Simulation and Fabrication of Low Frequency Multiferroic Laminate Antenna

Discovery of new types of multiferroic materials has allowed us to realize new devices with superior performance taking advantage of strong magnetoelectric (ME) coupling. In such systems, electric polarization and magnetization coexists which allows to achieve ME coupling. Notably, magnetic fields can be controlled using voltage and vice versa. And this process is mediated by strain between magnetic and piezo material. Furthermore, strong ME coupling allows us to realize a system with improved power efficiency, compact and lightweight design when compared with traditional material. Direct ME coupling allows magnetic field control of electric field while the opposite is true for converse ME coupling.

Heterostructure with piezoelectric and ferro magnetic materials bonded by adhesive allows us to take advantage of ME coupling mediated via strain to design a new class of compact low frequency antenna. The ME laminate discussed in this presentation consists of piezo material sandwiched between magnetic materials. For transmitter application, piezo layer is driven by voltage alternating at its resonance frequency, the strain generated in piezo layer is transferred to magnetic material resulting in change in magnetization and emission of oscillating magnetic field. Conversely, for receiver application, the incident magnetic field results in alternating voltage across the piezo layer.

The proposed antenna is simulated and optimized using COMSOL Multiphysics software. To realize the multiferroic heterostructure stack, PVDF and metglas® are used as piezo and magnetic layers respectively. For receiver application, the current coil is used to generate magnetic fields while a probe across piezo layer is used to measure alternating voltage. Similarly, for transmitter application, a probe across the piezo layer is used to supply alternating voltage while coil is used to measure radiating magnetic field. Furthermore, we note the shifting of electromagnetic resonance of material while changing the length of laminate. The proposed system is target to design portable KHz antenna for power transfer and wearable applications.