

LARGE CURRENT TERAHERTZ ANTENNA FEEDING USING MICROSTRIP COMBINERS INTEGRATED WITH ARRAYED UNI-TRAVELLING CARRIER PHOTODIODES

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(単一走行キャリアフォトダイオードアレーを集積したマイクロストリップ型結合器による大電流テラヘルツアンテナ給電)

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論 文 内 容 の 要 旨

Recent advancements in semiconductor photonic and electronic devices such as Uni-travelling-carrier photodiodes (UTC-PDs), have played a significant role in the development of Terahertz communication technology. However, a major challenge that still persists is the limited output power from a single UTC-PD required for practical transmission distances. To enhance the output power, this thesis proposes and demonstrates a novel Terahertz wave power combining technique using photomixer devices that comprise of arrayed UTC-PDs monolithically integrated with microstrip line-based T-junction and Wilkinson power combiners, and a rectangular patch antenna optimized for 300 GHz, on a Silicon Carbide (SiC) substrate that has a higher thermal conductivity than the conventional Indium phosphide (InP) substrate. The combiners are designed and fabricated with 2×1 , 4×1 , and 8×1 configurations exhibiting a power enhancement of about 5.8 dB, 11 dB, and 16 dB respectively. Measurement results are consistent with the theoretical assertion that power can be enhanced by a factor of N^2 if the photocurrent is multiplied by a factor of N . This technology presents a holistic and cutting edge platform for further power multiplication by further increasing the number of arrayed UTC-PDs.

Additionally, it is experimentally demonstrated that the device output is a function of electron velocity overshoot in the depletion layer of the UTC-PD that depends on an optimum bias voltage which is -1 V for the device used in this work that corresponds to an optimal electric

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field of 80 kV/cm. Moreover, the device saturation depends on space charge effect that is as a result of a critical charge density that modulates the electric field in the depletion region.

Furthermore, the research demonstrates up to 4 Gbps data transmission rate with a 4×1 T-junction combiner integrated device and 2 Gbps for a 2×1 Wilkinson combiner integrated device.