

# Gallium Nitride GaN Physics Devices And Technology Devices Circuits And Systems

Gallium nitride

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Gallium nitride (GaN) is a binary III/V direct bandgap semiconductor commonly used in blue light-emitting diodes since the 1990s. The compound is a very hard material that has a Wurtzite crystal structure. Its wide band gap of 3.4 eV affords it special properties for applications in optoelectronics, high-power and high-frequency devices. For example, GaN is the substrate that makes violet (405 nm) laser diodes possible, without requiring nonlinear optical frequency doubling.

Its sensitivity to ionizing radiation is low (like other group III nitrides), making it a suitable material for solar cell arrays for satellites. Military and space applications could also benefit as devices have shown stability in high-radiation environments.

Because GaN transistors can operate at much higher temperatures...

Semiconductor device

*wafers thus making mass production of GaAs devices significantly more expensive than silicon. Gallium Nitride (GaN) is gaining popularity in high-power applications*

A semiconductor device is an electronic component that relies on the electronic properties of a semiconductor material (primarily silicon, germanium, and gallium arsenide, as well as organic semiconductors) for its function. Its conductivity lies between conductors and insulators. Semiconductor devices have replaced vacuum tubes in most applications. They conduct electric current in the solid state, rather than as free electrons across a vacuum (typically liberated by thermionic emission) or as free electrons and ions through an ionized gas.

Semiconductor devices are manufactured both as single discrete devices and as integrated circuits, which consist of two or more devices—which can number from the hundreds to the billions—manufactured and interconnected on a single semiconductor wafer (also...

Gallium arsenide

*used in the manufacture of devices such as microwave frequency integrated circuits, monolithic microwave integrated circuits, infrared light-emitting diodes*

Gallium arsenide (GaAs) is a III-V direct band gap semiconductor with a zinc blende crystal structure.

Gallium arsenide is used in the manufacture of devices such as microwave frequency integrated circuits, monolithic microwave integrated circuits, infrared light-emitting diodes, laser diodes, solar cells and optical windows.

GaAs is often used as a substrate material for the epitaxial growth of other III-V semiconductors, including indium gallium arsenide, aluminum gallium arsenide and others.

Gallium

*of gallium in electronics, is used in microwave circuits, high-speed switching circuits, and infrared circuits. Semiconducting gallium nitride and indium*

Gallium is a chemical element; it has symbol Ga and atomic number 31. Discovered by the French chemist Paul-Émile Lecoq de Boisbaudran in 1875,

elemental gallium is a soft, silvery metal at standard temperature and pressure. In its liquid state, it becomes silvery white. If enough force is applied, solid gallium may fracture conchoidally. Since its discovery in 1875, gallium has widely been used to make alloys with low melting points. It is also used in semiconductors, as a dopant in semiconductor substrates.

The melting point of gallium, 29.7646 °C (85.5763 °F; 302.9146 K), is used as a temperature reference point. Gallium alloys are used in thermometers as a non-toxic and environmentally friendly alternative to mercury, and can withstand higher temperatures than mercury. A melting point...

Integrated circuit

*carbon nanotube field-effect transistor, gallium nitride transistor, transistor-like nanowire electronic devices, organic field-effect transistor, etc.*

An integrated circuit (IC), also known as a microchip or simply chip, is a compact assembly of electronic circuits formed from various electronic components — such as transistors, resistors, and capacitors — and their interconnections. These components are fabricated onto a thin, flat piece ("chip") of semiconductor material, most commonly silicon. Integrated circuits are integral to a wide variety of electronic devices — including computers, smartphones, and televisions — performing functions such as data processing, control, and storage. They have transformed the field of electronics by enabling device miniaturization, improving performance, and reducing cost.

Compared to assemblies built from discrete components, integrated circuits are orders of magnitude smaller, faster, more energy-efficient...

## High-electron-mobility transistor

2657579. Medjdoub, F. (2016). Medjdoub, Farid (ed.). *Gallium Nitride (GaN): Physics, Devices, and Technology (1st ed.)*. CRC Press. doi:10.4324/b19387. ISBN 9781315215426

A high-electron-mobility transistor (HEMT or HEM FET), also known as heterostructure FET (HFET) or modulation-doped FET (MODFET), is a field-effect transistor incorporating a junction between two materials with different band gaps (i.e. a heterojunction) as the channel instead of a doped region (as is generally the case for a MOSFET). A commonly used material combination is GaAs with AlGaAs, though there is wide variation, dependent on the application of the device. Devices incorporating more indium generally show better high-frequency performance, while in recent years, gallium nitride HEMTs have attracted attention due to their high-power performance.

Like other FETs, HEMTs can be used in integrated circuits as digital on-off switches. FETs can also be used as amplifiers for large amounts...

## Tomás Palacios (engineer)

*various centers and programs, including being founding director of the MTL Center for Graphene Devices and 2D Systems and MTL Gallium Nitride (GaN) Energy Initiative*

Tomás A. Palacios Gutiérrez (born 1978) is a Spanish-American Electrical & Microelectronics Engineer known for his work in advanced device and material design. He holds the chair Clarence J. LeBel Professor of Electrical Engineering and Computer Science at the Massachusetts Institute of Technology and director of Microsystems Technology Laboratories (MTL). Palacios is known for inventing a super-thin 'sheet' that can charge mobile phones without electricity.

## Ferdinand-Braun-Institut

*scientific and industrial applications. In 2006, BeMiTec was founded to develop, produce and sell high-power gallium nitride transistors (GaN) for future*

The Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik (FBH) is a research institute, which is a member of the Gottfried Wilhelm Leibniz Scientific Community. The institute is located in Berlin at the Wissenschafts- und Wirtschaftsstandort Adlershof (WISTA), its research activity is applied science in the fields of III-V electronics, photonics, integrated quantum technology and III-V technology

## History of the LED

*issues concerning gallium nitride-on-silicon (GaN-on-Si) technology and wafer scale up challenges". 2013 IEEE International Electron Devices Meeting. pp. 13*

The history of the light-emitting diode begins with the 1906 discovery of electroluminescence from a solid state diode by Henry Joseph Round. In 1927, Russian inventor Oleg Losev created the first LED. The first practical LED was developed in 1961 by researchers at Texas Instruments. The 1970s saw the first commercial LEDs. In the early 1990s,

Shuji Nakamura, Hiroshi Amano and Isamu Akasaki invented blue LEDs that were dramatically more efficient than their predecessors, bringing a new generation of bright, energy-efficient white lighting and full-color LED displays into practical use, work that won them the 2014 Nobel Prize in Physics.

Aristos Christou

*surface and interface science and methodologies for achieving reliable high frequency devices, optoelectronic devices and circuits. Christou is a life fellow*

Aristos Christou is an American engineer and scientist, academic professor and researcher. He is a Professor of Materials Science, Professor of Mechanical Engineering and Professor of Reliability Engineering at the University of Maryland.

Christou has conducted research in basic device physics, solid state electronics, semiconductor materials, radiation effects in microelectronics, radiation hard design methodologies, basic processes of materials degradation, along with degradation of metal microstructure and high pressure induced transformations in steels and iron alloys. His technical contributions include the development of material's surface and interface science and methodologies for achieving reliable high frequency devices, optoelectronic devices and circuits.

Christou is a life fellow...

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