An electrically charged glass display smoothly transitions between a spectrum of colors

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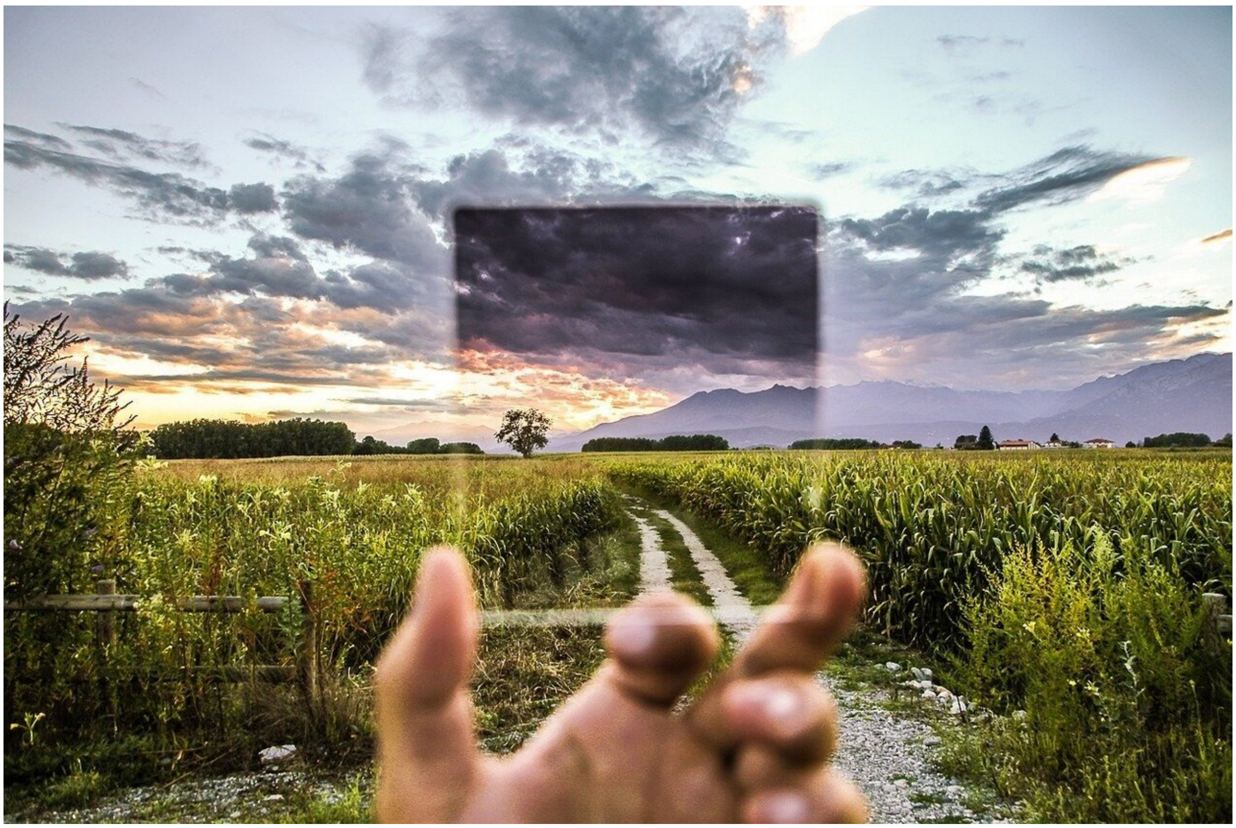

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Scientists have developed a see-through glass display with a high white light contrast ratio that smoothly transitions between a broad spectrum of colors when electrically charged. The technology, from researchers at Jilin University in Changchun, China, overcomes limitations of existing electrochromic devices by harnessing interactions between metal ions and ligands, opening the door for numerous future applications. The work appears March 10 in the journal *Chem*.

"We believe that the method behind this see-through, non-emissive display may accelerate the development of transparent, eye-friendly displays with improved readability for bright working conditions," says Yu-Mo Zhang, an associate professor of chemistry at Jilin University and an author on the study. "As an inevitable display technology in the near future, non-emissive see-through displays will be ubiquitous and irreplaceable as a part of the Internet of Things, in which physical objects are interconnected through software."

With the application of voltage, electrochromic displays offer a platform in which light's properties can be continuously and reversibly manipulated. These devices have been proposed for use in windows, energy-saving electronic price tags, flashy billboards, rearview mirrors, augmented virtual reality, and even artificial irises. However, current models come with limitations—they tend to have low contrast ratios, especially for white light, poor stability, and limited color variations, all of which have prevented electrochromic displays from reaching their technological potential.

To overcome these deficiencies, Yuyang Wang and colleagues developed a simple chemical approach in which metal ions induce a wide variety of switchable dyes to take on particular structures, then stabilize them once they have reached the desired configurations. To trigger a color change, the electrical field is simply applied to switch the metal ions' valences, forming new bonds between the metal ions and molecular switches.

"Differently from the traditional electrochromic materials, whose color-changing motifs and redox motifs are located at the same site, this new material is an indirect-redox-color-changing system composed by switchable dyes and multivalent metal ions," says Zhang.

To test this approach, the researchers fabricated an electrochromic device by injecting a material containing metal salts, dyes, electrolytes, and solvent into a sandwiched device with two electrodes and adhesive as a spacer. Next, they performed a battery of light spectrum and electrochemical tests, finding that the devices could effectively achieve cyan, magenta, yellow, red, green, black, pink, purple, and gray-black displays, while maintaining a high contrast ratio. The prototype also shifted seamlessly from a colorless, transparent display to black—the most useful color for commercial applications—with high coloration efficiency, low transmittance change voltage, and a white light contrast ratio that would be suitable for real transparent displays.

"The low cost and simple preparation process of this glass device will also benefit its scalable production and commercial applications," notes Zhang.

Next, the researchers plan to optimize the display's performance so that it may quickly meet the requirements of high-end displays for real-world applications. Additionally, to avoid leakage from its liquid components, they plan to develop improved fabrication technologies that can produce solid or semi-solid electrochromic devices.

"We are hoping that more and more visionary researchers and engineers cooperate with each other to optimize the electrochromic displays and promote their commercialization," says Zhang.

More information: *Chem*, Wang et al.: "A see-through electrochromic display via dynamic metal-ligand interactions"
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