Novel Metamaterial Polarizer

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Metamaterials have many potential applications to antennas and associated devices. One application examined in the recent literature is a metamaterial polarizer using a planar two-layer structure of double split-ring resonator (DSRR) elements (S. Yan, G. A. E. Vandenbosch, "Compact circular polarizer based on chiral twisted double split-ring resonator," Applied Physics Letters 102, 103503, 2013). These DSRR metamaterial polarizers can transform an incident linearly polarized wave into a circularly polarized wave. Typically, the polarizer has a dual resonance where circular polarization is produced with low axial ratio.

These polarizers have several deficiencies that limit their potential use to practical antennas. The loss of the DSRR elements is high at resonance, making it unsuitable for low-loss applications. The bandwidth over which the polarizer has low axial ratio is small, typically 1% to 2% at most. The performance of the polarizer is also sensitive to the arrival angle of the incident electromagnetic waves, and responses are often non-symmetric because of the chiral nature of the metamaterial designs.

This work introduces a novel metamaterial polarizer in a cylindrical form factor. Starting from the existing planar DSRR designs, a compact cylindrical metamaterial polarizer is developed. The circular symmetry of this cylindrical polarizer allows it to be easily combined with several different antenna types, such as monopoles, dipoles, discones, and bicones, for efficient operation. The polarizer may be precisely tuned for operating frequency and beam patterns. Losses are shown to be minimal and lower than that of planar polarizers. The bandwidth over which good circular polarization is achieved is also increased by optimization of resonant element designs.

Prototype metamaterial polarizers are built by printing with conducting ink on dielectric cylinders. The polarizers are integrated with antennas and the test results presented, which confirm the design simulations. Conclusions and recommendations for future work are given.