

Leveraging Polarization Retransmission Agility of Reflective Surfaces for Enhanced Signal Control

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Polarization, critically influences electromagnetic behaviour in applications such as wireless communication and stealth technology, where precise alignment of the wave's electric field vector ensure reliable communication and enhanced channel capacity. Mismatch, however, is leveraged in stealth to reduce signal coupling.

Signal coupling is essentially sensitive to polarization alignment, which can be disrupted by misalignments or dynamic channel conditions. Despite extensive studies on polarization converters, their practical use for signal optimization in wireless communication remains underexplored. Similarly, reflective surfaces, primarily studied for beamforming and beam steering (although, not enough unless correctly polarized), their role in polarization conversion has received limited attention.

This study investigates the polarization agility of a passive reflective surface, focusing on its ability to redirect signals with altered polarization, thus exploring experimental understanding on polarization aspect of RIS structures. By integrating the polarization aspect of RIS structures, this experiment analyze the cross coupling efficiency of the structure and angular misalignment effects on its performance, marking the first integration of polarization considerations in RIS research.

The experimental setup maintains the reflective surface at 45° orientation to optimize Signal coupling between the transmitter and the receiver, both with orthogonal polarizations facing the surface, shown in Figure 1(a). The surface elements are matched to $50\ \Omega$, collecting incident signals via one feed point and retransmitting them with altered polarization through the orthogonal identical feeds.

To evaluate performance, the transmitter's polarization is systematically rotated across elevation/cross-polar planes, as illustrated in Figure 1(b), to analyze the effects of angular alignment on the redirected signal. This approach enables a comprehensive assessment of polarization agility of the reflective structure and its contribution to signal cross coupling between orthogonally polarized antennas.

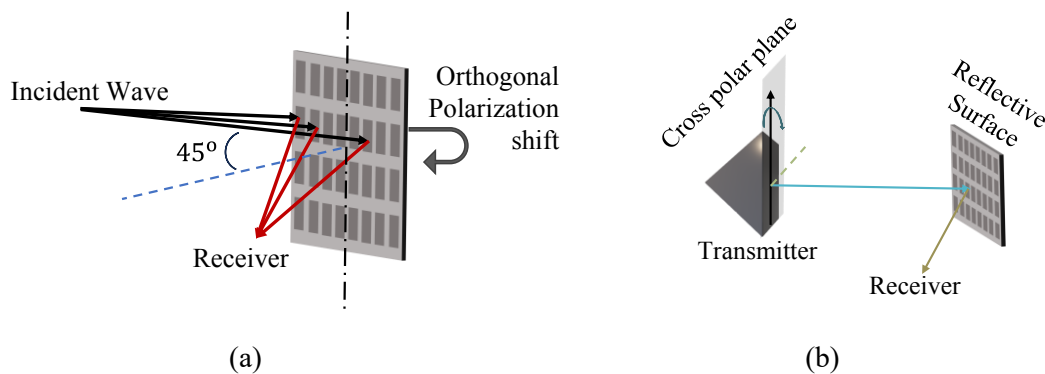


Figure 1. Altering polarization through reflective surface.

This work offers a novel perspective on the interplay between reflective surfaces and the complexities of electromagnetic wave polarization discrepancies in multipath propagation. The findings highlight the practical advantages and limitations of RIS structures of specific dimensions in optimizing signal performance through polarization manipulation.