Dish-antenna-integrated Resonant Tunneling Diode Module for Terahertz Wireless Applications

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Interest in the terahertz (THz) frequency range has drastically increased in recent years due to its large underutilized spectral bandwidth. Significant efforts are being invested into extending the area of applications at the THz range through near-lossless all-intrinsic-silicon micro-photonic waveguides, for which hybrid integration with active devices facilitates the inclusion of sources and detectors. For instance, a Resonant Tunneling Diode (RTD) was recently integrated on a photonic-crystal-based silicon waveguide via an efficient subwavelength mode-converter to be operated as a receiver [1]. However, such micro-scale silicon devices are fragile and require robust packaging structures for practical systems. In [2], a packaging strategy was introduced, and it has subsequently been extended to include a parabolic reflector dish, thereby realizing a packaged high-gain antenna for THz waves [3]. In this work, we further proceed the packaging strategy towards the realization of a complete transceiver module using a photonic crystal waveguide [4], an RTD [1] and a dish antenna [3]. Figure 1 presents the packaged module. The photonic crystal waveguide is built in a 200µm-thick silicon slab using an array of through-hole arranged in a triangular lattice. The waveguide is terminated by a broadband dielectric rod antenna that serves as a feed for the parabolic reflector dish. The focal length of the dish is chosen to be half the aperture diameter for compactness. Two antennas of aperture diameter 1 cm and 2 cm have been manufactured, and the radiation pattern of the antenna in isolation (i.e. without RTD chip) has been characterized, and is presented on Figure 1. Figure 1(b) shows reasonable agreement between simulated gain and measured gain for both dishes, as well as maximum gains of 27 dBi and 33 dBi. Figures 1(c) and (d) show radiation patterns with side lobes lower than -15 dB and a sharper beam for the 2-cm dish compared to the 1-cm dish, as expected. On-going efforts are dedicated to incorporate the RTD chip into the aforementioned module, and deploy the resulting packaged module in various applications.

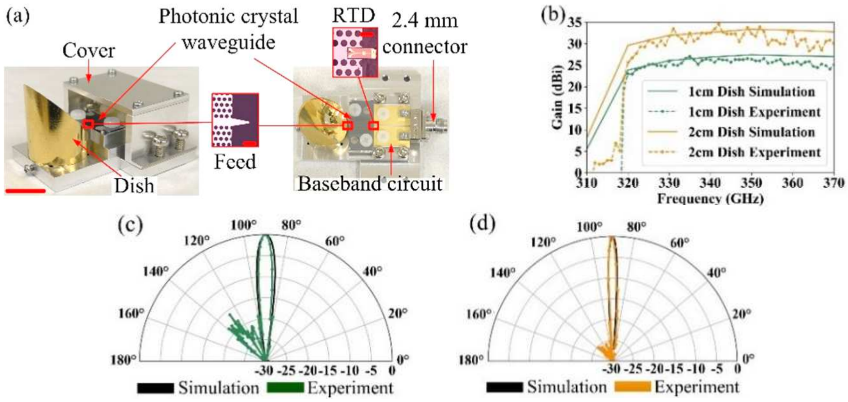

Figure 1. Packaged module, (a) Assembly showing inset micrographs of the feed and the RTD chip. The scale bars for the module and the micrographs are 20 mm and 500 µm respectively, (b) Simulated and measured gain, (c) Farfield patterns at 340 GHz for 1-cm dish, (d) farfield patterns at 340 GHz for 2-cm dish.

References

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