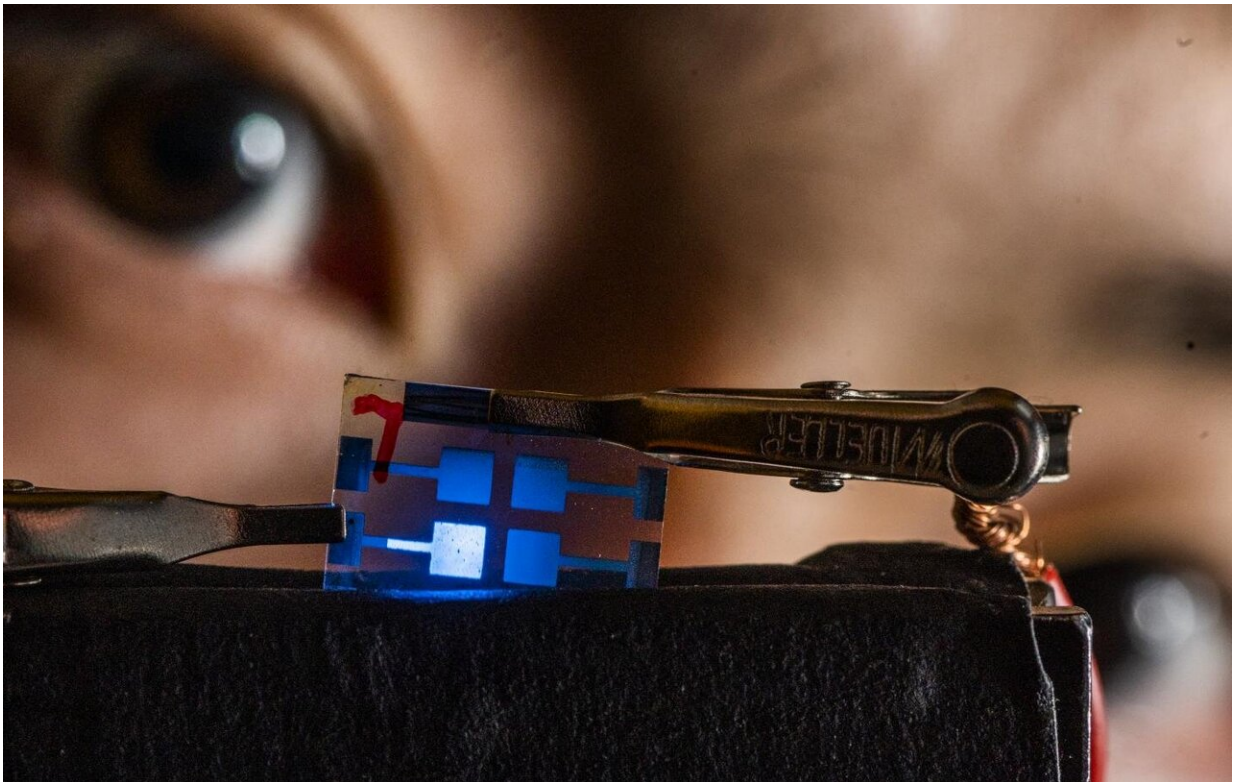


Blue light means big progress for perovskite-based LEDs

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Researchers at Linköping University, Sweden, have developed efficient blue light-emitting diodes based on halide perovskites. Credit: Thor Balkhed

Researchers at Linköping University, Sweden, have developed efficient blue light-emitting diodes based on halide perovskites. "We are very excited about this breakthrough," says Feng Gao, professor at Linköping

