Terahertz Reflectarrays for Beam Manipulation and Polarization Control

Christophe Fumeaux[1], Wendy S.L. Lee[1], Daniel Headland[1], Tiaoming Niu[2], Sharath Sriram[3], Madhu Bhaskaran[3], Withawat Withayachumnankul[1]
(1) The University of Adelaide, Adelaide, SA 5005, Australia
(2) Lanzhou University, Lanzhou 730000, China
(3) RMIT University, Melbourne, VIC 3000, Australia

The terahertz frequency range is loosely defined as extending between 300 GHz and 10 THz, i.e. between the millimeter-wave and infrared frequency ranges. The spectral properties of large molecules in the terahertz band makes this frequency range attractive for various applications such as pharmaceutical quality control or non-invasive medical/biological tissue imaging. Furthermore, the short wavelength and ability to penetrate through clothing and packaging material makes terahertz waves attractive for security screening. Finally, there are several hundred gigahertz of untapped bandwidth associated with terahertz carrier frequencies, and this suggests future applications in ultra-high data-rate short distance point-to-point communications. All those applications will require antennas with extremely high gain, as well as the ability to control polarization and radiation patterns.

Being located at the cross-road of electronics and optics, the terahertz frequency range may benefit from developments form both sides, albeit pushing the spectral limits of the respective technologies. In terms of antenna engineering for example, the use of standard transmission lines as used in the microwave regime would result in prohibitive loss when implemented as feeding network for a terahertz phased array antenna. An alternative configuration that seems better amenable to scaling to terahertz frequencies is offered by the concept of reflectarray, i.e. the combination of free-space feeding with a reflector realized as passive array of scatterers.

The presentation will review the recent developments of terahertz reflectarrays at the University of Adelaide. In the last few years, various devices have been designed and experimentally validated at frequencies around 1 THz. The demonstrated functionalities have included beam formers, beam splitters, absorbers and polarization converters/splitters (D. Headland et al., IEEE J. Sel. Top. Quantum Electron., 23(4), 8500918 (2017)). Importantly, both metallic and dielectric resonators have been considered and thoroughly investigated. The presentation will elaborate on the advantages and weaknesses of both approaches, and consider the challenges for application of terahertz reflectarray in practical systems.

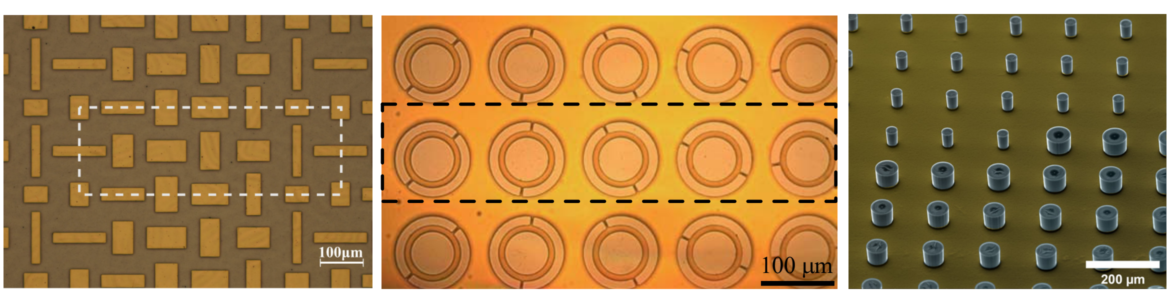

Figure 1. Example of terahertz reflectarrays developed at the University of Adelaide, from left to right: Linear polarization beamsplitter, circular polarization beamsplitter and focusing mirror made of dielectric resonators