Fabrication of a 20 GHz Array of Dielectric Resonator Antennas Using Ceramic Stereolithography

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This research will demonstrate the use of a ceramic stereolithography processing technique to fabricate an array of rectangular dielectric resonator antennas (DRA). Stereolithography offers the important advantage of obviating placement and bonding of each array element, tasks which requires precision often difficult to achieve by hand and expensive otherwise.

Rectangular DRA's are chosen as the array elements because they are simple to design, low loss, and capable of providing large bandwidth. The elements will have relative permittivity of 6 and operate at 20 GHz. The prototype array will have a four-by-four element configuration. Uniform excitation will be achieved using a microstrip corporate feed network and aperture-coupling. The fabricated array will be a monolithic device in which all of the elements are connected by thin strips of material that do not interfere with array performance.

Recent research efforts have developed stereolithographic prototyping methods that achieve a fully three-dimensional ceramic end product. This has opened up a range of millimeter wave applications that are not available using polymer techniques. In this process, a UV-curable ceramic suspension is cured using a HeCd laser over a perscribed area. This step is repeated layer-by-layer while the part is gradually submerged, creating a three-dimensional "green" part which is 50% ceramic by volume. The polymer is then removed through pyrolysis at 350° - 450° C and sintering at 1600° C.

Stereolithography, while making element placement and bonding unnecessary, does present a different challenge. Obtaining flat surfaces over the area of the fabricated part is difficult using the conventional stereolithographic approach which creates a rough support structure to build the part on. Grinding is not a viable option for small, intricate parts. In order for the array to operate correctly, however, it is critical that its bottom be flush with the ground plane, avoiding air gaps. A promising means of solving the problem has been developed and will be tested. It is noted that successful resolution of this issue is key to further development of the stereolithographic technique in the fabrication of other ceramic array designs and microwave components.

The details of ceramic stereolithographic processing, array design, and measurement results will be presented at the symposium.