Science.
Applied to Life.™

Security at your fingertips

Your digital assets are best protected by your digits

Access to your phone is access to your life. Not all of it, of course. Just the most sensitive parts. Photos of your children. The passcode to your home security system. Your car. Your health records. Your love letters. Your credit card charges and your retirement savings.

Protecting that access has made phone and computer security a preoccupation, if not an obsession, for many people. But despite a high level of interest and concern, the tools for protecting your digital assets are few and often flawed: passcodes can be stolen by cameras and prying eyes, and face recognition systems—for all their impressive technology—are much less convenient when the world is masked against disease. (Also, facial recognition works when your eyes are closed, which means every nap constitutes a potential security lapse.)

For now, the most secure and convenient way to access your digital assets is with your digits. Fingerprint readers, which have been used on computers and phones since the early 2000s, are affordable, reliable and convenient—but they have several drawbacks. On less expensive phones, the readers demand real estate: some of the screen's surface (such as a "home" button) must be dedicated to it. On more expensive phone models, the reader can be replaced with an under-the-screen optical sensor, but these sensors only work in a small, designated area that demands precise finger placement. These systems are also prohibitively expensive for mass adoption.

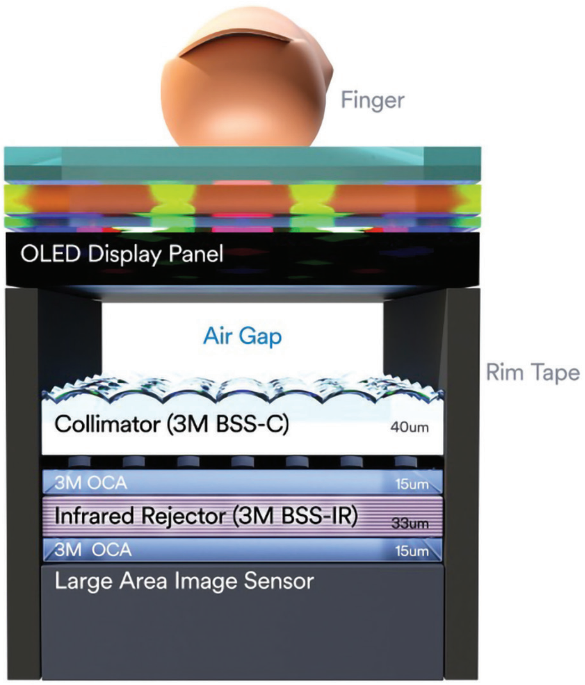
These drawbacks of fingerprint readers are about to disappear. 3M is collaborating with several sensor manufacturers to create full-screen fingerprint sensing systems for both LCD and OLED displays. The sensor companies will provide the hardware and software for reading the fingerprints; 3M will supply specialized films that sharpen the image, thereby improving accuracy and reliability. When these systems begin appearing in phones and laptops—probably in late 2022—they will be able to sense the user's fingerprints and unlock the device, no matter where the user contacts the screen.

The image-sharpening films used in these systems rely on several unique 3M technologies. The first is microreplication, a capability that allows the company to manufacture films patterned with precise, micron-sized structures (often with nanometer-sized features). The second is multilayer optical film (MOF) technology, which gives 3M the ability to create films no thicker than a piece of printer paper (around 100 microns) that contain hundreds of layers; these films can manipulate light in remarkable ways—for example, blocking one state of polarization or one range of frequencies while allowing the other state of polarization or frequencies to be transmitted—depending on the materials and thicknesses of the layers.

