



# EPIWORKS®

## Semiconductor Industry Glossary of Terms

**bandwidth:** The range of frequency of a signal or signal-carrying channel. For digital signals, the width is expressed as the data transfer rate, in bits per second. In semiconductor devices, the bandwidth is the frequency range in which the performance characteristics fall within specified limits.

**base:** The region of a bipolar transistor that separates the emitter and collector regions.

**bipolar transistor:** Commonly used for amplification, a bipolar transistor is made from a sandwich of N- and P-type semiconductor material, resulting in either a PNP or NPN transistor. The middle section is known as the "base" and the other two as the "collector" and "emitter." In P-type material, electric charges are carried mainly in the form of electron deficiencies called holes. In N-type material, the charge carriers are primarily electrons. Bipolar devices can switch signals at high speeds, and can be manufactured to handle large currents, making them useful for applications such as high-power amplifiers in wireless transmitters.

**carbon doping:** Adding carbon to a semiconductor material to increase its conductivity. Other common dopants include silicon, beryllium, and zinc. The material and type and level of doping determine whether the semiconductor is N-type or P-type.

**circuit:** An assemblage of interconnected electrical or electronic components.

**clean room:** A room in which the climate and particulate matter are precisely controlled. Clean rooms are "classed" according to a maximum number of particles (0.3 micron or larger) that may exist in any one cubic foot of space within the defined area. A Class 1 clean room is limited to only one particle in a cubic foot of space.

**conductor:** Any material that offers little resistance to the flow of electrical current (e.g., aluminum, copper, gold).

**DC operation:** Direct Current (DC) is the mode of operation where a transistor is operated under constant, direct voltage bias. Also see RF Operation.

**DC / RF properties:** DC (direct current ) and RF (radio frequency) properties are determined by the vertical and horizontal dimensions of transistor layers.

**double crystal X-ray diffraction:** The use of X-rays to determine the spacing between atoms in a semiconductor crystal.

**edge-emitting lasers:** Semiconductor devices that have a region of optical gain that can emit light, or lase, from the edge of the gain region (as opposed to the surface-emitting, vertical cavity type, called VCSEL).

**electrochemical C-V profiling:** A method to determine the dopant profile in semiconductor devices by measuring the capacitance (C) of the material as a function of voltage (V).

**epitaxy:** The growth on a crystalline substrate of a crystalline layer, called an epilayer, that mimics the orientation of the substrate.

**etch:** To remove, in a controlled manner, selected material from a wafer by employing chemical, electrolytic, or plasma means.

**fab:** Fabrication. In semiconductor manufacturing, specifically the front-end process of making devices and integrated circuits in semiconductor wafers.

**FET:** Field-effect transistor. Transistors, commonly used for weak-signal amplification, in which the output current is varied by varying the value of an electric field within a region of the device. A FET has a region of donor material with two terminals called the "source" and the "drain," with a region of acceptor material, called the "gate," lying between. The gate is so called because it can be used to control the flow of electrons along the channel.

**GaAs:** Gallium arsenide. A III-V compound semiconductor material used for making optoelectronic devices and high-frequency ICs. The charge carriers, mostly electrons, move at high speed among the atoms (twice the speed of those of silicon), making GaAs components useful for producing higher-speed devices. Also, GaAs devices generate less noise than most other types of semiconductor components, important for weak-signal amplification.

**gate:** The control electrode in a field-effect transistor (FET). The application of a voltage to the gate varies the electrical diameter of the semiconductor path or channel, allowing the regulation of its conducting properties.

**growth process:** The process of making device wafers by depositing, or "growing," layer by layer, on a substrate.

**HBT:** Heterojunction bipolar transistor. A vertical transistor used for high performance wireless and telecom circuits, such as circuits for digital cell phone handsets and high-bandwidth fiber-optic telecommunications systems. See bipolar transistor.

**HEMT:** High-electron-mobility transistor. A type of FET that utilizes a high-mobility layer to enhance performance.

**HFET:** Heterojunction field-effect transistor. A type of FET with enhanced performance achieved by employing a heterojunction between two semiconductors of different bandgap.

**InGaP:** Indium gallium phosphide. Used in HBT device wafers. A III-V compound semiconductor material used for making optoelectronic devices and high-frequency ICs. This material is often employed in very high-speed, reliable HBTs, FETs, and lasers.

