Gallium Nitride

March 16, 2022

In news—Recently, the Union Minister of State for Electronics & Information Technology has visited the Gallium Nitride Ecosystem Enabling Centre and Incubator (GEECI) facility at the prestigious Indian Institute of Sciences (IISc), Bengaluru.

About Gallium nitride (GaN)-

- It is a **binary direct bandgap semiconductor commonly used in blue light-emitting diodes(LED)** since the 1990s.
- The compound is a **very hard material** that has a Wurtzite crystal structure.
- **Its wide band gap of 3.4 electron-volt affords it special properties for applications in optoelectronic, high-power and high-frequency devices.**
- For example, GaN is the substrate which makes violet laser diodes possible, without requiring nonlinear optical frequency-doubling.
- With higher breakdown strength, faster switching speed, higher thermal conductivity and lower on-resistance, power devices based on GaN significantly **outperform silicon-based devices.**
- Gallium nitride crystals can be grown on a variety of substrates, including sapphire, silicon carbide (SiC) and silicon (Si).
- 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 radiation environments.
- As GaN transistors can operate at much higher temperatures and work at much higher voltages than gallium arsenide (GaAs) transistors, t**hey make ideal**

power amplifiers at microwave frequencies. In addition, GaN offers promising characteristics for THz devices.

- Due to high power density and voltage breakdown limits GaN is also emerging as a **promising candidate for 5G cellular base station applications.**

Gallium Nitride Technology in India-

- In December 2021, **Indian researchers had developed a high performance industry-standard model for Aluminium gallium nitride (AlGaN/GaN) High Electron Mobility Transistors (HEMTs)** with simple design procedures which **can be used to make high-power Radio Frequency (RF) circuits owing to its high breakdown voltage.**
- Radio Frequency circuits include amplifiers and switches, which are used in wireless transmission and are useful for space and defense applications.
- As AlGaN/GaN HEMTs can also extend the power level of solid-state microwave circuits by a factor of five to ten, resulting in an appreciable **reduction in the overall chip size and cost, the standard developed** can significantly reduce the development cost of the circuits and devices for transmitting high-frequency signals.

- **It has two excellent properties – high mobility and high-power performance.**

- These properties reduce the noise figure and complexity while designing Low Noise Amplifiers (LNAs) (used in wireless transmission like mobile phones, base stations) while increasing the achievable bandwidth.
- **AlGaN/GaN HEMTs have become the technology of choice for high-frequency and high-power applications like 5G, radars, base stations, satellite communications, etc.**
- In this work, the team led by Prof. Yogesh Singh Chauhan at IIT Kanpur developed and standardized a physics-based compact model for AlGaN/GaN HEMTs – the Advanced Spice

Model for GaN-HEMTs (ASM-HEMT).

About GEECI-

- The facility has been jointly set up by the Ministry of Electronics and Information Technology and IISc Bengaluru aimed at establishing GaN based Development Line Foundry facility, especially for RF and power applications, including strategic applications.
- AGNIT Semiconductors Pvt. Ltd. the first startup has already been incubated in TBI-InCeNSE an incubator of SID, IISc. It has raised its first round of angel funding.
- This will be the first startup to leverage the infrastructure created by GEECI.
- In order to promote it, the government has announced $10 billion incentive package for setting up Semiconductor fab units in India and to make india a global hub for Electronics systems design and manufacturing (ESDM).

Further reading: https://journalsofindia.com/high-electron-mobility-transistor-hemts/