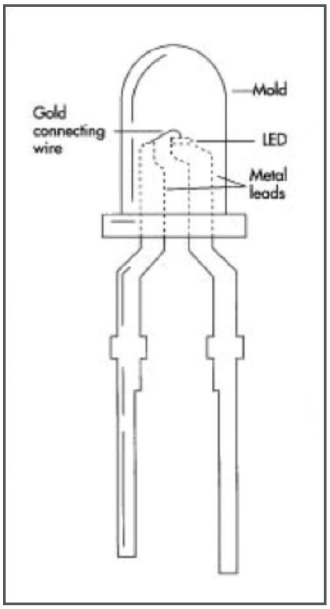
Focused Microelectronics Applications

LIGHT EMITTING DIODES

A diode is a specialized electronic component made with semiconductor materials such as silicon, germanium, or selenium. They contain two electrodes, one of which is referred to as the anode and the other as a cathode based upon the direction (charge) of electrons that they contain. This difference causes electrons to move from one layer to another, thereby generating light or power. Diodes that emit visible light or IR energy when current passes through it are referred to as light-emitting diode (LED).

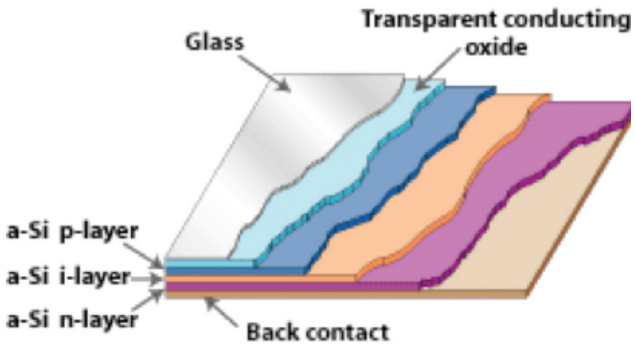


1. The manufacturing process for a light emitting diode is quite similar to most other semiconductors:
2. A semiconductor wafer is produced by growing an ingot and then slicing and polishing it to produce a thin wafer referred to as the substrate.
3. Additional layers are then grown on the wafer through the doping process to create the charge characteristics by placing the wafer in a high temperature furnace tube, where it is immersed in a gaseous atmosphere containing the dopants, nitrogen or zinc ammonium being most common. By altering the type of dopants, the characteristics such as color or efficiency are created.
4. Metal contacts are created through the process of photolithography (photoresist, develop, etch) and subsequently polished.
5. The chips are then cut from the wafer.

Once the chip is produced, lead wires can be attached and then the diode can be encased in plastic or epoxy to produce the finished LED.

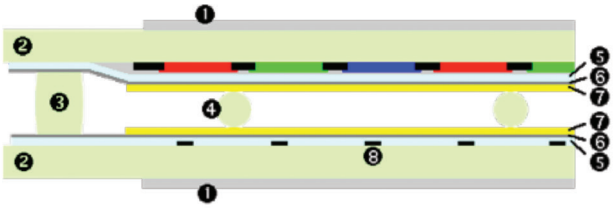
PHOTOVOLTAIC CELL (SOLAR CELLS)

A typical photovoltaic cell (PV) is composed of a thin wafer consisting of an ultra-thin layer of phosphorus-doped (N-type) silicon on top of a thicker layer of boron-doped (P-type) silicon and as such, is essentially a diode. When sunlight strikes the surface of a PV cell, this electrical field provides momentum and direction to light-stimulated electrons, resulting in a flow of current when the solar cell is connected to an electrical load. An anti-reflective coating is applied to the top surface of the cell, and electrical contacts are imprinted on the top (negative) surface of the cell. An aluminized conductive material is deposited on the back (positive) surface of each cell. These can then be assembled in a series to create solar panels.



FLAT PANEL DISPLAYS

A flat panel display (FPD) consists of two glass plates with a material compressed between them that respond to an electrical signal by emitting light. Rows and columns of electrical conductors form a grid pattern on the glass plates and it is the intersection of these rows and columns that define the picture elements, called pixels. The modulation of light by each pixel creates the images on the screen. While there are three broad types of commercially available FPDs, liquid crystal displays (LCD) account for 80% of the market. In liquid crystal displays, a thin layer of liquid crystal, a liquid that exhibits crystalline properties, is sandwiched between two electrically conducting plates. The top plate has transparent electrodes (TFT: thin-film transistors) deposited on it, and the back plate is illuminated. By applying proper electrical signals across the plates, various segments of the liquid crystal can be activated, causing changes in their light diffusing or polarizing properties to create images.



Setup of a typical LCD panel: 1) Polarizer, 2) Glass Substrate, 3) Seal, 4) Spacer, 5) ITO, 6) Hard Coat, 7) Polyimide, 8) TFT

The manufacturing process for LCD consists of a series of cleaning and deposition processes followed by bonding of the plates and then filling the space between the plates. The cleanliness of the deposited materials as well as the glass is critical to bonding and performance. Common lithographic equipment like resist coaters, steppers and dry or wet etching equipment is used in the process making it similar to some of the processes for producing a semiconductor or circuit board.

FILTRATION OPPORTUNITIES

CMP Slurry: A polishing process using an aqueous slurry composed of nanometer sized abrasive particles, such as silica, alumina, ceria, suspended in various chemicals such as oxidizers, pH stabilizers and corrosion inhibitors to erode the surface both. Depending on the slurry, filtration requirements may range from 0.3 micron to 10 micron. High performance melt blown filters such as the Stratum series are the main technology in use. The goal is to remove any agglomerated particles while leaving behind the nanometer sized particles of the polish.

Ultra-Pure Water: As many of the process are similar to semiconductor process, water is required in high volumes. Requirements exist for pre-R.O., resin traps, tank vents, prefilters and final filters. ZTEC E polyethersulfone membrane filters offers flow and performance advantages and has become the typical membrane used. The critical nature of the water requires the use of high end melt blown filters are such as Stratum for pre RO while the water delivered to the Fab will require a prefilter and final filter such as 0.1 micron followed by a 0.03 micron ZTEC E filters.

FPD Array Process: Filtration requirements include pre-clean, post-clean, rubbing cleaning, detergent and post cutting edge cleaning. Since acids and solvents are used in these processes, filter requirements may require the use of PTFE membranes such as TefTEC for compatibility.

FPD Color Filter Process: Liquid filters will be used for coating processes, developer and DI rinse water. The chemistries used in the application may require the use of PTFE filters such as Citadel™ and TefTEC, but the weaker acids may allow the use of ZTEC E.

FPD Facilities (BCDS and CDS): Delivering chemicals in bottles is impractical so the chemicals are supplied from storage tanks and drums through pump systems which are all part of the bulk chemical delivery system. The chemicals used are ultrapure, thus the the filters have a long cycle life and are changed out on a PM (preventative maintenance) basis up to 1 year. Due to the life and varying nature of the chemicals, all-fluorpolymer filters such as the Citadel are utilized in many cases.

FPD Photolithography, Wet Etch and Clean: These processes involve aggressive chemistries such as strong acids, oxidizers and solvents at potentially high temperatures. While the etch process may allow the use of ZTEC E, quite often Citadel will be the choice since it reduces the risk of compatibility issues and provides the upmost purity.