Millimeter Wave Integrated Antenna Array On Low Temperature Co-Fired Ceramic Tapes

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The saturation of lower frequency bands has made millimeter waves attractive for communications as well as imaging and synthetic aperture radars. Millimeter wave devices have been traditionally fabricated using metal structures that generally leads to size and cost increase. But in recent years, Low Temperature Co-Fired Ceramic (LTCC) tapes have been used to fabricate compact packaging modules.

In this paper, we present LTCC millimeter wave integrated horn antenna arrays operating at 94 GHz. The proposed arrays have applications in a cohort of applications, including: Compact integrated interferometric sensing arrays, synthetic aperture radars, active and passive millimeter wave imaging, beam forming, automotive sensing, and so on. This work focuses on interferometric imaging and their packaging with an electro-optical modulator to achieve optical up-conversion. The proposed solution includes fully integrated on-chip interferometric sparse arrays. Notably, each unit cell of the array is a 2x2 horn antenna subarray.

At the conference, we will discuss the LTCC packaging process to create the number of layers needed for controlling the size/height of the horn antennas. Using an in-house LTCC process, passive circuit elements are individually fabricated and characterized for an optimum design of the integrated horn antenna. Substrate integrated waveguide (SIW), integrated power splitter and an integrated SIW-to-Microstrip transition are used during the fabrication. The SIW has been designed in accordance to the smallest reachable features of vias while minimizing RF leakage. Simulations showed transmission losses of 0.1dB/mm at 94-GHz and a transition for matching to 50Ω was used. The design of the integrated power splitter relies on an inductive matching post that was optimized to reduce reflection at the feeding port. Concurrently, minimal power and phase imbalance was assured. For this particular device, simulations show that power imbalance of less than 0.02 dB was achieved and a phase imbalance of 1° across the W-Band. At the conference, we will show simulations and measurements of the entire LTCC array at 94GHz.