Knowledge Transfer Office
香港城市大學
City University of Hong Kong

Terahertz Metasurface Antenna for 6G Communications

Communications & Information

Manufacturing

Digital Broadcasting, Telecommunication and Optoelectronics

Nanotechnology and New Materials

Metasurface Antenna

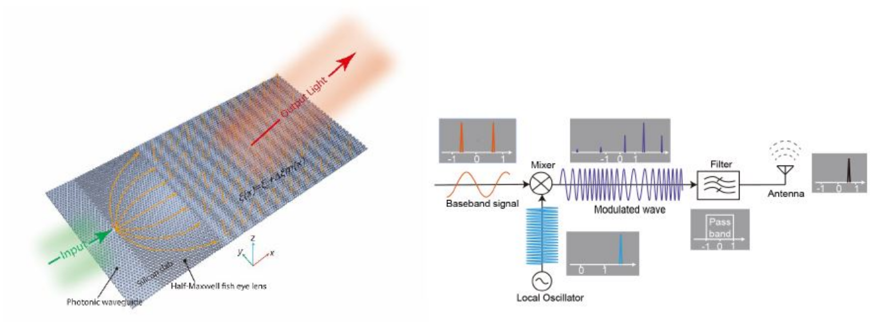

Figure 1. Waveguide-integrated superheterodyne THz metasurfaces for free-space coupling

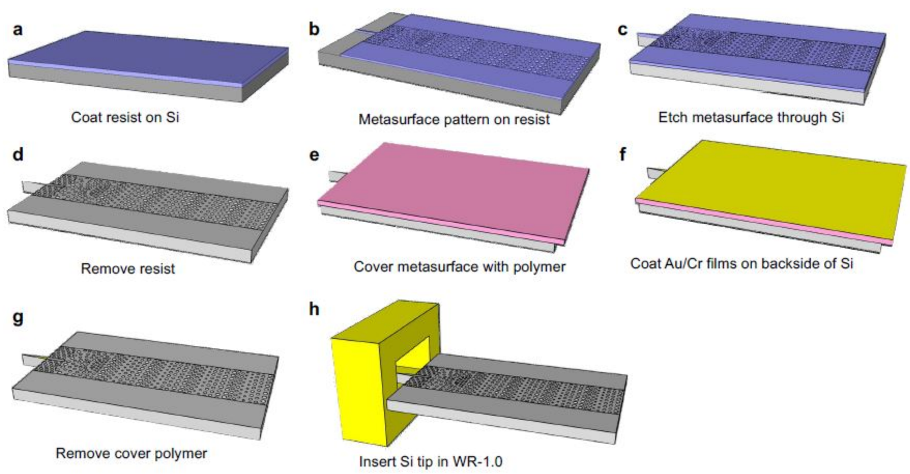

Figure 2. Fabrication technology for waveguide-integrated superheterodyne THz antenna

