Design, Analysis, and Reconfiguration of a Multi-arm Spiral Frequency Selective Surface

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Frequency selective surfaces (FSS) have a range of applications from radome design, radar cross section reduction, and minimizing electromagnetic interference – to name a few. However, after fabrication, the surface's frequency response is static. Adding a reconfiguration mechanism to the FSS expands upon its versatility. Some common FSS tuning techniques use varactors, MEMS, and ferrite materials. However, these methods require the use of a biasing network, and only a few reconfiguration states are achievable. Fluidic tuning systems provide a viable alternative to the aforementioned methods. First, using fluidics removes the need for a biasing network. Second, by doping the base fluid with high dielectric particles a continuous spectrum of reconfiguration states is possible.

This work discusses the analysis, design, and measurements of a fluidically tunable frequency selective surface. The FSS topology used is an Archimedean spiral. Each arm of the spiral acts as a quarter wave resonator. The resonant frequency of the FSS's unit cell is thus a function of the effective dielectric constant. A series of circular reservoirs make up the surface's superstrate. The reservoirs connect through a series of horizontal channels. A 3-D printer fabricates the superstrate separately from the FSS. It is plasma bonded to the surface. A low loss dielectric fluid is pressure driven through the channels. To tune the frequency response, high dielectric particles dope the dielectric fluid in order to increase the effective dielectric constant. A waveguide system measures the FSS. Due to the presence of fluidic channels a custom sample holder is machined. Its design is to be compatible with a preexisting waveguide system. Measurements and simulation of the prototype fluidic FSS system will be presented.