Multi-material Printed C-Band Coupler for Phased Array Applications

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Additive manufacturing for RF and Microwave devices is a rapidly growing area with promise of rapid prototyping and low-cost. One of the major obstacles is the utilization of multiple materials within integrated 3D electronics. The aim of this work is to demonstrate feasibility of such an integrated device and a C-band quadrature coupler will be printed as a testbed for characterization. This integrated approach will allow for full characterization of materials, deposition capabilities and design tools for 3D multi-material prototypes.

As part of this presentation, design and simulations of the C-band coupler will be shown and the optimization of parameters including, material choice, linewidths, as well as tolerances associated with each element of the device will be discussed. Moreover, details of RF characterization of dielectric and conductive ink will be provided. Testbeds have been developed to determine the RF behavior, as opposed to just DC which is typically reported, and dielectric constant and loss tangent for several dielectric inks. These testbeds rely on conventional microstrip and CPW lines, as well as novel methods (M. Haghzadeh, C. Armiento and A. Akyurtlu, IEEE Transaction on Microwave Theory and Techniques, 65, 2030, 2017). Various 2D and 2.5D printers are utilized for the different inks and the process parameters, including resolution and registration, are optimized.

Fully printed couplers for phased array applications will be presented. Full characterization of the performance of the entire device will be shown. This work provides a detailed level of understanding of the process tolerances and varying materials properties on the RF performance of devices and a clear pathway to integration of printed 3D devices.