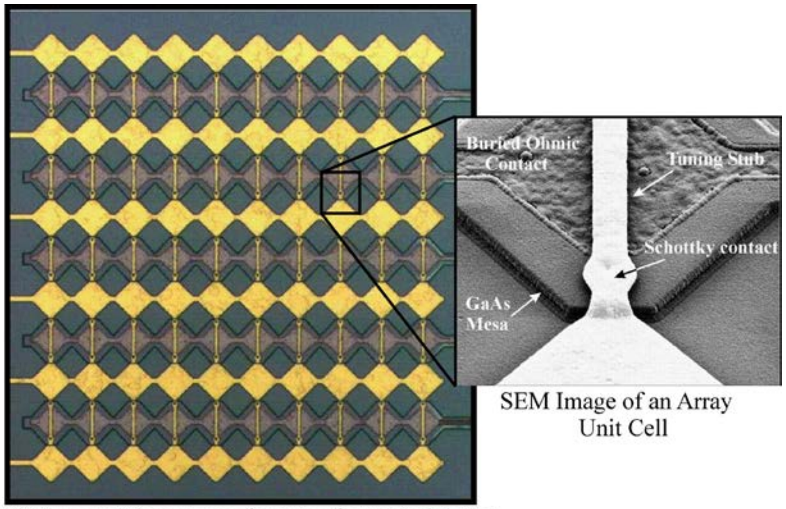
Weikle Research Group



SEM Image of an Array Unit Cell

100 Element Diode Array for Wavefront Modulation

Our group works in the area of millimeter and submillimeter-wave electronics. This research incorporates a broad range of fields including semiconductor physics, device fabrication and modeling, high-frequency circuit design, nonlinear circuit analysis, electromagnetic field theory and optics. Specific research areas of focus include terahertz diodes and sensors, heterogeneous integration of III-V semiconductor devices on thin silicon carriers, semiconductor and superconductor devices, quasi-optical arrays for imaging and beam forming, low-noise receiver elements, integrated-circuit antennas and micromachined components and electronics for terahertz metrology.

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“Guiding students on a fascinating journey of discovery.”

Submillimeter-wave Semiconductor Devices

The terahertz (THz) spectrum is critical to a wide range of scientific applications, from radio astronomy to remote sensing. However, due to the challenges of realizing the high-speed devices and circuits needed to operate at these frequencies, the terahertz range remains one of the least explored and utilized regions of the electromagnetic spectrum. The terahertz spectrum represents the transition between microwave electronics and infrared optics and carrier transport is dominated by unwanted parasitics. Consequently device geometries must be controlled carefully to mitigate the parasitic effects that limit circuit performance. To address this issue, our group researches design techniques that closely integrate full electromagnetic characterization of device and circuit architectures with nonlinear circuit simulation. In addition, our work focuses on novel device fabrication methods that permit heterogeneous integration using epitaxial transfer techniques as well as the incorporation of beamleads and other device interconnects, substrate removal and transfer processes, and nanoscale lithography.

Terahertz Quasi-Optical Arrays

The limited power handling capacity of solid-state terahertz devices is inherent; to operate at high frequencies, devices must be small to reduce parasitics and minimize carrier transit times. The reduction in size, however, also reduces the ability of these devices to generate or dissipate power. To address this, our group researches spatial power combining methods to allow power to be spread over many antenna-integrated devices (one example is shown in the previous image). Quasi-optical arrays such as this also form the foundation for terahertz focal plane imaging systems and wavefront modulation for beam steering and sideband generation that are investigated by our group.

Submillimeter Wave Metrology

The test and measurement infrastructure that allows prototyping and troubleshooting for RF and microwave circuits is largely absent in the submillimeter and terahertz frequency range. Moreover, standard waveguide interfaces used to connect terahertz components are generally imprecise due to limited tolerances of milled components. Consequently, our group has focused on a number of efforts to allow more accurate and repeatable measurements in the frequency range above 300 GHz. These include the development of low-cost integrated six-port reflectometers for scattering parameter measurement, new precision interfaces for waveguides, calibration methods that are insensitive to interface misalignment, and micromachined probes that permit on-wafer calibration and measurement at frequencies up to 1 THz.

RECENT RESEARCH DEVELOPMENTS

- 100 Element Schottky diode array for high-power wavefront phase modulation.
- Micromachined probes for on-wafer device measurements above 500 GHz.
- Integrated six-port analyzers for imaging and reflectometry.

RECENT GRANTS

- Northrop Grumman – Metrology and Wafer Probing for S-Parameter Characterization of Terahertz Devices and Circuits
- Teledyne – Develop Terahertz Wafer Probes
- NGIC – SMM Wave Device/System Technical Assistance, Fabrication, and Support
- NSF – Electronically-Actuated Coded Aperture Arrays for Millimeter and Submillimeter-Wave Imaging

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