Non-Contact Probes for On-Wafer Characterization of THz Devices and Integrated Circuits

Cosan Caglayan*, Georgios C. Trichopoulos, and Kubilay Sertel
ElectroScience Laboratory, Department of ECE
The Ohio State University, Columbus OH 43212

We present a novel, non-contact metrology for on-wafer characterization of sub-mmW devices, components, and integrated circuits. Unlike conventional high-frequency probes which rely on fragile tips and physical contact with the device on the chip, the new non-contact probes are based on electromagnetic coupling of vector network analyzer test port signals onto the coplanar waveguide (CPW) environment of on-chip integrated devices and circuits. Efficient signal coupling is achieved via a quasi-optical link between the VNA ports and the planar antennas that are monolithically integrated with the device-under-test. The test chip is then interfaced with an extended hemispherical lens on the back side to collimate the VNA port signals onto the non-contact probe antennas. These antennas act as "virtual" probe-tips on the test chip and connect to the device through optimized, impedance matched CPW lines.

Radiation patterns and the impedance performance of the on-chip double-slot antennas are optimized using in-house moment method (MoM) tools for robust and broadband quasi-optical coupling of the VNA ports. Repeatable errors of the non-contact probe setup are calibrated using on-wafer standards, allowing for accurate *S*-parameter measurements. Experimental validation of the new non-contact device metrology system will be presented to demonstrate the repeatability and reliability of non-contact probes for the 325-500GHz (WR2.2) and 500-750GHz (WR1.5) bands.

Conventional contact probes are extremely limited in performance due to losses and parasitic. They also suffer from exceeding cost and fragility issues. As such, device testing in the 0.3-3 THz remains a specialty of few research groups that can shoulder the high cost of operating and maintaining such setups. Owing to the non-contact nature, the new non-contact probes are low-cost and free from fragility, wear & tear issues. More importantly, they can be easily scaled beyond 900GHz where there is no existing solution for on-chip device and IC testing.