Frequency Reconfiguration of a Microstrip Patch Antenna Enabled by Colloidal Dispersions

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The reconfiguration of a microstrip patch antenna's resonant frequency and/or matched impedance bandwidth has been implemented using numerous technologies (e.g., PIN diodes, RF MEMS, and photoconducting switches). These (and many other) antenna designs have in turn provided wireless systems with radiating elements that can support the increased functionality and efficiency needed to operate over multiple bands, in different geographic regions, or for MIMO and other multiple antenna techniques. However, there can be significant increases in overall system/fabrication complexity from these antenna designs due to the implementation of the antenna's reconfiguration mechanisms. Depending on the complexity of the design, this can sometimes also place a burden on the system through spatial constraints, bias/control circuitry, and power consumption. In worst case scenarios, this can hinder the performance or even make the use of the antenna impractical.

This work examines the use of a microfluidic antenna reconfiguration mechanism that can mitigate, or potentially eliminate much of the local complexity from biasing and control circuitry that must be in close proximity (or contact) with the antenna. In doing so, the interaction with peripheral components can be avoided and the reconfigurable properties of the antenna can be more competitive towards its overall use in the wireless system. The proof-of-concept for the inclusion of microfluidic elements within the antenna has been accomplished in this work through the circulation of electromagnetically functional colloidal material (nanoparticles) dispersed in a non-aqueous media – termed Electromagnetically Tunable Fluid (ETF). The design – a linearly polarized, frequency reconfigurable, microstrip patch antenna enabled by ETFs – achieves radiation pattern and polarization stability throughout reconfiguration. Measured, modeled/analytical, and numerical results of the input impedance, VSWR, and radiation patterns will be provided for this design.