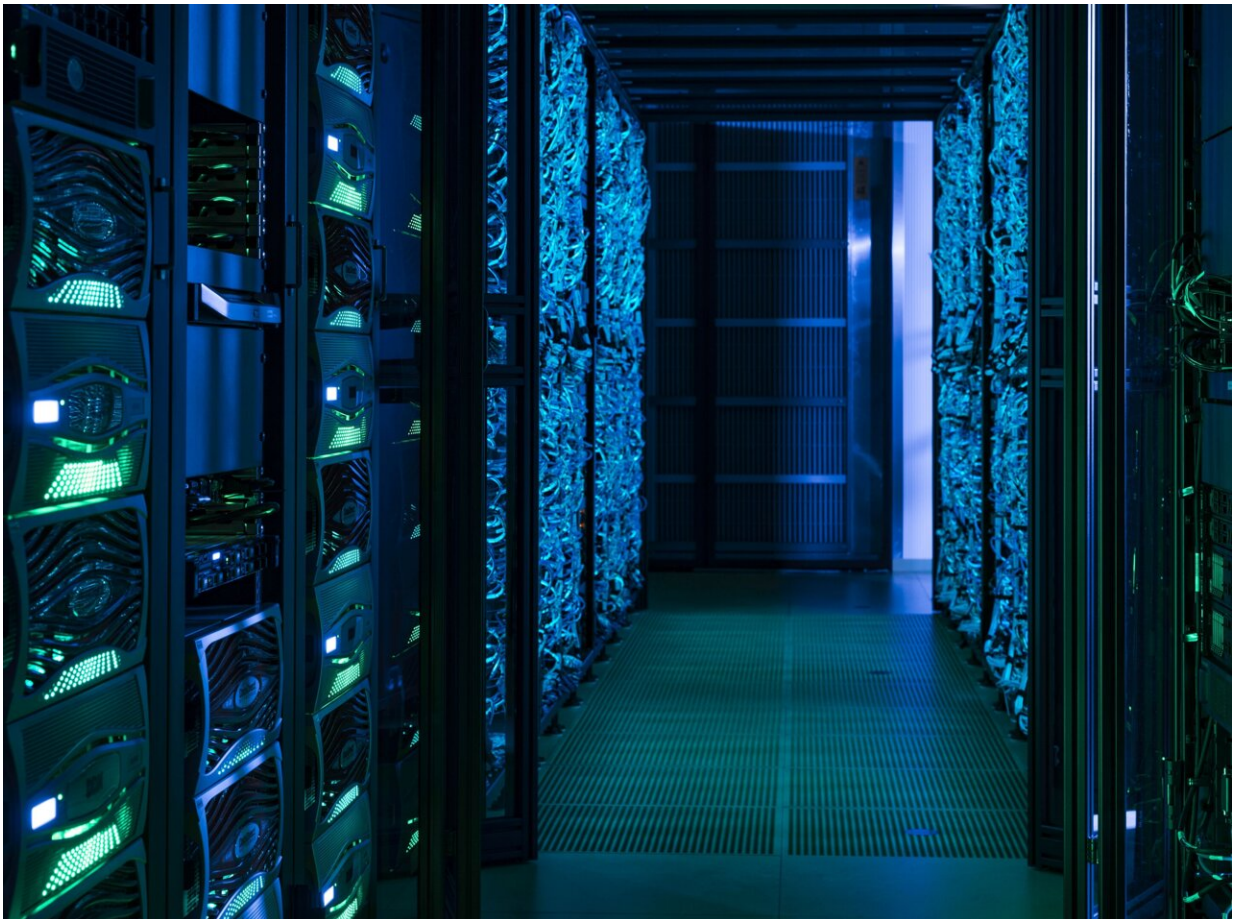


Organic light-emitting diodes: Making the blue shine brighter and longer

June 19 2023



Thanks to a new molecule, blue OLEDs will shine brighter and fade more slowly in the future. Credit: Markus Breig, KIT

Organic light-emitting diodes are used in smart phones, tablets, and large

TV screens. As they do not need any additional background illumination, they are energy-efficient. They can be produced at low costs by thin-film technology and also work on flexible carrier materials, thus enabling bendable displays and variable room illumination solutions.

An OLED consists of two electrodes, of which at least one is transparent. Thin layers of organic semiconducting materials are located between them. Their light results from electroluminescence. When applying an [electrical field](#), electrons from the cathode and holes (positive charges) from the anode are injected into the organic materials that act as emitters. There, [electrons](#) and holes meet and form electron-hole pairs. When these pairs collapse into their [initial state](#) again, they release energy that is used by the organic materials to emit light. All colors can be obtained by mixing blue, green, and red.

Why blue is difficult

So far, phosphorescent OLEDs in red and green have been available for commercial applications only. Blue light can be produced by fluorescent OLEDs for a short time only. Combining a [high efficiency](#) with a high luminescence and a long service life is difficult with blue OLEDs. Blue pixels are fainter or fade more quickly than green and red pixels.