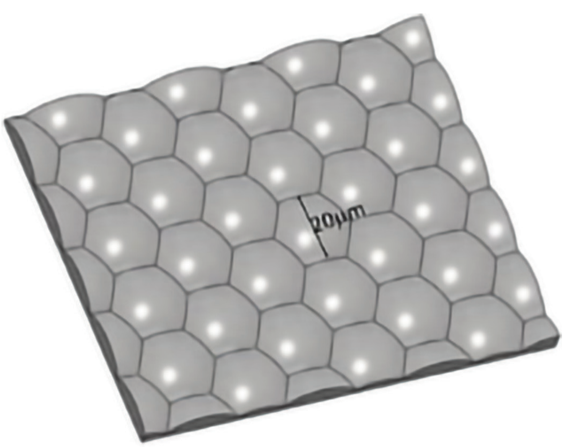
Here's how these technologies are used in fingerprint readers for OLED displays. Unlike other approaches based on CMOS or ultrasonic sensors—which can suffer from cost, performance and thickness issues—the system being developed by 3M and its collaborators is based around thin-film transistor (TFT) sensors. These sensors are thin and affordable, with a large sensing area, and they can be used with both flexible and rigid OLED panels. The chief drawback of TFT sensors is a lack of sensitivity under some conditions, particularly harsh ambient light.

This drawback is solved by two image-sharpening films that comprise the 3M™ Biometric Security System (BSS) for OLED displays.

Here's how they work: As the image of a fingerprint passes through the display panel, it encounters the Biometric Security System-Collimator (BSS-C), a microreplicated film patterned with microlenses that collimate the light and sharpen the image. (See Visuals 1 and 2.)

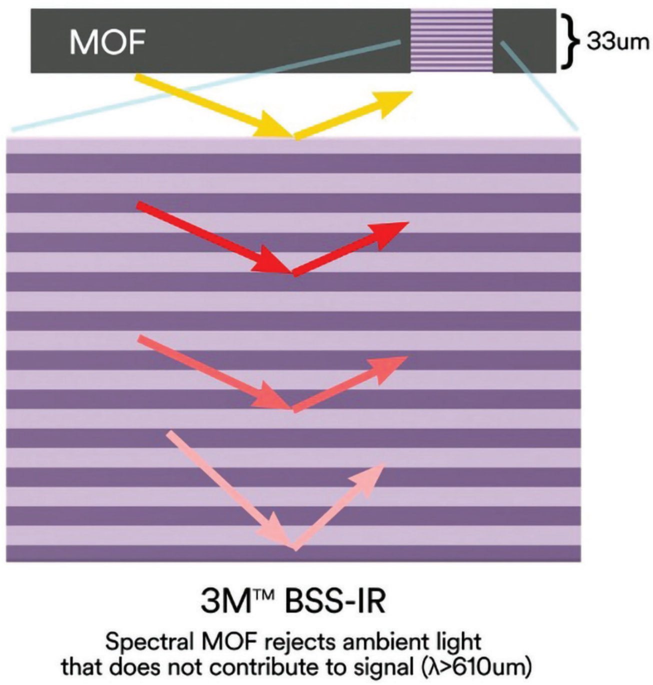


Visual 1: 3M™ Biometric Security System (BSS) for OLED displays



Visual 2: 3M Biometric Security System Collimator (BSS-C) – Microlens Design

The collimation film directs the image to the Biometric Security System-Infrared Rejector (BSS-IR), a multilayer optical film that rejects near-IR light. (Visual 3.) This is important because the human finger has higher transmission in the near-IR spectral range; additionally, when used outdoors, strong sunlight can transmit through the finger. As a result, this strong ambient light can negatively affect the sensor's signal-noise ratio. By rejecting near-IR light, BSS-IR improves the sensor's signal-noise ratio and helps create a sharper image.



Visual 3: 3M Biometric Security System-IR Rejector (BSS-IR) – Film Structure

Finally, this collimated and tuned light reaches a large-area TFT optical sensor that reads the image. All layers can be bonded with 3M's optically clear adhesives (OCAs) to ensure clarity and integrity, although some designs might include an air gap between the OLED display panel and the collimation film. (Visual 1.)

The most obvious benefit of a full-screen reader is convenience: depending on the design, the user simply touches the screen, anywhere, and the phone is available. This makes the experience faster and more intuitive, two attributes that are highly valued by consumers.

Less obvious—but crucial for many users—is the enhanced or multilevel security that a full-screen reader provides. Instead of just one fingerprint, the full-screen reader can be set up to accept multiple fingers, simultaneously or in a defined sequence.