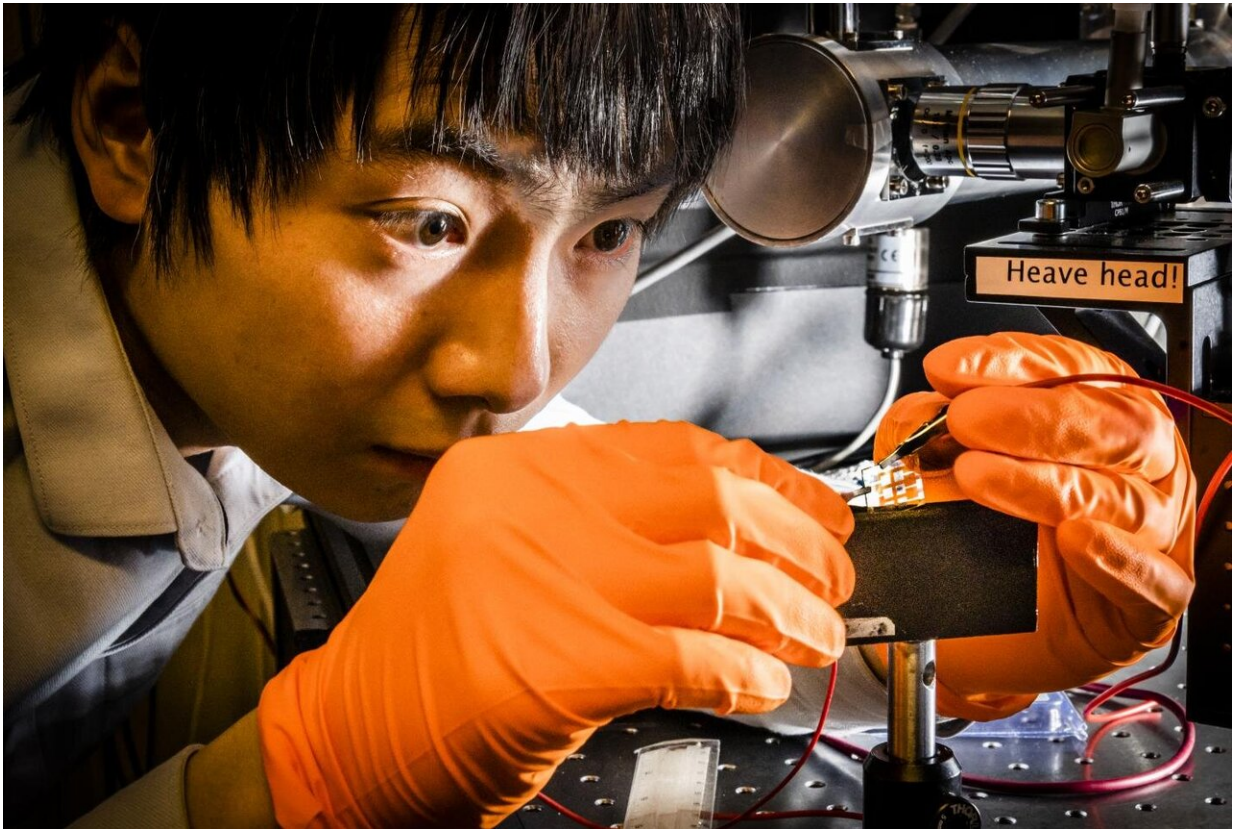
University. The new LEDs may open the way to cheap and energy-efficient illumination.

Illumination is responsible for approximately 20% of global electricity consumption, a figure that could be reduced to 5% if all light sources consisted of light-emitting diodes (LEDs). The blue-white LEDs currently in use, however, need complicated manufacturing methods and are expensive, which makes it more difficult to achieve a global transition.

LEDs manufactured from halide perovskites could be a cheaper and more eco-friendly alternative for both illumination and LED-based monitors. Perovskites are a family of semiconducting materials defined by their cubic crystal structure. They have good light-emitting properties and are easy to manufacture. Using elements from the halogen group, i.e. fluorine, chlorine, bromine and iodine, perovskites can be given properties that depend on the chemical composition of the crystal.

LEDs for green and red light have already been created with perovskites, but one color, blue, has so far been lacking, making it impossible to achieve white light.

"Blue light is the key to bringing light-emitting perovskites to practical applications. Our most recent breakthrough is one step on the way," says Feng Gao, professor at the Department of Physics, Chemistry and Biology at Linköping University.



Weidong Xu, postdoc at the Department of Physics, Chemistry and Biology at Linköping University, Sweden is part of the research group that have developed efficient blue light-emitting diodes based on halide perovskites Credit: Thor Balkhed

