OLED Tunes its Colors for Sunlight-Style Illumination

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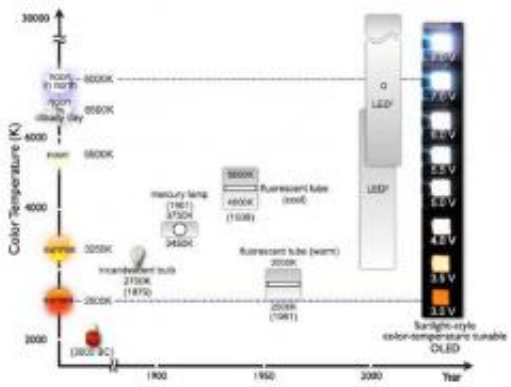

This chart shows the color temperature of sunlight at different times of day, along with the color temperatures of various lighting devices: candles, incandescent bulbs, mercury lamps, fluorescent tubes, LEDs, and the new sunlight-style OLEDs. Image credit: Jou, et al.

(PhysOrg.com) -- Scientists have developed a lighting device that can change its color temperature throughout the day, matching the natural daylight chromaticities produced by the sun. Currently, no other type of lighting device is capable of producing this wide a span of sunlight-style illumination, which could make the new technology an attractive future high-quality lighting source.

The developers, from National Tsing Hua University in Hsinchu, Taiwan, have designed an organic light-emitting diode (OLED) whose color temperatures range between 2300 and 8200 K, fully covering those

of daylight at different times and regions. The color temperatures are controlled by varying the applied voltage to the device. By providing a natural outdoor light, the device could have an especially strong effect on human psychology and creating a more natural looking environment.

As the researchers explain, no other single lighting device can exhibit daylight-like emission with a color-temperature range that covers the entire spectrum of sunlight (2500 K - 8000 K). This breaks down to 2500 K at dawn, 3250 K at dusk, and 5500 K at noon or 8000 K at noon in high-latitude regions. Currently, lighting devices have different color temperatures that make them resemble a specific time of day; for example, the color temperature is 2000 K for candles, 2700 K for incandescent bulbs, 2500-3000 K for warm-white fluorescent bulbs, and 4000-5000 K for cool-white fluorescent bulbs. Some white LEDs can cover a wider - but still limited - range of color temperatures, but require a complicated structure.

The sunlight-style OLEDs demonstrated here have a relatively simple design, consisting of layers just a few nanometers thick of various color-emitting materials, as well as an electron-transporting layer and an electron-injection layer. As the researchers explain, changing the voltage varies the color temperature by increasing the number of electrons and holes transported between certain layers. For example, at 3 volts, the illumination is predominantly red, at 5.5 volts it turns to pure white, and at 9 volts becomes bluish white. The scientists also experimented with devices using slightly different layer thicknesses for comparison.

“The daylight color and its corresponding color temperature is currently manually controlled for the prototype,” Professor Jwo-Huei Jou of National Tsing Hua University told *PhysOrg.com*. “A simple driver-IC can be used to automatically modulate its applied voltage to give any desired color temperature between 2300 and 9000 K at any designated time.”

Besides having a wide color temperature span, the OLED device also emits high luminescence at relatively low applied voltages, and can cover large areas with the potential for flexibility. With these advantages, the color temperature tunable OLED could one day provide a possible alternative for the replacement of incandescent and fluorescent bulbs and even LEDs, especially if the OLEDs can be made as efficient as previous research suggests they can be.

"Our future plans are to use phosphorescent in lieu of fluorescent materials to enhance the device efficiency and to investigate the color temperature effect on plant and animal growth," Jou said. "Of course, we mostly hope to have some lighting devices made so that people in northern countries can have sun-like daylight even in winter time."

More information: Jwo-Huei Jou, et al. "Sunlight-style color-temperature tunable organic light-emitting diode." *Applied Physics Letters* 95, 013307 (2009).