A Frequency Agile Substrate Integrated Waveguide (SIW) Bandpass Filter Using Nanoparticle Dispersions

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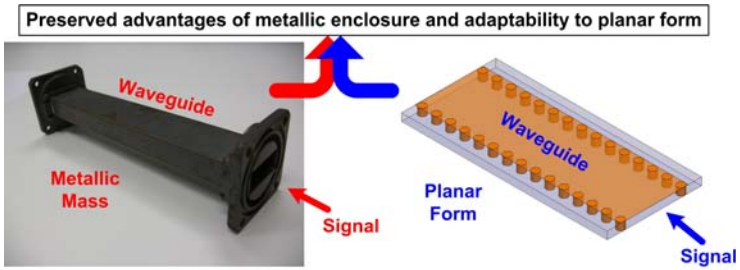
Objective

SIW microwave and RF device topologies are fast becoming items of interest. Filters, directional couplers, and antennas are such devices which take advantage of SIW topology.

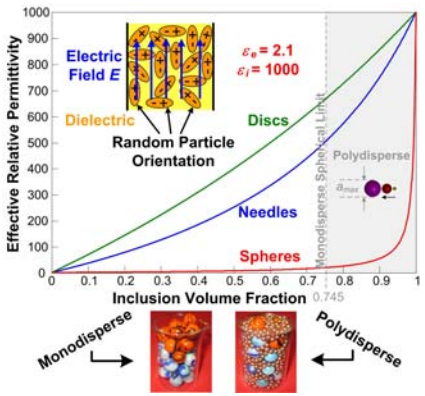


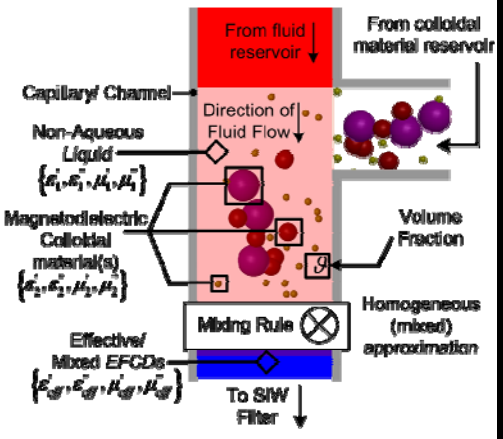
Thesis: Changing material properties within a substrate integrated fluid reservoir can provide a significant degree of electromagnetic agility in an SIW filter topology

Electromagnetically Functionalized Dispersions of Nanoparticles

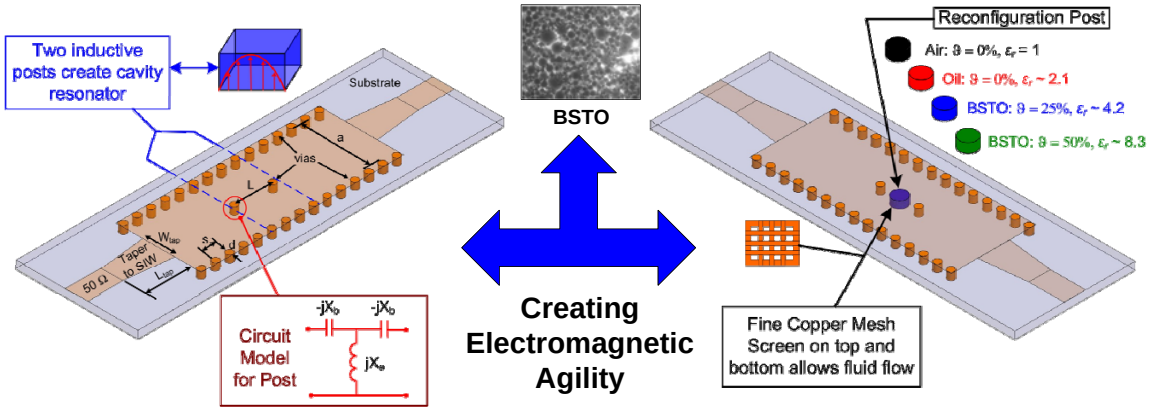
Electrostatically stabilized dispersions of magnetodielectric colloidal materials dispersed into a low loss, low dielectric, and non-magnetic fluid

$$\varepsilon_{eff} = \varepsilon_e + 3g\varepsilon_e \frac{\varepsilon_i - \varepsilon_e}{\varepsilon_i + 2\varepsilon_e - g(\varepsilon_i - \varepsilon_e)}$$



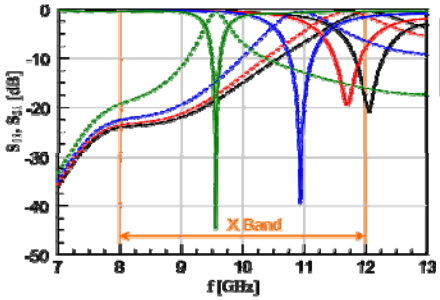


Reconfigurable SIW Bandpass Filter Implementation

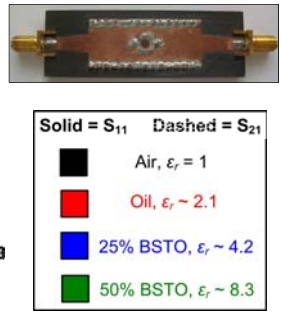


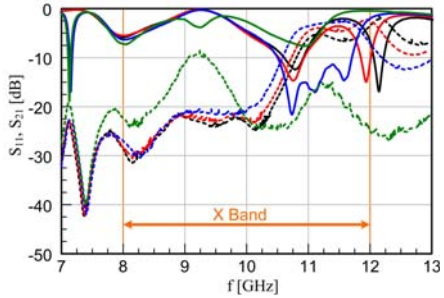
Taper transition to SIW optimized for performance, *s* and *d* determine leakage characteristics of waveguide, *d/a* determines X_b and X_a, cavity width $L \sim \lambda_0/2$, 4 cases of materials in reconfiguration post

Simulated and Measured Results



Air is the base case tuned at top of X Band. Introduction of new materials causes a sweep down to ~ 9.6 GHz



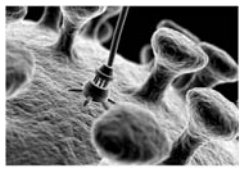


Introduction of dispersions causes losses, however reconfiguration potential still observed and well matched to simulation!

Conclusion and Future Work

Changing material properties within a substrate integrated fluid reservoir can in fact provide significant electromagnetic agility in a SIW filter topology

Short term future work will refine this reconfiguration method, long term will scale down this device to terahertz in preparation for future graduate work on nano-scale antennas and wireless sensing systems for homeland security!



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