Reconfigurable Shielding Architecture Using Multiferroics in 1 to 6 GHz Frequency Band

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With the discovery of new multiferroic materials with strong magnetoelectric (ME) coupling, new devices with improved performance have been demonstrated. Notably, multiferroic materials allow for the coexistence of magnetization and electric polarization properties, allowing us to realize ME coupling. Magnetic field can be controlled using electric fields and vice versa, a process mediated via the strain between the material layer comprising the multiferroic heterostructure, composed of magnetics on ferro/piezoelectric materials. Strong ME coupling provides the advantage of power efficiency, lightweight and compact design over traditional material. Direct ME coupling leads to electric polarization control. Conversely, E-field control provides for magnetization switching, permeability and spin wave effects.

In this paper, we will present substrate architectures using multiferroics and tunable-frequency RF shielding. This is achieved by H-field control of the permittivity, using coils with soft or nanocrystalline cores to attain focused magnetic fields that can reconfigure the multiferroic shielding architecture. Specifically, static magnetic field biasing coils are stacked over the tunable multiferroic frequency selective surface (FSS). Concurrently, H-field control could modulate permittivity and therefore the frequency performance of the substrate. We show a relation between the dielectric properties of the multiferroics and external magnetic fields. Numerical simulations are performed to model and design reconfigurable shield based on multiferroics for interference signals between the 1 GHz to 6 GHz frequency band. This novel approach for smart and tunable shielding methods could be a powerful tool for analog security.

We also present a new device architecture, and field biasing coils with soft nanocrystalline cores (of permeability varying from 20000 – 50000) to realize the multiferroic stacks. This allows application of the generated magnetic field to over 0.5 T using only mA current densities. The multiferroic stack that constitutes the periodic FSS is comprised of metglas® or nanonickel ribbons with barium titanante or sodium potassium niobate piezoelectric layers placed top. At the conference, we will show that wide tunability range can be achieved using ferroelectric biasing by varying the biasing magnetic field.