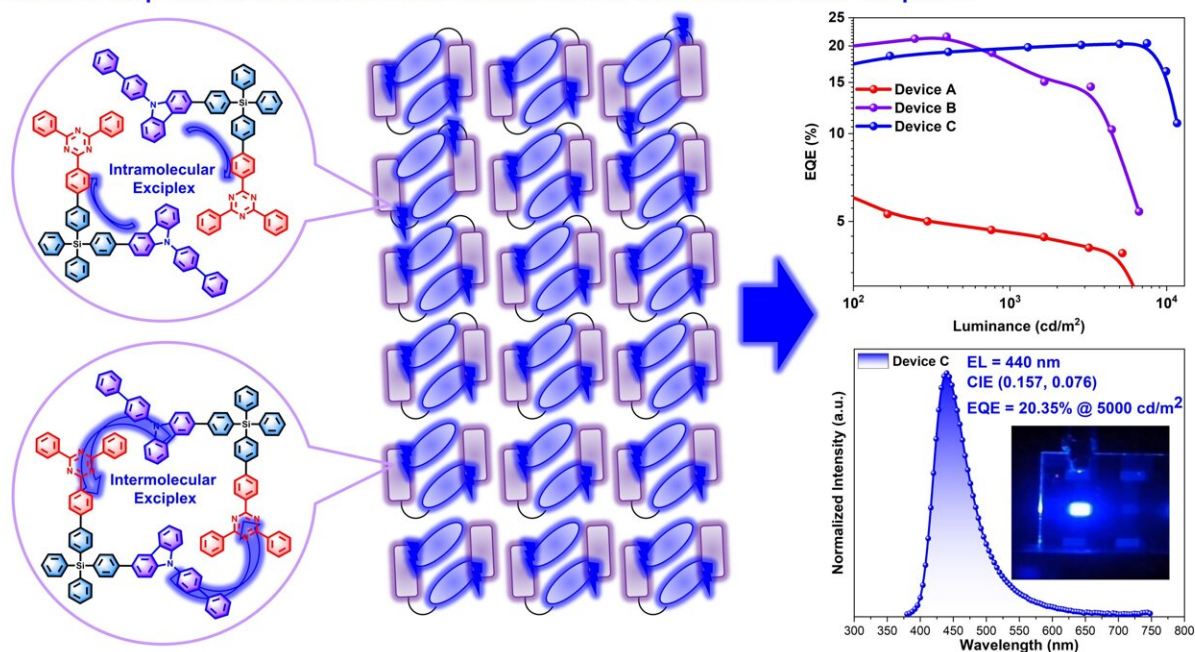
In cooperation with researchers from Shanghai University, researchers from KIT's Institute of Organic Chemistry (IOC) and Institute of Biology and Chemical Systems—Functional Molecular Systems (IBCS-FMS) have now developed a new strategy for the production of highly efficient and stable deep-blue [organic light-emitting diodes](#). Their research is published in the journal *Science Advances*.

The researchers produced a new type of molecule, in which carbazole and triazine fragments are linked by a silicon atom (CzSiTrz). When the molecules assemble to form nanoparticles, electronic excitation causes

intramolecular charge transfer emission and intermolecular exciplex luminescence, resulting in a dual-channel intra-/intermolecular exciplex emission.

An exciplex is an electronically excited molecule complex. Its emission differs from the emissions of excited single molecules. "The exciplex strategy allows to achieve deep-blue electroluminescence, because the energy levels of the electron-donating carbazole fragments and electron-accepting triazine fragments can be adjusted independently of each other," says Professor Stefan Bräse from IOC and IBCS-FMS.

Efficient deep-blue luminescence based on dual-channel intra-/intermolecular exciplexes



Emission within and between the molecules makes deep-blue OLEDs shine more efficiently and stably. Credit: Zhen Zhang

New OLEDs reach a high external quantum efficiency and high

luminance

The team succeeded in producing deep-blue OLEDs with a record-setting external quantum efficiency of 20.35%. The external quantum efficiency is the ratio between the radiation output and power input. Moreover, these OLEDs reach a high luminance of 5,000 candela per square meter (cd/m^2).

The perceivable blue has the coordinates of 0.157/0.076 on the chromaticity diagram of the International Commission on Illumination (CIE). "Easy synthesis of the molecule and production of the components pave the way for a new generation of efficient and long-lived deep-blue OLEDs," Bräse says.

More information: Zhen Zhang et al, Efficient deep-blue luminescence based on dual-channel intra/intermolecular exciplexes, *Science Advances* (2023). [DOI: 10.1126/sciadv.adf4060](https://doi.org/10.1126/sciadv.adf4060)

Provided by Karlsruhe Institute of Technology

Citation: Organic light-emitting diodes: Making the blue shine brighter and longer (2023, June 19) retrieved 28 April 2024 from <https://phys.org/news/2023-06-light-emitting-diodes-blue-brighter-longer.html>

| |
|--|
| <p>This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.</p> |
|--|