**integrated circuit (IC):** Sometimes called a chip or microchip, an IC is a small electronic device (consisting of thousands or millions of tiny resistors, capacitors, and transistors) made from a semiconducting material. Devices containing integrated circuits have a variety of applications including microprocessors, audio and video equipment, and automobiles.

**low noise amplifier (LNA):** Integrated circuits (ICs) used to amplify lower-power, smaller signals into larger, more easily used signals. LNAs are designed to contribute very little noise.

**LP-MOCVD:** Low-pressure Metal Organic Chemical Vapor Deposition. LP-MOCVD is a method to deposit or "grow" semiconductor materials by allowing gaseous sources to react on the surface of a semiconductor and form another perfect crystal semiconductor on the surface.

**masking:** When making integrated circuits, a process using photoresist or light-sensitive film applied to a wafer to define the pattern of the areas to be etched or metallized.

**micron:** A metric unit of linear measure that equals one millionth of a meter. Symbol:  $\mu\text{m}$

**MOCVD:** Metal Organic Chemical Vapor Deposition. The same as LP-MOCVD, but with growth at higher pressures.

**N-type semiconductor:** A semiconductor in which current is conducted by excess free electrons.

**optoelectronic:** Pertaining to any device that functions as an electrical-to-optical or optical-to-electrical transducer (i.e., a device that is responsive to or that emits or modifies light waves), or an instrument that uses such a device in its operation.

**P-type semiconductor:** A semiconductor in which current is conducted by electron vacancies.

**photodetectors:** Semiconductor devices that receive light and convert it into electrical signals.

**photoluminescence:** A method of measuring some critical semiconductor material characteristics by shining a laser on the material and measuring the signal that returns.

**photorefectance:** One of an extensive set of characterization techniques used to analyze epitaxial layers. Photorefectance (PR) is a method of characterizing semiconductor material properties by analyzing how light reflects off the material.

**power amplifiers:** Integrated circuits (ICs) used to amplify lower-power, smaller signals into larger, more easily used signals. Power amplifiers are designed to handle high power levels.

**profilometry:** A method for measuring the profile, or heights, of semiconductor layers by dragging a needle across the surface of an etched semiconductor.

**reflectance difference spectroscopy:** Developed in the 1980s, reflectance difference (anisotropy) spectroscopy provides a surface-sensitive, non-destructive method of examining the order of molecules adsorbed on the clean substrate. The surface is probed by a light beam with two orthogonal polarization components, and the relative difference in complex reflectances is then measured.

**resistivity mapping:** A method to map the resistance of a semiconductor across an entire wafer.

**RF operation:** Radio frequency (RF) is the mode of operation where a transistor is rapidly switched off and on with smaller biases. This rapid switching occurs at a rate consistent with the radio frequency range/spectrum.

**semiconductor:** A material, usually a solid chemical element or compound, that is neither a good conductor of electricity (like copper) nor a good insulator (like rubber). The conductance varies depending on the current or voltage applied to a control electrode, or on the intensity of irradiation by infrared, visible, or ultraviolet light, or X rays. Common semiconductors include silicon, germanium, gallium arsenide, indium antimonide, and the oxides of most metals. Of these, gallium arsenide (GaAs) is widely used in low-noise, high-gain, weak-signal amplifying devices.

**substrate:** The underlying material on which other layers are deposited. Such material may be electrically active, such as gallium arsenide or silicon, or passive, such as alumina ceramic.

**transistor:** A three-terminal device composed of semiconductor material that amplifies a signal or opens or closes a circuit. Transistors are the basic elements in integrated circuits, which consist of very large numbers of transistors interconnected with circuitry and contained within a single "chip."

Note: John Bardeen, an engineering professor at the University of Illinois at Urbana-Champaign, was awarded his first Nobel Prize for developing the transistor while at Bell Labs.

**Van der Pauw-Hall:** A method used to measure the doping level and "mobility," or ease for an electron or hole to move about a semiconductor material. This mobility is used to gauge the quality of the semiconductor.

**VCSEL (pronounced "vixel"):** Vertical cavity surface emitting laser. A type of laser that emits light vertically and is often used in fiber-optic communication systems.

**wafer:** A thin semiconductor material (approximately 1/30" thick) used as the foundation for integrated circuit manufacture.