Discussion of novel III-V material for High-power switching and TeraHertz (THz) electronics for Bio-Medical Sensing & Imaging Applications

Imaging, radar, spectroscopy, and communications systems that operate in the millimeter-wave (MMW) and sub-MMW bands of the electromagnetic spectrum have been difficult to develop because of technical challenges associated with generating, detecting, processing and radiating the high-frequency signals associated with these wavelengths. To control and manipulate radiation in this especially challenging portion of the RF spectrum, new electronic devices must be developed that can operate at frequencies above one Terahertz (THz), or one trillion cycles per second.

To fully exploit the sub-MMW band will require monolithic microwave integrated circuits (MMICs) that can operate up to THz frequencies. Terahertz frequencies represent one such opportunity, with progress pegged back by the difficulties of building sources operating in this domain. But if these challenges could be overcome, it would be great news for mankind. It could open the door to ultra-high speed circuits used for information and communication systems, including those operating wirelessly, as well as terahertz imaging systems and spectroscopy detection.

To make these THz MMICs (or "TMICs") will require THz transistors with maximum oscillation frequencies (f_{max}) well above 1 THz. The objective of the Terahertz (THz) Electronics is to develop the critical device and integration technologies necessary to realize compact, high-performance electronic circuits that operate at frequencies exceeding 1.0 THz. Transistors made from III-V channels, we have chosen them to pursue a terahertz transistor. There are several options in this regard, and we have decided to focus our attention on III-V based devices, because they are known to have a higher critical breakdown field, greater robustness, higher current density and better thermal conductivity (when grown on SiC).

III-V materials having high electron mobility and high injection velocities can provide high ON current with reduction in device delay. High mobility III-V semiconductors also have significant transport advantage and are being extensively researched as channel materials for upcoming highly scaled devices. Compound semiconductors such as InN, InAs, InP, GaN, InSb, InGaAs, AlGaN, etc have shown excellent properties and thus, investigation to these compounds needs to done for integrating them in modern nano devices.