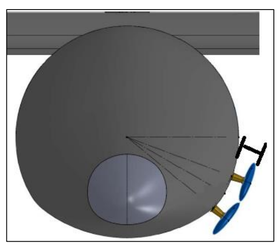
Metaferrite Enhanced Antennas

S&T Campaign: Materials Research
Electronics
RF Active & Passive

Greg Mitchell
(301) 394-2322
gregory.a.mitchell1.civ@mail.mil

Research Objective

- Metaferrites are a unique class of anisotropic, low loss, magneto-dielectric materials enabling the design of wideband low-profile antennas.
- Replacing large VHF/UHF antennas with novel low-profile Metaferrite antennas reduces ground vehicle target signatures and increases aerodynamics of aircraft lengthening flight times and reducing fuel cost.

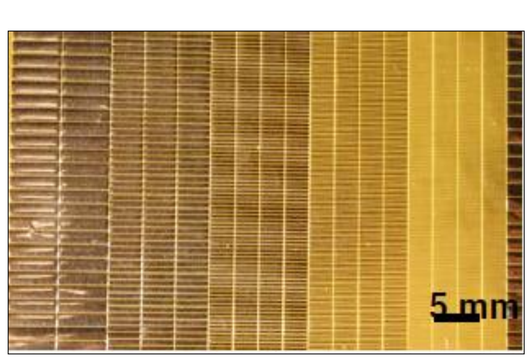


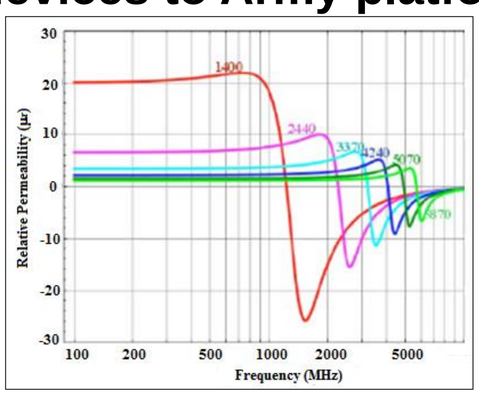
Antennas with large visual signatures make communications vehicles easy targets. Large antennas on airborne platforms reduce available payload weight and reduce flight durations.

Challenges

- Design electrically thin Metaferrite antennas that track or improve on current antenna performance.

- Engineer anisotropic, high refractive index ($\mu_r \approx 40$), low loss, conformal, light weight substrates from 100-1300 MHz and beyond.
- Develop reliable, high yield production methods for transition of Metaferrite devices to Army platforms.





Magnetic inclusions generate permeability at the unit cell level, and lithography of the sputtered layer yields effective anisotropic properties.

ARL Facilities and Capabilities Available to Support Collaborative Research

- Far field anechoic chambers calibrated down to 200 MHz and near field chamber calibrated down to 1.1 GHz.
- Electromagnetic software tools: HFSS, CST, FEKO, Sentri, GEMS.
- High performance server workstations (64 cores, 512 GB RAM, 4 NVIDIA K6000 GPUs) to model and solve electrically large problems.
- Current prototypes include:
  1) 1.5 octaves of bandwidth and positive realized gain from 200–500 MHz, 2” profile, linear polarization.
  2) RHCP SATCOM antenna from 240–320 MHz with 2” profile with similar performance to commercial antennas.

- G. Mitchell, “Theoretical anisotropic transverse resonance…”, IET Trans. on Microwaves, Antennas, and Propagation, 3/16.
- G. Mitchell, “Investigation of Anisotropic Transverse Resonance in the Design of Low Profile Wideband Antennas. Doctoral Dissertation, George Washington University, 8/15.
- G. Mitchell, et. al., “Extremely Low Profile UHF antenna”, IEEE APS/URSI Proceedings, Vancouver, Canada, 7/15.
- G. Mitchell and W. Wasylkiwskyj, “Extremely Low-Profile Broadband UHF Antenna based on Anisotropic Transverse Resonance Condition *(patent pending)”,* ARL-14-48, 2014.
- G. Mitchell and W. Wasylkiwskyj, “Extremely Low-Profile Tapered-Cavity Broadband Antenna at UHF *(patent pending)”,* ARL-14-45, 2014.
- S. Weiss and G. Mitchell, “Metaferrite Antennas”, Antennas Applications Symposium Proceedings, 9/14.
- G. Mitchell, “Modeling of Anisotropic Metamaterials…”, IEEE APS/URSI Proceedings, Memphis, TN, 7/14.
- G. Mitchell, “Investigation of the Properties of Metamaterials Exhibiting Anisotropic…”, GOMACTECH Proceedings, 2012.

Complementary Expertise / Facilities / Capabilities Sought in Collaboration

- Instrumented outdoor flight facilities.
- Dedicated satellite channels for tactical SATCOM testing on ground vehicles in urban environment.
- Design, fabrication and characterization of anisotropic, low loss magneto-dielectric media from 2 – 20 GHz.