These multilevel passwords provide more security than single fingerprints, which can be faked using 3D printers or even inexpensive rubber stamps. (If a fake fingerprint is created, the user must stop using single-fingerprint biometric sensing—for the rest of his or her life!) Multi-finger with sequencing grows the complexity of security infinitely. This could remove the annoying need for multi-level security (e.g. password + texted passcode) for many applications.

Full-screen, multilevel security also lets users tailor their interactions with their devices, including customized access and restrictions to features and apps for different individuals with whom the device is shared.

Finally, and perhaps most important for users' day-to-day experience, 3M's BSS films virtually eliminate readers' problems recognizing fingerprints when fingers are dirty or wet.

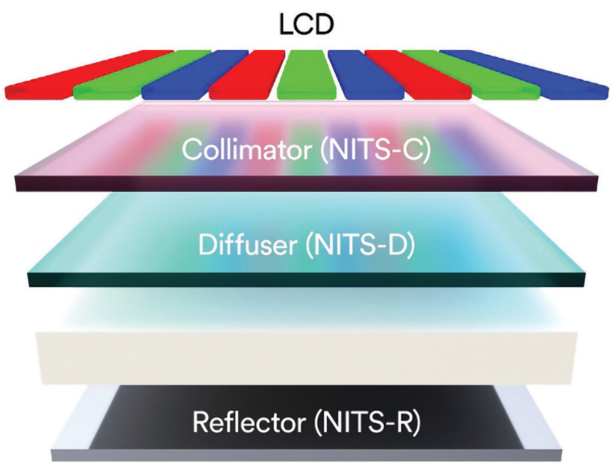
The many benefits of full-screen fingerprint sensors *seem* like they should belong only to expensive OLED displays, but that's not true. Another set of new films, 3M's Near-Infrared Transmission System (NITS), makes it possible—for the first time—for more affordable LCDs to incorporate full-screen sensing.

NITS is based around an IR sensor rather than the visible-light sensor used in the BSS for OLED displays. (Why the difference? For an LCD, conserving visible light—primarily through recycling between the polarizer and the reflector—is a key to display efficiency and battery life; allowing visible light to pass through the reflector to the sensor would undermine that efficiency, so the system relies on an IR sensor. In contrast, the light used in an OLED system is generated at the screen, which is why there is no backlight and no reflector; preserving visible light is less of a concern, so BSS uses a visible-light sensor.)

However, using an IR sensor requires a reimagining of the conventional LCD film stack, which contains several components that can distort IR light. With 3M NITS, the IR-distorting films are replaced with new films designed for IR-selective full-screen readers.

With NITS, the display functions much like a standard LCD. Light is generated at the backlight, passes through a diffuser (NITS-D) and a collimator/reflective polarizer (NITS-C); light with a state of polarization that is not useful for the display is reflected back into the light cavity, where it bounces off the reflector (NITS-R) and again acquires two states of polarization. However, unlike a standard LCD, the NITS diffuser, collimator/polarizer and reflector are all sensitive to visible light but transparent to IR light. As a result, when a finger is placed on the screen, its image passes unimpeded through the NITS-C, NITS-D and NITS-R films to the sensor. (Visual 4.)

NITS-C and NITS-R are based on the same MOF technology used in creating BSS-IR. NITS-D, the diffuser, is based on a third 3M technology, precision coating.



Visual 4: 3M™ Near Infrared Transmission System (NITS) – Film Stack

With this IR-compatible film stack, LCDs can have full-screen fingerprint readers that compare to those in OLED displays—and with similar benefits for ease of use and greatly enhanced, multilevel security. When optimized, the new stack also brings an improved viewing angle with virtually the same brightness and thinness as the conventional LCD system.

For additional information, contact Kristy Gillette (kagillette@mmm.com) or Quinn Sanford (qsanford@mmm.com) at 3M.

3M Display Materials & Systems Division
3M Center, Building 235-1E-54
St. Paul, MN 55144-1000 U.S.A.

Phone 800-553-9215
Web 3M.com/displayfilms