Printed tunable reflectoarrays on flexible functionalized BST-polymer based substrates

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We present the development of novel flexible functionalized thin substrates for tunable reflectoarrays in the X-band regime. The tunable reflectoarrays were designed based on analytical electromagnetic theory and investigated and proven through full-wave electromagnetic simulations based on the developed substrate properties. There has been previous work using liquid crystals or ferroelectric materials (e.g. BST) to implement tunability. However, due to the difficulty in fabrication, limited dielectric properties, and rigidity of these candidates, tunable flexible thin sheet substrates with a wide range of dielectric constant was developed.

A nano composite was prepared by mixing the BaSrTio (BST) nanoparticles with different loading values in the range of 10 - 40 vol. % with a thermoplastic polymer which has a very low loss tangent. Twin screw compounding techniques were utilized for mixing and extruding the thin sheet substrates. The dielectric properties of composites were measured via three different methods: 1- Waveguide method 2- Free space method 3- concentric circular capacitor method to validate the results (M. Haghzadeh, C. Armiento and A. Akyurtlu, 87th ARFTG, 2016, pp. 1-4.). The highest dielectric constant measured is 16 for 40 vol% BST loading while the loss tangent is 0.005 for RF and microwave applications in the X-band frequency range. The novel reflectoarrays were printed on the 40 vol% BST/polymer substrate using the Optomec aerosol jet printer.

The reflection coefficient was measured using a network analyzer while a DC voltage was applied via a power source connected to the structures through a bias tee and SMA connector and tunability up to 4% was measured. Comparisons between the prototype measurement results and the simulation results show good agreement and validate the tunability. Although, we have demonstrated the tunability of the developed substrates via the implementation with reflectoarrays, these substrates are useful for various RF and microwave applications such as Frequency Selective Surfaces (FSS), antennas, phase shifters, etc.