Novel Electromagnetic Structures Enabled by 3D Printing Technology

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Additive manufacturing (AM), or often referred as 3D printing technology, has attracted microwave researchers' attention as novel manufacturing and prototyping technology. Compared to conventional approach, AM allows for arbitrary 3D structures with lower cost and shorter prototyping time. Polymer jetting method, one of the 3D printing techniques, has been explored for a number of microwave applications including bandgap structures, THz EMXT horn antennas, THz waveguide, holograms, Luneburg lens antenna, and dielectric reflectarray antennas.

In this talk, two novel EM structures realized by polymer jetting techniques are introduced and demonstrated. First, a monopole antenna surrounded by arbitrary dielectric distribution is designed and implemented. Different from the traditional monopole having a donut-like omnidirectional radiation pattern, the radiation pattern of this monopole can be changed by loading different surrounding dielectric distributions. This beam control method has the advantage of simplicity compared with conventional arrays that need feeding networks and potentially have mutual coupling issues. Several beam patterns including single-beam and multi-beam examples are demonstrated. The dielectric constant distribution of each case is obtained by genetic algorithm. Based on the effective medium theory, the desired dielectric distribution is realized by mixing 3D printed polymer and air. An experimental prototype is measured and the results show good agreement with the simulation. Furthermore, Potential tunable materials could also be incorporated in this technique to achieve electronically tunable patterns. The second example is a 90 °wave bending structure at Ka band (26 - 40 GHz). Based on geometrical optics, EM wave bending is achieved by varying the spatial dielectric constant distribution. Similarly, different effective dielectric constants are realized by varying the ratio of 3D printed polymer and air voids. The printed prototype is characterized and experiment results show reasonable agreement with the simulation.