Printed Interconnects between Components for Microwave Applications

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Wire bond interconnects have been the main approach to interconnecting microelectronic devices within a package. Conventional wirebonding however offers little control of the impedance of the interconnect and also introduces parasitic inductance that can degrade performance at microwave frequencies. The size and compactness of microchips is often an issue when it comes to attaching wirebonds to the microchip or other components within a microwave module. This work demonstrates the use of additive manufacturing for printing interconnects directly between bare die microchips and other components within a microwave module.

A test structure was developed consisting of a GaAs microchip sandwiched between two alumina blocks patterned with coplanar waveguides (CPW). A printed dielectric ink is used to fill the gap between the alumina CPW blocks and the GaAs chip. Conductive interconnects are printed on top of the dielectric bridge material to connect the CPW traces to the bonding pads on the GaAs microchip. Simulations of these structures were modeled in HFSS to optimize the printed interconnects at 1-40 GHz. The dielectric constant and loss tangent of the simulated dielectric was varied along with the dimensions of the conductive interconnects. The best combination of dielectric properties and interconnect dimensions was chosen for impedance matching by analyzing the insertion losses and return losses. A dielectric ink, which was chosen based on the simulated results, was experimentally printed between the two CPW blocks and the GaAs chip and subsequently cured. The conductive interconnects were then printed with an aerosol jet printer, connecting the CPW traces to the bonding pads on the GaAs microchip.

The experimental prototype was then measured with a network analyzer and the measured data were compared to simulations. Results show good agreement between the simulated and measured S-parameters. This work demonstrates the potential for using additive manufacturing technology to create impedance-matched interconnects between high frequency ICs and other module components such as high frequency CPW transmission lines.