W-band Vivaldi Antennas and Arrays

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Growing interest in millimeter wave components has been driven by a surge in application needs, such as collision avoidance radar, passive and active imaging, electronic warfare, and communications, just to mention a few. The frequency band from 75 – 110 GHz is of particular interest, due to inherent advantages such as high data transmission rates and lower atmospheric loss. Typical antenna array requirements for these applications include high gain, low profile, and low loss. Microstrip-fed antenna arrays have been studied and used, however they have decreased radiation efficiency in large part due to the resistive and coupling losses in the feeding network. Rectangular and ridge waveguide have been used in many applications due to their small conductor loss, but suffer from bulkiness and cost when complex integrations are considered.

A possible alternative technology for wideband millimeter-wave applications is PolyStrata™. This technology, developed by Nuvotronics, BAE Systems, and the University of Colorado, is a sequential micromaching process able to produce high performance monolithic rectangular coaxial lines and related components over multi-decade bandwidths. The process uses dielectric straps to support the inner conductor of a monolithic coaxial line which enables low loss, dispersion, and cross-talk along with tight packaging, 3-D interconnection and overall high degree of monolithic integration. This presentation will discuss the development of a W band Vivaldi antenna array using the aforementioned technology. A detailed analysis of a single W band Vivaldi antenna is conducted and tradeoffs between design features such as antenna length and growth rate are discussed. The use of corrugations in the single antenna structure is also discussed as it relates to antenna performance. Combining two to four Vivaldi elements into array configuration is proposed for direction-finding and low-power communication system applications. Antennas and arrays are fabricated and relevant conclusions will be supported by the measurements and theory.