Preface

In the pursuit of extracting more information about our universe, terahertz technology is taking center stage in achieving high data rate communications. This technology uses the spectrum that lies in between the microwave and the infrared region with frequencies ranging from 300 GHz to 3 THz. The terahertz band provides a transition between the electronic and the photonic regions thus adopting important characteristics from these regimes. These characteristics corresponding with the progress in semiconductor technology help researchers to exploit this hitherto unexplored domain for a variety of applications.

This relatively new technology is now being extensively researched as it finds numerous applications across disciplines such as communication systems, bio-medical imaging, and security systems, to name a few. This diversification has forced the researchers to come up with feasible and novel devices for the sources, antennas, detectors, etc. The two major challenges where technology needs further exploration, are the implementation of compact, consistent and cheap terahertz sources, and high sensitivity terahertz detectors. Additional complexities involved in scaling from the microwave domain also need to be specifically mapped and managed.

The lack of feasible terahertz sources has hindered the direct applications of terahertz technology in various areas. Realization of nanotechnology has led to the creation of devices such as QCLs, uni-travelling-carrier photo diodes and RTDs providing new avenues to generate terahertz radiation. Critical improvements in the design and characteristics of antennas and antenna arrays are for realizing the desired requirements. Scaling of the existing technologies to adapt to the terahertz region leads to inefficient designs and does not give optimum solutions. Advancements in micromachining techniques have broken the traditional norms of manufacturing, allowing one to fabricate novel, highly integrated devices. Integration of the functional elements provides better transmission, radiation with a higher order of reliability and compactness. Fabrication of arrays to improve the directivity and the gain of the systems has become much more convenient.

The advent of PBG structures and metamaterials has helped to optimize the existing technologies to give improved directivities and gains. Adopting new materials and nanostructures such as graphene has further miniaturized antenna technology while maintaining the desired output levels. Terahertz antenna characterization of bandwidth, impedance, polarization, etc., has not yet been methodically structured, and it continues to be a major research challenge. Developing accurate models to characterize and simulate the designed antennas and state-of-the-art compact antenna test ranges to measure and test the antennas is paramount.

Space applications incorporate all the components of the terahertz technology, viz., communications, detection, and imaging. Concentrations of the order of parts per billion are encountered in astronomical observations, and thus there is a need to improve the sensitivity of the detectors and the receivers. Communication signals decrease with the square of the distance between the receiver and the transmitter. The distances encountered in deep-space communications are very large compared to the distances between satellites and ground stations. High data rates can be achieved using terahertz communications. The basis of all these components is the antennas that transmit and receive these terahertz signals. This brief describes an overview of this rapidly developing technology.

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