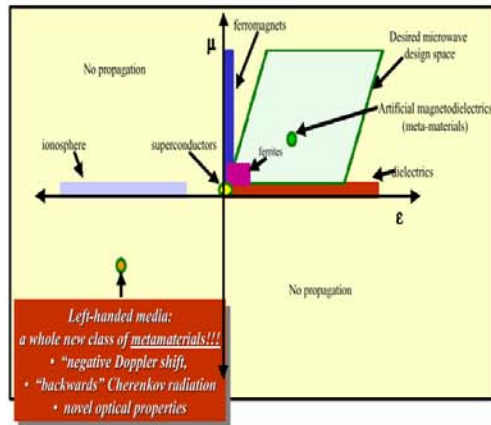


## LEFT-HANDED MATERIALS IN MAGNETIC NANOCOMPOSITES

D. Streilein (MSME), S. Yarlagadda, J. W. Gillespie, Jr., J. Q. Xiao, and X. Zhang (PhDPhysics)

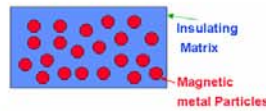
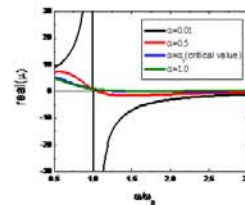
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### Propagation in Different Materials



### Using Magnetic Nanocomposites to Achieve these Properties

Negative magnetic permeability can be obtained by ferromagnetic resonance  
Dielectric constant is negative for metal below plasma frequency



Small Particles and polymer matrix are used to get small damping. Low loss is important for future practical applications.

### Sample Preparation

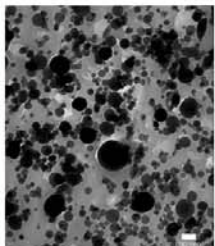
- Particles and polystyrene mixed in solution to avoid exposure to air (particles are very reactive)
- Dried
- Extruded using DACA mini-extruder
- Hot pressed to final testing form
- Tested for dielectric properties, resonance behavior



### Materials Tested

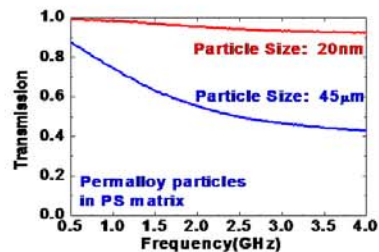
- Particle Types: Nickel, Permalloy, Ferrite
- Particle Sizes: ~10 nm, ~100nm, ~45 um
- Polymer Matrix Materials: Polystyrene, Polysulfone

### TEM Characterization



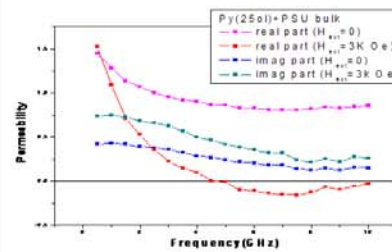
- Image shows good particle distribution
- You can see particle size distribution (~100nm, but varies)

### Low Loss Materials



Very Low Loss for small particles!

### Effective Permeability



Permeability goes negative under external field!

### Future Work

- Characterize the variables which affect the results
- Directly prove effect by Snell's Law
- Experiment in magnetic thin films
- Research ways to align particles without external field

### Acknowledgements

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