Device Characterization with Non-Contact Probes in the THz Band

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Advances in high-speed electronic devices enabled by new electronic materials and advanced processing techniques are opening up the THz band for integrated solutions in sensing, imaging, and communications. For example, InP-integrated circuits (mixers, LNAs, oscillators, etc.) have recently been demonstrated at 0.67 THz (Deal et al, IEEE Microwave and Wireless Component Letters, 21, 7, 368-370, 2011) and GaN is being considered to realize high power THz amplifiers and sources. Moreover, to circumvent the shortcomings of available devices, unconventional device topologies are being investigated (Dyakonov and Shur, Phys. Rev. Lett. 71, 15, 2465-2468, 1993; Zhang et al. IEEE Microwave and Wireless Component Letters, 21, 5, 267-269, 2011; Lederer et al. Solid State Electronics, 49, 9, 1488-1496, 2005). Nonetheless, testing and verification of the new devices at their intended operation frequencies has been a challenge (Reck et al, IEEE Trans. on Terahertz Science and Technology, 1, 2, 357-363, 2011). Particularly for frequencies above 500GHz, conventional contact probes are either not available, or extremely fragile for continuous use.

To address the aforementioned difficulties in THz-frequency device testing, we have been developing a non-contact measurement approach that avoids the requirement to make physical contact with the test chip. Our approach is based on radiative coupling of network analyzer ports into the electromagnetic environment of the device (input and output co-planar waveguides) using integrated planar THz antennas (Topalli et al, 2012 IEEE Int. Symp. on Antennas and Propagation). Broadband butterfly-shaped antennas are used to ensure that the characterization setup is not limited by the bandwidth of the non-contact probe setup. As a first step in realizing these new probes, we recently fabricated test antennas and calibration structures (shorted CPW lines with varying lengths) on a 400um-thick GaAs wafer. The input impedance of the THz antennas were characterized in the 325-500GHz using contact probes (SP-I500-GSG-50-01) from Cascade Inc. and the implementation of the non-contact THz probe is under way. We will present the characterization details and our progress toward realizing this new THz-frequency device testing methodology.