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2-D Scalable Coherent High-Power Terahertz Radiator Array

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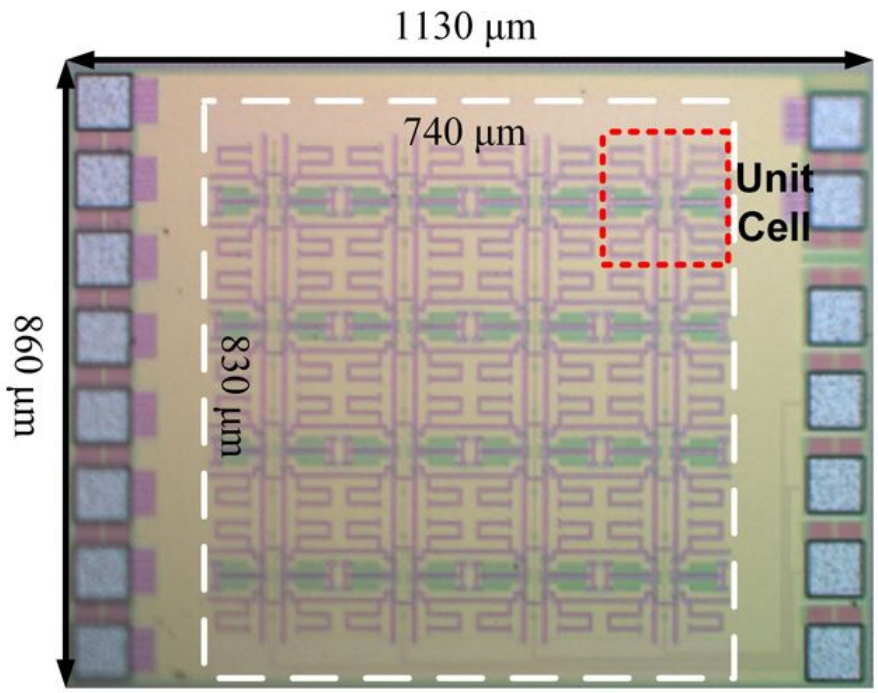

IP Status
Patent granted

Technology Readiness Level (TRL) ? 7

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The micrograph of the fabricated terahertz radiation source chip in 65-nm CMOS process.
It emits a power of -3dBm at 700GHz within a compact area of less than 1 square millimeter, featuring a coupled 4×4 oscillator array and a 4×8 antenna array. The emitted power is sufficiently robust for numerous terahertz applications, and the size of this array can be expanded to achieve even greater radiated power.

Opportunity

Many applications are emerging for terahertz (THz) radiation in diverse fields including high-speed wireless data transmission, spectroscopy, imaging, gas sensing, security scanning, and radar, leading to demand for high-power terahertz sources. However, even with the utilization of harmonic power, the operation frequencies of most silicon-based scalable radiators are limited to frequencies below 600 GHz. This is because oscillator-based radiators above 600 GHz require fundamental high-

frequency oscillation near fmax of the transistor and high-order harmonic power extraction and radiation. The current invention uses low-cost CMOS technology to generate and radiate high-power and high-frequency terahertz signals, breaking the 600 GHz barrier with an output frequency measured as high as above 700 GHz.

Technology

This invention describes a novel and compact 2-D scalable architecture of coupled harmonic oscillator array for high-power terahertz (THz) radiation. The compact and symmetric scalable unit cell comprises two oscillators with two slot antennas radiating the third-harmonic power. Each unit cell is coupled horizontally out-of-phase and vertically in-phase with adjacent cells at the fundamental frequency. Therefore, coherent radiation and power combining are achieved at the third harmonic. A 4×4 array prototype (32 radiating elements) was designed and fabricated in 65-nm CMOS technology. An elliptical Teflon lens is attached at the backside of the chip for a highly directive beam.

The invention is applicable to other frequencies and other IC fabrication technologies.

Advantages

- Higher power and higher frequency signals than current THz sources.
- Can be produced at low cost using commercially available CMOS technology.
- Easy to apply to SiGe technology and high-speed and high-power III-V semiconductor technology.
- The output power level is comparable to terahertz sources implemented using III-V technology, but the cost is much lower.

Applications

- High-speed wireless data transmission (6G)
- Spectroscopy
- Medical and scientific imaging
- Gas sensing