Researchers break bandwidth record for data communication using laser-based visible light

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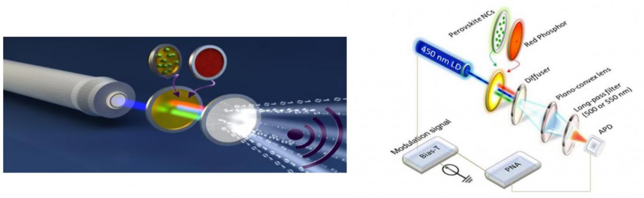

Illustration and schematic drawing of the visible light communication (VLC) device that uses a new color converter made of perovskite nanocrystals combined with red-light-emitting phosphor. Credit: Dursun et al. ©2016 American Chemical Society

(Phys.org)—Cell phones and Wi-Fi devices typically transmit data using radio waves, but as the demand for wireless data transfer increases, congestion in the radio spectrum is expected to become more of a problem. One way to solve this problem is with visible light communication (VLC), a technology that uses visible light rather than radio waves for data transmission.

VLC uses lasers or LEDs that look just like traditional lights, but by rapidly switching on and off faster than the eye can see, the light transmits data in binary code to a receiver. Besides expanding the spectrum of data transfer, VLC is expected to have other advantages over wireless radio communication, including faster speeds, higher security, and better energy efficiency.

Currently, however, one of the biggest challenges facing VLC is a very small bandwidth, which greatly limits the speed of data transmission. The main reason for this problem is the small bandwidth of the color converter—a component that converts blue LED light into the different colors needed to make the white light that is ultimately used to transmit data.

In a new paper published in *ACS Photonics*, a team of researchers led by Osman Bakr and Boon Ooi at the King Abdullah University of Science and Technology (KAUST) in Saudi Arabia has developed a new VLC color converter that has a bandwidth that is 40 times greater than that of commercial converters, and more than twice as large as that of any potential candidate converter proposed to date.

"In this work we break the record for data communication using visible light, and more impressively produce white light with a very high color rendering index of 89, by designing a special color converter based on hybrid perovskite nanocrystals," Bakr told *Phys.org*. "Our work demonstrates white light as both a lighting source and a system for ultra-high-speed data communications."

Like commercial color converters, the new design is based on phosphors, which are luminescent materials that are commonly used in conventional LEDs as well. The problem with phosphors in the commercial color converters is that they have a long photoluminescence lifetime, on the order of microseconds, which results in a maximum bandwidth of about 12 megahertz (MHz).

In the new study, the researchers combined a conventional phosphor with perovskite nanocrystals, which are being researched for use in solar cells due to their efficient energy transfer. Here, the scientists showed that the addition of perovskite nanocrystals to conventional phosphor decreases the photoluminescence lifetime to just 7 nanoseconds. As a result, the new color converter has a bandwidth of nearly 500 MHz and can transmit data at a high rate of 2 Gbits/second. For reference, Wi-Fi technologies can reach speeds of only a few tens of Mbits/second.

This bandwidth is also larger than that of non-phosphor-based color converters that scientists have recently been investigating, which have a bandwidth in the range of 40-200 MHz.

The researchers showed that the light emitted by the new color converter looks nice, too. Its high coloring index of 89 means the device produces a warm white light that has a higher quality emission than commercially available white LEDs. The good quality suggests that the device will be well-suited for fulfilling its dual purpose as both a wireless communication device and an indoor light or optical display.

In the future, the researchers plan to work on methods for packaging the color converter to ensure its long-term reliability. They also hope to further improve the speed of data transfer.

"In this bandwidth hungry era, there will be a continuous push by consumers for VLC systems with higher bitrates," Ooi said. "We believe that white light generated by semiconductor lasers will one day replace the LED white light bulb for energy-efficient lighting. To achieve this objective, we set our long-term goal to develop nanocrystals that can convert high-energy excitation photons from semiconductor lasers to Red-Yellow-Green-Blue (RYGB) lights at ultra-short photon lifetime. In the near-term objective, we plan to further improve the light conversion yield of our nanocrystals to produce near ideal white light, with a color rendering index close to 100, while being able to transmit data at bitrates of multi-gigabits per second."

More information: Ibrahim Dursun et al. "Perovskite Nanocrystals as a Color Converter for Visible Light Communication." *ACS Photonics*. DOI: 10.1021/acsphotonics.6b00187