Small Array Behavior of Frequency Reconfigurable Antennas Enabled by Functionalized Dispersions of Colloidal Materials

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Physical limitations on radiation behavior, impedance matching, and bandwidth requirements have encouraged the development of numerous reconfiguration mechanisms. These reconfiguration mechanisms have been extended into the operation of arrays, many of which are applicable to the microstrip-based antennas and arrays thereof. Frequency reconfiguration of microstrip-based antenna arrays has been implemented with numerous technologies (e.g., RF MEMs and PIN diodes). These, and many other antenna reconfiguration, mechanisms have been designed to provide antenna element versatility for increased functionality and efficiency for multiband and/or broadband frequency operation, space and military applications under harsh environmental and/or electromagnetic conditions, multiple input and output (MIMO) systems, and other techniques. However, the potential for significant increases in antenna and fabrication complexity, through the implementation of these reconfiguration mechanisms, can present many integration issues. Depending on the reconfiguration technology, the bias/control lines, power consumption, and spatial limitations can combine to degrade system performance and offset the gains achieved from increased aperture functionality.

This work will examine the performance and adaptability of a microfluidic reconfiguration mechanism in a small array, and examine for its ability to reduce system degradation due to complexity and physical limitations incurring from the close spatial proximity of bias/control systems on or near the antenna. Implementation of the microfluidic network can reduce or mitigate the interactions between individual mechanisms within the aperture and increase the competitiveness of microfluidics over current state-of-the-art. The proof-of-concept comes from the microfluidic system being based on the integration of a vascular network displacing electromagnetically functionalized colloidal dispersions (*EFCD*); dielectric nanoparticles dispersed in a low-loss fluid. A 1x2 array of linearly polarized microstrip patch antennas with parallelized capillary structures has been chosen to demonstrate this concept. Measured, modeled, and analytical results for impedance, VSWR, and radiation will be provided and extended to include the effects on nanoparticles in the applied fields.