New 'Pure Light' Technology Makes Computer Screens, Cell Phone Displays More Power Efficient

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Flat screens have replaced bulky, energy-gobbling tube-style computer screens on the desks of many businesses and homes, but scientists at the University of Rochester have found that even these power-sipping screens have room for energy-efficiency improvement. Rochester researchers have patented a new class of optical materials that efficiently create "pure polarized light," which uses far less energy than conventional flat-panel displays to produce the same images. The technology, called glassy liquid crystals, has been licensed to Cornerstone Research Group, Inc., of Dayton, Ohio, for manufacture and use in displays, optical drives, and "color tunable" filters.

The new materials emit nearly perfect circularly polarized light—the kind necessary to create 3-D displays and striking color images—that is hundreds of times more pure than light emitted from today's materials. Light emerges by twisting its way through thousands of layers of molecules, spiraling from one side to the other. The material includes special additives, or dopants, that allow it to emit and manipulate color light without color filter arrays, which are necessary in today's display systems.

Whether it's a video game, a movie projector or a computer, a bit of optical wizardry occurs out of sight in a display system. The first step is creating light that is polarized, or whose electric field vibrates in only one of two directions, horizontal or vertical. Today that's done simply by stripping away more than half the light, in the same way that some sunglasses and car windshields cut down glare.

Now a team led by Shaw H. Chen, professor of chemical engineering and materials science and senior scientist at the Laboratory for Laser Energetics (LLE) at the University of Rochester, has made a material that actually emits color polarized light, eliminating the need to dump half the light that a system produces.

“It’s the voracious nature of the display drawing on the battery that makes laptops or cell phones so power-hungry,” says LLE scientist Ansgar Schmid, who took part in the research. “Half the light must be thrown away. This is not an esoteric problem; it’s something millions of people confront every day.” One of the reasons 3-D displays aren’t available commercially is because they require tremendous power to produce twice as much light as necessary.

The material the team developed is based on liquid crystal technology but is very different from traditional materials. Conventional liquid crystals flow at room temperature, and the rod-like molecules stand at attention when an electric field is applied, giving manufacturers a way to control how light moves through them. Displays on laptop computers, cell phones, watches, and calculators all rely on this technology.

In contrast, the new materials are solid, stable films that are as clear as glass but whose molecules are also highly ordered, unlike normal glass. “This is really liquid crystal glass, because it has characteristics of both glass and liquid crystals,” says Chen. “It’s also easy to process using current technology.”

The materials are actually stacks of layered molecules, each rotated slightly so that together the molecules form a clear spiral path for light to follow. Altogether the layers, which form themselves spontaneously into this rotational pattern, are anywhere from 4 to 35 microns thick, less than half the thickness of a human hair. When hit with unpolarized light from an ultraviolet source, the materials emit circularly polarized, color light. Residual light is reflected and recycled, rather than absorbed and wasted as in current systems.

Most displays today use linear polarization, even though it’s not as efficient as circular polarization, and then use additional optical devices to produce color. “Up to now there simply haven’t been materials to pursue this avenue of research,” Chen says. “We’re hoping to make circular polarization an option for display technology.”

Besides brighter and more efficient displays, other applications of glassy liquid crystals include laser goggles that selectively filter out laser light at certain wavelengths, and electro-optic devices for optical communication. Chen says the materials also have potential for optical storage, since at high temperatures they can switch states instantly in response to heat or light.

The patented technology licensed to Cornerstone Research Group will allow the production of materials in quantities for testing, experimental use, and product development.

Chen’s research was supported by the National Science Foundation, the U.S. Air Force Office of Scientific Research, the Ballistic Missile Defense Organization, the Japanese Ministry of International Trade and Industry, Kaiser Electronics, and the University’s NSF Center for Photoinduced Charge Transfer and Laboratory for Laser Energetics. Also working on the project were graduate student Dimitris Katsis, research associate John Mastrangelo, applied physicist T. Tsutsui of Kyushu University in Japan, and Tom Blanton of Eastman Kodak Company.

Source: University of Rochester