Barker Research Group

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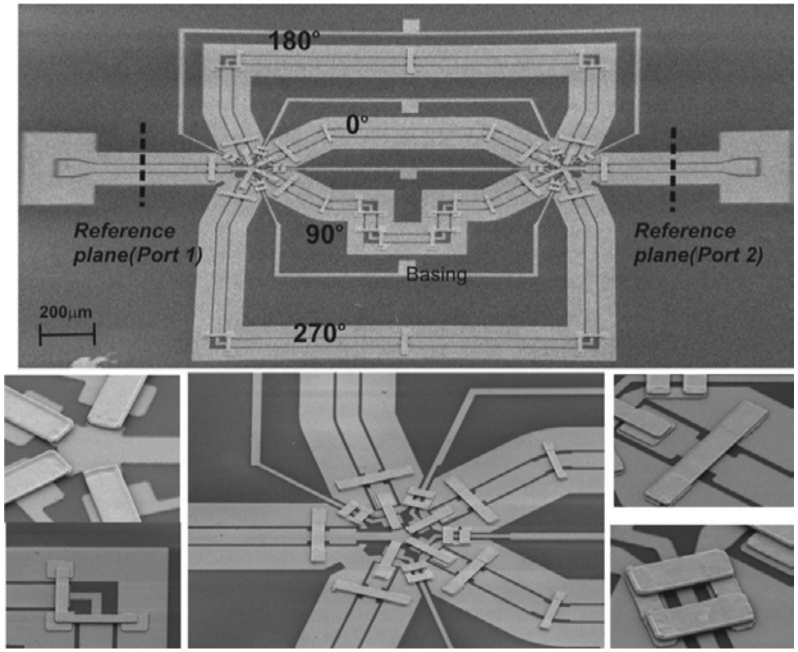

My research focuses on the development of micromachined millimeter-wave and terahertz frequency components. Over the past several years my group has developed RF-MEMS 60-GHz switched-line phase shifters, vertical interconnects for 3D integration of heterogeneous semiconductor substrates with excellent performance out to 100 GHz, RF-MEMS tunable matching networks for reconfigurable systems, and THz frequency on-wafer probes.

"Application of RF micro-electromechanical system devices to microwave and millimeter-wave circuits and systems."

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RF-MEMS Phase Modulators for Millimeter-wave Polarimeter Array

Measurements of the linear polarization of the cosmic microwave background (CMB) offer a unique probe of the early universe. The 'concordance' model of modern cosmology posits an epoch of exponential expansion of space-time shortly after the Big Bang. Gravity waves, excited during this inflationary epoch, propagate freely through the universe and interact at much later times to impart a distinctive pattern of linear polarization in the CMB. Detection of this gravity-wave signature of inflation would have profound consequences for both cosmology and high-energy physics. Detection would test physics at energies above 10^{15} GeV, more than 12 orders of magnitude beyond those accessible to direct experimentation in particle accelerators, yielding new insight into the nature of Grand Unification and quantum gravity. We are developing fast, low-power RF switches to combine the sensitivity of large-format bolometer arrays with the phase-sensitive polarization techniques of radio astronomy. The resulting combination of sensitivity and control of systematic errors will produce new capabilities for CMB polarization and mm-wave astronomy.

THz Frequency On-Wafer Probe Station

The terahertz frequency range has enormous potential for both scientific discoveries in the areas of radio astronomy, chemical spectroscopy, and material characterization as well as applications in atmospheric ozone monitoring, concealed weapons and chem/bio hazards detection, and compact-range radar systems. We are developing the first terahertz frequency (>0.5 THz) on-wafer probe station in the world.

RF-MEMS Phase Shifter for Phased-Array Antennas

Due to its potential to meet the demand of high data-rate wireless communication, 60-GHz wireless radio has recently attracted significant interest. It allows for an unprecedented capacity of information transfer (500 Mb/s/channel), and is ideal for a number of wireless personal area network (WPAN)/wireless local area network (WLAN) applications such as home high-definition multimedia streaming. Despite its advantages, there remain significant challenges that limit the potential performance, such as high path loss due to atmospheric oxygen and multipath effects due to cluttered indoor environment. We are exploring the use of a phased array in conjunction with low-loss phase shifter in order to realize low-cost phased-array systems that will meet the needs of WPAN/WLAN applications.

RECENT RESEARCH DEVELOPMENTS

- 500-750 GHz On-Wafer Probes
- 3D Vertical Interconnects operating to 100 GHz
- 60-GHz switched-line phase shifters using RF-MEMS switches.
- Cryogenic RF-MEMS switches operating at 1.6 K.
- RF-MEMS tunable matching networks for reconfigurable systems.

RECENT GRANTS

- NSF – MRI: Development of a THz Frequency On-Wafer Probe Station
- MEMtronics – Cryogenic MEMS Technology for Sensing Applications
- NSF – RF-MEMS Phase Modulators for Millimeter-wave Polarimeter Array
- DOD/ARO – 4.6 THz Science & Technology Submillimeter Wave Resonators for Investigation of the Dynamical Properties of Biological Molecules

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