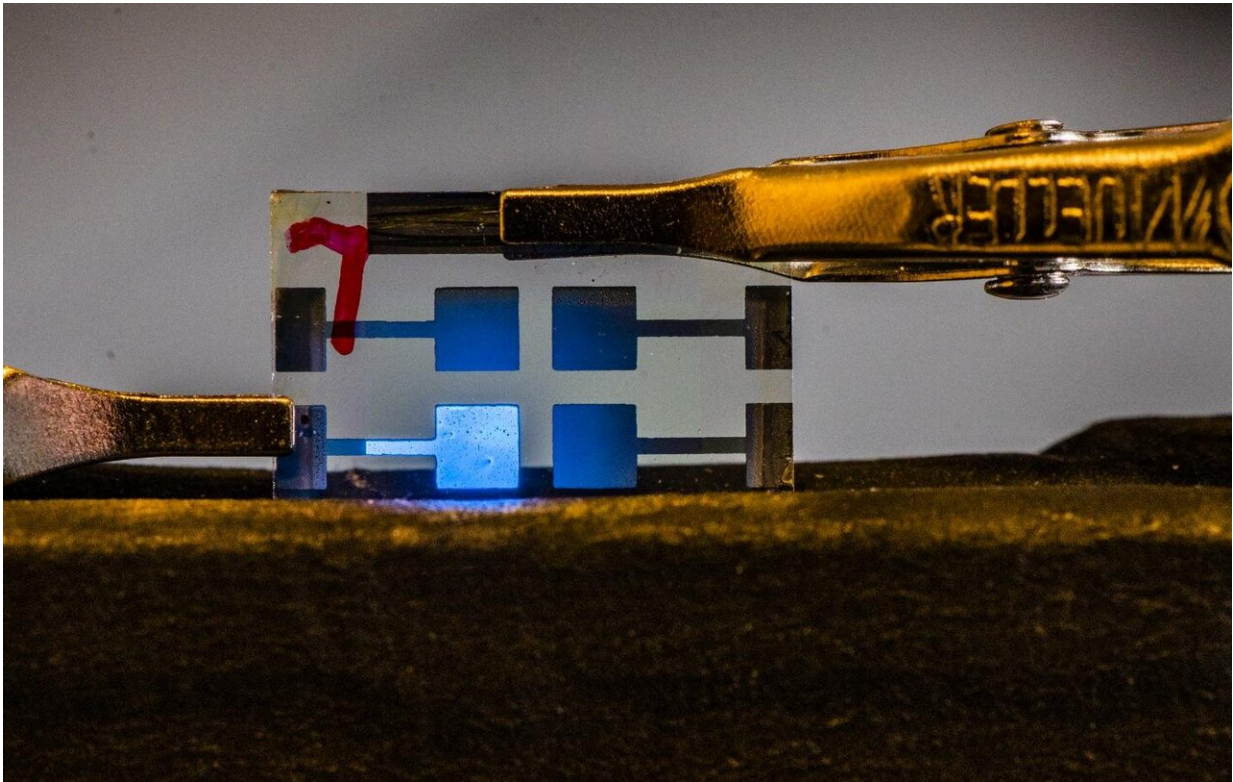
Feng Gao's research group, in collaboration with colleagues in Lund, Great Britain, Germany, China and Denmark, has managed to create halide perovskites that give stable emission in the [wavelength range](#) 451-490 nanometres—corresponding to deep blue to sky blue colors. Max Karlsson is doctoral student at Linköping University and joint first author of the article now published in *Nature Communications*. He says:

"Metal-halide perovskites are easily color-tuneable over the whole visible spectrum by simple alloying. Unfortunately, and a blue LED turns

green during operation. We have found a method that can prevent this color shift by controlling the film crystallization dynamics when creating the [perovskite](#). These findings pave the way for stable perovskite alloys, not only for LEDs but also for solar cells."

The challenge of creating [blue light](#) in perovskites is that it requires a chemical composition with a large fraction of chloride, which makes the perovskite unstable. Blue perovskite-based LEDs have previously been created with using what is known as the "quantum confinement technique," which gives low-intensity LEDs with poor efficiency. However, stable perovskites with the desired amount of chloride can be created with the aid of the "vapor-assisted crystallization technique." Furthermore, the Linköping University researchers have achieved an energy efficiency of up to 11% for the blue perovskite-based LEDs.

"We have shown that blue light-emitting diodes based on halide perovskites can be both efficient and stable across a broad spectrum, without using quantum confinement. We have managed to create one of the most efficient blue perovskite-based LEDs so far known," says Weidong Xu, postdoc at Linköping University.



Blue light-emitting diodes based on halide perovskites. Credit: Thor Balkhed

The science of perovskites is a relatively new research field that has aroused major international interest, since it offers a great potential for developing cheap and efficient materials. Feng Gao, however, is quick to point out that the work they have done is basic research, and applications are still some way off in future.

"Perovskite LEDs are a young technology and have some way to go before they see the light of day. Currently, the short lifetime and poor performance of blue LEDs are the main obstacles for perovskite light-emitting diodes before they can start to compete with existing technologies such as light-emitting diodes based on organic and inorganic semiconductors. We will keep working on that to make

PeLEDs comparable to the other technologies," says Feng Gao.

More information: Max Karlsson et al, Mixed halide perovskites for spectrally stable and high-efficiency blue light-emitting diodes, *Nature Communications* (2021). [DOI: 10.1038/s41467-020-20582-6](https://doi.org/10.1038/s41467-020-20582-6)

Provided by Linköping University

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