dynamics of light stimulation controlling the speed of crawling and other aspects of animal movement.

"While the precise neuronal mechanism behind the animal response remains unknown, we are now in a much better position to test a range of hypotheses related to the locomotion of these organisms," explains Dr. Caroline Murawski, from the School of Physics and Astronomy and the first author of the second study.

The researchers are currently combining their breakthrough in making light, flexible and robust organic LEDs with what they have learned about controlling neural activity in flies to make light sources that can be implanted into the brain of vertebrate organisms. This will allow researchers to study brain function in a less invasive and more versatile manner than existing techniques.

In addition to contributing to future development of mobile displays, and opening new avenues for basic research, the technologies developed in these studies could ultimately be used to improve clinical treatments by creating optical interfaces that send information directly to the brain of human patients who suffer from a loss of vision, hearing or sense of touch.

The papers, "A substrateless, flexible, and water-resistant organic light-emitting diode," by C. Keum et al, and "Segment-specific optogenetic stimulation in Drosophila melanogaster with linear arrays of organic light-emitting diodes," by C. Murawski et al, are published in *Nature Communications*.

More information: Caroline Murawski et al. Segment-specific optogenetic stimulation in Drosophila melanogaster with linear arrays of organic light-emitting diodes, *Nature Communications* (2020). DOI: 10.1038/s41467-020-20013-6

Changmin Keum et al. A substrateless, flexible, and water-resistant organic light-emitting diode, *Nature Communications* (2020). DOI: 10.1038/s41467-020-20016-3

Provided by University of St Andrews