Plasmonic Nanosensors for THz Communication and Sensing for IoT Applications

Michael S. Shur

Electrical, Computer, and Systems Engineering and Physics, Applied Physics, and Astronomy
Rensselaer Polytechnic Institute
shurm@rpi.edu

Terahertz (THz) sensing technology\(^1\) and sub-THz and THz communications\(^2\) have potential to meet challenging demands of IoT applications by providing high responsivity, selectivity, and large bandwidth. THz communications links in the 300 GHz and 600 GHz atmospheric windows operated at distances up to several hundred meters.\(^3\) Semiconductor two-terminal THz devices, such as IMPATT diodes, Resonant Tunneling Diodes (RTD) and Schottky diodes operated at frequencies up to several THz. High speed three terminal electronic devices (FETs and HBTs) have penetrated the sub-THz and THz ranges with cutoff frequencies and maximum frequencies of operation above 1 THz and close to 0.5 THz for InGaAs and Si technologies, respectively. In this talk, we will discuss a new “plasma wave electronics” approach for achieving terahertz emission and detection using GaAs-based, GaN-based, graphene and Si nanostructure arrays. Recently proposed “plasmonic boom” terahertz (THz) sources\(^4,\)\(^5\) using such nanostructures have promise of achieving powers up to 100 mW or higher at one THz. These devices operate under the ballistic transport conditions and use the spatially modulated electron drift velocity exceeding the plasma velocity and causing a “plasmonic boom” instability. The plasmonic THz detectors\(^6\) have reached Noise Equivalent Powers down to pW/Hz\(^{1/2}\). Therefore, the plasmonic electronics technology might become a dominant THz electronics technology and support both sensing and communications at THz frequencies for IoT applications.

---

\(^1\) M. Shur, Recent developments in terahertz sensing technology, Proc. SPIE 9836, Micro- and Nanotechnology Sensors, Systems, and Applications VIII, 98362Q (May 25, 2016); doi:10.1117/12.2218682