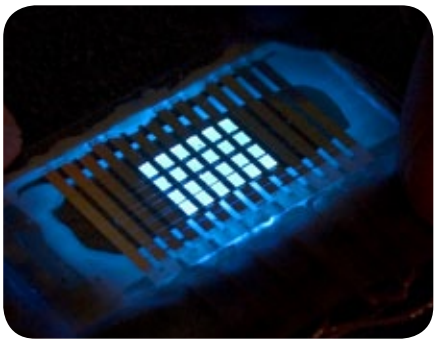
THE Ames Laboratory

*Creating Materials & Energy Solutions*

# OLED Sensors will Create an Inexpensive Web of Protection

***A tiny invention at the Ames Laboratory promises to make our world safer***

Liquid crystal displays may be the dominant TV and computer-monitor technology, today. But in the years ahead, they could be increasingly replaced by another display medium known as organic light emitting diodes. Call them OLEDs for short, they're made of organic thin films sandwiched between two electrodes. When exposed to electric voltage, they begin to glow brightly enough to make colors or images easily viewable. For that reason, OLEDs use far less energy than LCDs. The latter require power-hungry backlighting in order to be seen.



*Future uses of OLEDs include flexible displays, sensors, and even clothing that changes color.*

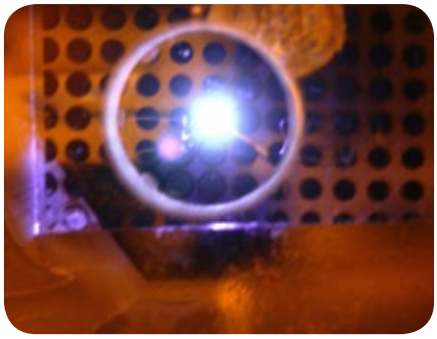
Small OLED displays can already be found in cell phones, MP3 players, and some larger displays. However, because they're relatively easy and cheap to manufacture, OLEDs may eventually yield many more products, some of which might seem almost magical today. Imagine, for example, magazines that display fresh animated graphics with each turn of the page or homes with walls that change color at the twist of a dial, even clothing that changes patterns depending on the wearer's mood.

## A web of protection

Thanks to pioneering work at the U.S. Department of Energy's Ames Laboratory, we may also soon see OLED-based sensing devices become as commonplace as electrical outlets. These sensors could be used to protect us from viruses, hazardous chemicals, even terrorist attacks.

The first working OLED sensors have already been developed by Ames Laboratory Senior Physicist Joseph Shinar, together with Ruth Shinar, a senior scientist at Iowa State University's Microelectronics Research Center.

The Shinars' early work shows that OLED-based sensors can identify chemical threats as well as or better than competing detection devices. But thanks to their low power requirement, OLEDs can operate unattended for a long time without a battery recharge. And because of their low cost, thousands of sensors might be placed in airports, train stations, and other potential target areas where



*OLEDs use less power and cost less to make than other displays.*

many people gather. The moment these sensors detect a suspicious substance, each could transmit an alarm to a computer, which would determine the nature of the threat and the level of danger it represents.

Ames Lab researchers are already looking at more complex sensors that would be able to detect threats from multiple substances. When perfected, such a device would be similar to a so-called lab on a chip, a tiny analysis tool in use today that's able to perform an array of scientific tests. Current research suggests that multiple sensors, each testing

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*OLEDs' ability to emit light brightly make them ideal for TVs.*

## HOW AMES LAB SCIENTISTS MAKE THEIR OLED SENSORS WORK

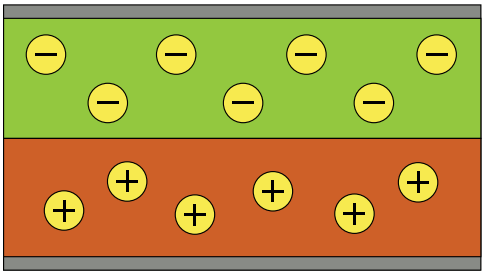
The substance the OLED is designed to detect comes in contact with a thin sensing film. The film has been chemically designed to react when contact with the potentially threatening substance occurs.

The OLED, powered by a small battery, provides a light source. In the presence of light, the reacting material will itself glow a specific color. This color signals the change when the sensing film is exposed to the target substance.

A photodetector records the changes in the glow and transmits the information to a computer, which can sound an alarm.

for a separate substance, could be placed on an OLED device no larger than one millimeter square per sensor. When that happens, OLED uses will expand to the point where data from sensors will become an important facet of our everyday lives.

Indeed, just as silicon chips eventually gave rise to the World Wide Web, the OLED sensors created at the Ames Laboratory could create a global web of protection from many of the dangers we now face.



*A cross-sectional view of an OLED*

## HOW OLEDS ARE MADE

Sensors currently on the market possess relatively complex designs. Some employ expensive lasers or other light sources that require careful assembly. OLEDs, by contrast, can be mass produced, using established processes such as spin coating or thermal vacuum evaporation. The result is that an array of individual OLED pixels can be made in a single production run. Here's how the thermal evaporation process works:

- In the thermal evaporation process, the organic materials that will form the OLEDs are heated until they turn into a vapor.
- The vapor is in a chamber that's kept at very low pressure.
- The vapor then condenses on top of a substrate, forming a thin film.
- Using a special design enables formation of multiple, individually addressable OLED pixels that are the base of a number of sensors.