Wireless Terahertz Communications

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Over the past years, interest in wireless THz communications with so-called T-waves has tremendously increased [1]–[4], because the large carrier frequencies in the range 0.2 THz to 0.9 THz support wide signal bandwidths and consequently large data rates. Transmission over hundreds of meters and line rates exceeding 100 Gbit/s were demonstrated [5]–[10]. Typical atmospheric losses are 0.2 dB/100 m at 0.2 THz, 0.5 dB/100 m at 0.3 THz, 1.5 dB/100 m at 0.4 THz, and 5 dB/100 m at 0.9 THz. For transmission over a 100 m-distance, however, the unity-gain free-space propagation loss $a_{\mathrm{dB}}^{(L=100\,\mathrm{m})} = 10\lg\left(4\pi L/\lambda\right)^2 = 120\,\mathrm{dB}$ ($\lambda = 1\,\mathrm{mm}$, $f = 0.3\,\mathrm{THz}$) dominates. To combat this propagation loss, multiple directional antennas with a high gain per sector can be employed at the base station to boost the reach and the data throughput on transmission and reception.

For generating these large carrier frequencies and for coherently receiving high-speed data, optoelectronic signal processing is the preferred technology [5]. Data provided by a fibre-optical network can be optical-to-terahertz converted by photomixing with a III-V uni-travelling-carrier photodiode in a T-wave transmitter (Tx). Coherent wireless multi-carrier THz transmission over distances of up to 40 m with a line rate of up to 100 Gbit/s are demonstrated [6]. An (electronic) in-phase/quadrature (IQ) subharmonic mixer realized as in [7] with a millimetre-wave integrated circuit (MMIC) served as receiver (Rx). An alternative Rx employs a III-V photoconductor which acts as a photomixer for generating the THz local oscillator frequency electro-optically, and which simultaneously down-converts the received signal to the baseband [11]. As a third option, a novel silicon-*p*lasmonic *i*nternal *p*hoto*e*mission *d*etector (PIPED) [12] can be used for terahertz-to-electrical baseband conversion and for coherent reception. The PIPED functions also as a photomixer and can be monolithically integrated for realizing a PIPED Tx and a coherent PIPED Rx on a common silicon chip [13]. If both, Tx and Rx, are connected with a co-integrated THz transmission line, the arrangement can be used as a lab-on-chip for investigating an analyte applied to the transmission line. A fourth Rx type relies on a Schottky barrier diode and digital signal post-processing. Finally, an electro-optical modulator may be driven by a received wireless T-wave signal to transfer the T-wave data transparently to an optical carrier for seamless photonic transport [14]–[17].

The talk will present various THz transmitter and receiver concepts as well as results from data transmission experiments.

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