Remarks

48th International Exhibition of Inventions Geneva (IEIG) (2023) - Gold Medal

IP Status

Patent filed

Technology Readiness Level (TRL) 5

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Develop Concept

Proof Concept

Follow-on Funding

Build Value

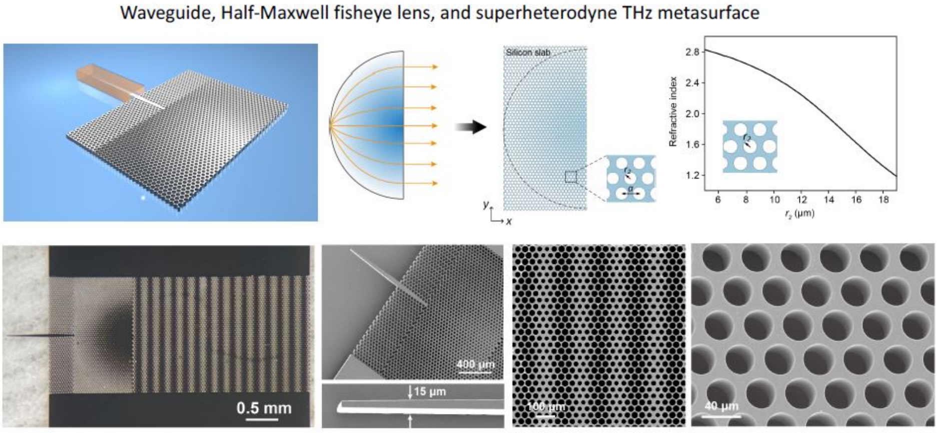

Figure 3. Prototype of superheterodyne THz metasurface antenna

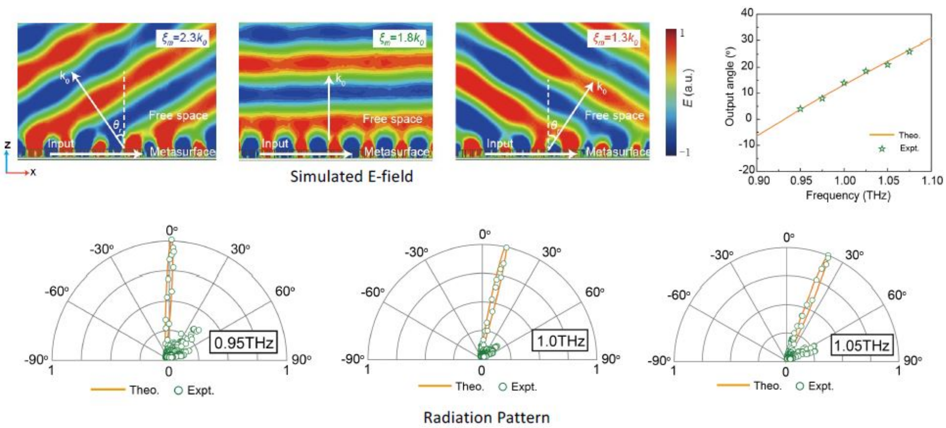

Figure 4. Simulated and measured output of superheterodyne THz antenna

Opportunity

At the dawn of the fifth generation (5G) wireless communications era, the ever-increasing demand for higher data transmission rates continues to drive carrier frequencies into the terahertz (THz) bands for improved channel capacities. However, the increased operating frequency imposes significant challenges in THz antenna design; it incurs high atmospheric absorption loss, significant metal and dielectric material losses, and limited fabrication tolerance. Moreover, conventional antenna design that alters current pathways on conducting surfaces cannot meet the new demands for beam management for next-generation wireless communications. The invention is a novel THz waveguide-integrated metasurface antenna designed based on the superheterodyne principle. The THz metasurface antenna features the advantages of a simpler structure, high gain, high efficiency, and potential on-chip integration compared with other THz antennas, making it an appealing antenna solution for B5G and 6G communications.

Technology

The invention is a novel waveguide-integrated metasurface antenna designed using the superheterodyne principle. Traditional radio superheterodyne architecture is temporal, while the proposed superheterodyne-inspired antenna is modulated in the spatial domain by modulation of the local spatial frequency of the guided wave in a transmission line. The spatial modulation is achieved using sub-wavelength air-hole metasurfaces in a silicon photonic platform. The engineered metasurface can convert the in-plane guided mode to out-of-plane free-space mode for radiation. From reciprocity, the metasurface antenna can also couple free-space waves into the waveguide, working as a spatial superheterodyne receiver. The superheterodyne-inspired metasurface antennas can realize various beam performances, e.g., frequency beam scanning and beam focusing at THz frequencies. This new design can also be integrated with optoelectronic technologies for high-speed wireless communications.

Advantages

- Simple structure
- Lower loss
- Potential on-chip integration
- High directivity
- Compatibility with CMOS for mass production

Applications

- B5G and 6G wireless communications
- Noncontact sensing
- RFID system
- Wireless power transfer
- Millimeter-wave and terahertz imaging