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Plasmonic Modulators for THz Wireless Signal Processing

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The THz frequency range is rapidly gaining attention in a number of key application domains, including security screening, sensing, medical imaging and, not least, next-generation wireless communications. Particularly evident is the exponential growth of wireless data traffic, with capacity demands reaching tens to hundreds of Gb/s [1]. Those speeds require large transmission bandwidths, but the currently used microwave bands have a limited allocated spectrum, typically limited to a few hundred MHz. Millimeter-wave spectrum in the V- and E-bands offer larger available spectral resources, yet contiguous bandwidths are still below 9 GHz. This renders wireless data rates of hundreds of Gb/s, while keeping hundreds meter link lengths, difficult to realize. The THz band (300 GHz – 10 THz) is thus seen as the "next frontier" for future data links thanks to the extremely large bandwidths available [2]. Accessing the THz spectrum, however, poses several challenges compared to microwaves, namely sensitivity to blockage, largely increased free-space path loss, and atmospheric absorption due to water vapor [1]. In addition, the generation of THz signals with sufficient power as well as their detection are not trivial tasks. Approaches use either electronic [3] or photonic techniques [2, 4, 5], the latter being particularly attractive as they offer seamless integration with the existing fiber networks [6, 7]. For optical-to-THz conversion, uni-travelling carrier photodiodes (UTC-PD) are a well-proven solution [2]. THz-to-optical conversion, in turn, demands very fast electro-optic modulators, with electro-optic bandwidth well above 300 GHz, high power handling and high linearity [8]. Impressive progress has been reported in lithium niobate modulators [9, 10], reaching losses as low as 0.5 dB and an RF half-wave voltage as little as 1.4 V [11]. We recently showed plasmonic Mach-Zehnder modulators displaying the desired characteristics of speed, linearity and power handling simultaneously [12], with a flat frequency response up to 500 GHz, a third-order input intercept point (IIP3) of 18.9 dBm and stable operation at high electrical power level up to 24.4 dBm. We will present their characterization and the implementation of a microwave photonic link at 325 GHz, with >100 GHz bandwidth, only limited by our electrical measurement equipment.

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