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Polymeric LED with Integrated Proximity-Sensor

A polymer thin-film optical touch and proximity sensor is based on the monolithic integration of polymer light emitting diodes, logos or displays and polymer photodiodes on a common substrate. Such optical sensors have the potential for cost-effective manufacturing on thin and flexible substrates.

The Concept

Polymer light emitting diodes (PLEDs) and polymer photodiode (PPD) pixel arrays have been integrated on the same side of a glass substrate. As illustrated in Figure 1, the sensor can be operated either in proximity mode or as touch sensor.

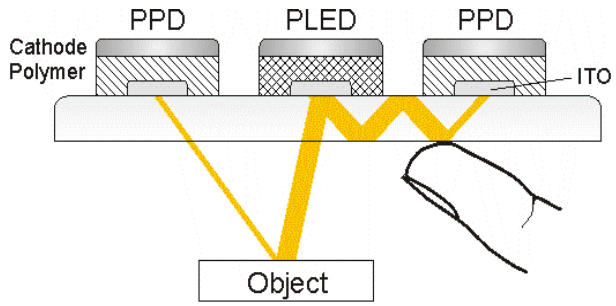

Figure 1 Device architecture and device operation

For the proximity mode, light emitted by the PLED is reflected from nearby objects falling back onto the photodiode pixels, leading to a signal enhancement. On the other hand, touching the surface leads to a change of the effective refractive index, which in turn influences the angle of total reflection and thus the guided modes in the substrate. This results in a change (generally a decrease) of the photodiode signals. Signal detection and background subtraction is achieved by modulation of the PLED driving current and a corresponding pixel-wise lock-in demodulation of the photodiode signals.

The Technology

PLEDs are based on a blend of polyfluorenes with peak emission close to 550 nm. Bulk heterojunction PPDs with peak quantum efficiency of 30% are fabricated from a blend of a C60-derivative and poly (3-hexylthiophene). A photolithographically patterned transparent conducting indium-tin-oxide (ITO) layer serves as anode for both PLEDs and PPDs. After the deposition of the polymer semiconductor thin-films, a cathode is deposited by thermal evaporation. Finally, the device is encapsulated. The sensor easily detects objects brought into close proximity, as illustrated by Figure 2. By touching the sensor with a finger, the demodulated PPD signal drops to about half its initial value, as seen in the black area of Figure 3c.

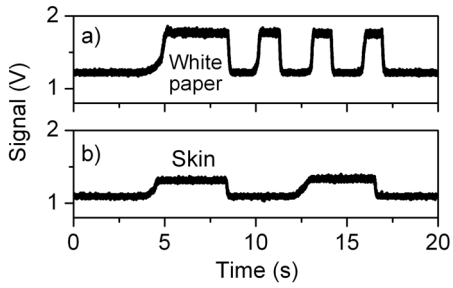

Figure 2 Response of the sensor to white paper and human skin brought repeatedly into proximity (~1.5 mm distance)

Applications

Apart from serving as thin-film illuminators, which allow the detection of nearby objects, the PLEDs can at the same time function as information displays, e.g. in the form of a static light-emitting logo or a passive matrix-display. Figure 3 shows a sensor with a light-emitting logo. Applications for these potentially very cost-effective, thin and flexible optical sensors are manifold, ranging from simple information displays with integrated touch-screen to artificial skin.

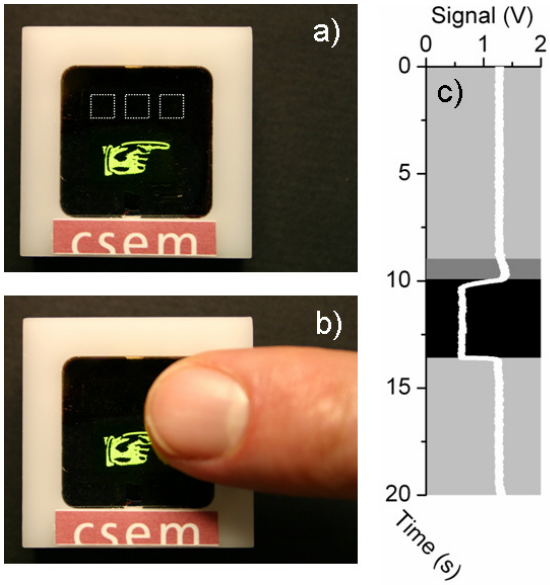

Figure 3 Sensor in operation. The locations of the photodiodes are indicated by white dashed squares in a). The response of the touch-sensor signal to a ~4 sec. lasting touch of a finger is shown in c).