Requirements of robust and compact devices at microwave frequencies, led to integration of components in one platform have increased demand on miniaturized microwave components having large bandwidth with enhanced performance. Microstrip patch antennas being an important transreceiving transducer in modern microwave devices, further low profiling of this component is necessary. The physical dimensions of an antenna are controlled by miniaturization factor which depends on material parameters, complex permittivity and permeability. Using magnetodielectric materials is an effective way of reducing the antenna profile without affecting its performance.

Natural and artificial ferrite materials have their distinctive disadvantages. Nano sized ferrites in polymer matrix give an advantage over its counter magnetic materials, in terms of low magnetic loss and ease in development. Magnetodielectric composites with nano sized cobalt ferrite (CoFe$_2$O$_4$) and nickel ferrite (NiFe$_2$O$_4$) are included as fillers in low density polyethylene (LDPE) matrix in different volume fractions. The synthesized materials are microstructurally characterized using X-ray diffraction (XRD), transmission electron microscopy (TEM) and scanning electron microscopy (SEM) to determine the spinel structure of ferrites, its particle size and its distribution in the matrix. Other desired properties of the developed materials, like thermal conductivity, water absorbance and saturation magnetization is studied. For applications as a substrate material for antennas at gigahertz frequencies, it is mandatory to determine complex permittivity and permeability of the nano magnetodielectric system at a desired frequency. The said parameters are used to design simple rectangular patch antennas in X band. The fabricated antennas are tested for S11 and radiation characteristics. A miniaturization factor of 3.14 is observed for 5% VF nickel ferrite/LDPE composite.

The developed antennas are studied under influence of external magnetic field. A field of 35-40 G is sufficient to effectively enhance the performance. A planar inverted F shaped (PIFA) antenna is designed over the developed substrate. The $S_{11}$ for PIFA is found to be -33.18 dB and -10dB bandwidth is found to be ~23 % of the operational frequency.
The substrate geometry is structurally modified to reduce the surface wave losses for the rectangular patch, showing an improvement in bandwidth and directivity. Slots are introduced on the patch for bandwidth enhancement. Single and double T slot patch on the modified substrate design shows dual resonance and -10 dB bandwidth of 17%. The developed magnetodielectric substrate with nano inclusions show an improved S11, -10dB bandwidth and directivity, over similar structures fabricated on standard dielectric glass epoxy substrate.

The designed microstrip antenna on nano magnetodielectric composite shows enhanced bandwidth with improved performance and percentage miniaturization factor of 39%.