OLEDs are solid-state devices composed of thin films of organic molecules that create light with the application of electricity. OLEDs can provide brighter, crisper displays on electronic devices and use less power than conventional light-emitting diodes (LEDs) or liquid crystal displays (LCDs).

Like an LED, an OLED is a solid-state semiconductor device that is 100 to 500 nanometers thick or about 200 times smaller than a human hair. OLEDs can have either two layers or three layers of organic material; in the latter design, the third layer helps transport electrons from the cathode to the emissive layer.

An OLED consists of the following parts:

- **Substrate (clear plastic, glass, foil)** - The substrate supports the OLED.
- **Anode (transparent)** - The anode removes electrons (adds electron "holes") when a current flows through the device.
- **Organic layers** - These layers are made of organic molecules or polymers.
  * Conducting layer - This layer is made of organic plastic molecules that transport "holes" from the anode. One conducting polymer used in OLEDs is polyaniline.
  * Emissive layer - This layer is made of organic plastic molecules (different ones from the conducting layer) that transport electrons from the cathode; this is where light is made. One polymer used in the emissive layer is polyfluorene.
- **Cathode (may or may not be transparent depending on the type of OLED)** - The cathode injects electrons when a current flows through the device.
OLEDs emit light (similar to LEDs), through a process called **electrophosphorescence**.

1. The battery or power supply of a device containing the OLED applies a voltage across the OLED.
2. An electrical current flows from the cathode to the anode through the organic layers.
   - The cathode gives electrons to the emissive layer of organic molecules.
   - The anode removes electrons from the conductive layer of organic molecules.
3. At the boundary between the emissive and conductive layers, electrons find electron holes.
   - when an electron finds an electron hole, the electron fills the hole (it falls into an energy level of the atom that's missing an electron).
   - when this happens, the electron gives up energy in the form of a photon of light.
4. The OLED emits light.
5. The color of the light depends on the type of organic molecule in the emissive layer. Manufacturers place several types of organic films on the same OLED to make color displays.
6. The intensity or brightness of the light depends on the amount of electrical current applied: the more current, the brighter the light.

**Polymer light-emitting diodes (PLED)**, also light-emitting polymers (LEP), involve an electroluminescent conductive polymer that emits light when connected to an external voltage. They are used as a thin film for full-spectrum colour displays. Polymer OLEDs are quite efficient and require a relatively small amount of power for the amount of light produced.
Types of OLEDs: Passive and Active Matrix
There are several types of OLEDs:
- Passive-matrix OLED
- Active-matrix OLED
- Transparent OLED
- Top-emitting OLED
- Foldable OLED
- White OLED

Passive-matrix OLED (PMOLED) have strips of cathode, organic layers and strips of anode. The anode strips are arranged perpendicular to the cathode strips. The intersections of the cathode and anode make up the pixels where light is emitted. External circuitry applies current to selected strips of anode and cathode, determining which pixels get turned on and which pixels remain off. Again, the brightness of each pixel is proportional to the amount of applied current. PMOLEDs are easy to make, but they consume more power than other types of OLED, mainly due to the power needed for the external circuitry.

Active-matrix OLED (AMOLED) have full layers of cathode, organic molecules and anode, but the anode layer overlays a thin film transistor (TFT) array that forms a matrix. The TFT array itself is the circuitry that determines which pixels get turned on to form an image. AMOLEDs consume less power than PMOLEDs because the TFT array requires less power than external circuitry, so they are efficient for large displays. AMOLEDs also have faster refresh rates suitable for video.
Transparent OLEDs have only transparent components (substrate, cathode and anode) and, when turned off, are up to 85 percent as transparent as their substrate. When a transparent OLED display is turned on, it allows light to pass in both directions. A transparent OLED display can be either active- or passive-matrix. This technology can be used for heads-up displays.

Top-emitting OLEDs have a substrate that is either opaque or reflective. They are best suited to active-matrix design. Manufacturers may use top-emitting OLED displays in smart cards.

Foldable OLEDs have substrates made of very flexible metallic foils or plastics. Foldable OLEDs are very lightweight and durable. Their use in devices such as cell phones and PDAs can reduce breakage, a major cause for return or repair. Potentially, foldable OLED displays can be attached to fabrics to create "smart" clothing, such as outdoor survival clothing with an integrated computer chip, cell phone, GPS receiver and OLED display sewn into it.

White OLEDs emit white light that is brighter, more uniform and more energy efficient than that emitted by fluorescent lights. White OLEDs also have the true-color qualities of incandescent lighting. Because OLEDs can be made in large sheets, they can replace fluorescent lights that are currently used in homes and buildings. Their use could potentially reduce energy costs for lighting.
OLED Advantages

- The plastic, organic layers of an OLED are thinner, lighter and more flexible than the crystal-line layers in an LED or LCD.

- Because the light-emitting layers of an OLED are lighter, the substrate of an OLED can be flexible instead of rigid. OLED substrates can be plastic rather than the glass used for LEDs and LCDs.

- OLEDs are brighter than LEDs. Because the organic layers of an OLED are much thinner than the corresponding inorganic crystal layers of an LED, the conductive and emissive layers of an OLED can be multi-layered. Also, LEDs and LCDs require glass for support, and glass absorbs some light. OLEDs do not require glass.

- OLEDs do not require backlighting like LCDs. LCDs work by selectively blocking areas of the backlight to make the images that you see, while OLEDs generate light themselves. OLED’s consume much less power than LCDs.

- OLEDs are easier to produce and can be made to larger sizes. Because OLEDs are essentially plastics, they can be made into large, thin sheets. It is much more difficult to grow and lay down so many liquid crystals.

- OLEDs have large fields of view, about 170 degrees. Because LCDs work by blocking light, they have an inherent viewing obstacle from certain angles. OLEDs produce their own light, so they have a much wider viewing range.

OLED Disadvantages

- While red and green OLED films have longer lifetimes (46,000 to 230,000 hours), blue organics currently have much shorter lifetimes (up to around 14,000 hours).

- Color balance issues: Additionally, blue light output will decrease relative to the other colors of light. This differential color output change will change the color balance of the display and is much more noticeable than a decrease in overall luminance.

- Manufacturing processes are expensive.

- Water - Water can easily damage OLEDs. Water damage may especially limit the longevity of more flexible displays.

- Outdoor performance: As an emissive display technology, OLEDs rely completely upon converting electricity to light, unlike most LCDs which are to some extent reflective; e-ink leads the way in efficiency with ~33% ambient light reflectivity, enabling the display to be used without any internal light source. The metallic cathode in an OLED acts as a mirror, with reflectance approaching 80%, leading to poor readability in bright ambient light such as outdoors. However, with the proper application of a circular polarizer and anti-reflective coatings, the diffuse reflectance can be reduced to less than 0.1%. With 10,000 fc incident illumination (typical test condition for simulating outdoor illumination), that yields an approximate photopic contrast of 5:1.