Transparent Dual Polarized Antenna

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Primary CNF Tools Used: ABM Contact Aligner, PV75 Sputtering System, Even/Odd Hour Evaporators

Abstract:

Herein, we present a novel transparent antenna with ultra-wideband (UWB) performance along with polarization diversity through four ports allowing MIMO operation. The antenna design can be of a great interest for a vehicular applications and Internet of Things (IOT) where the dual polarization and multiple ports allows as well as medical glasses and vehicular windows where transparency is needed for visibility. The proposed antenna provides compact size with dimensions of 50 mm x 50 mm, through the employment of CPW, dual orthogonal-polarization, isolation level of 20 dB, and envelope correlation coefficient (ECC) of 0.0016 as well as MIMO performance.

Summary of Research:

The structure of the proposed antenna, as shown in Figure 1, is a circular slot fed by four coplanar waveguide (CPW) lines through four semi-circular patches placed in a perpendicular arrangement to achieve orthogonal polarization. Four strips are inserted between the semi-circular patches to enhance the isolation between the ports and maximize the polarization purity of the antenna. The conductive layer of the antenna is composed of a thin film of Silver (Ag) inserted between two layers of Indium Tin Oxide (ITO). The conductor stack was deposited onto a glass substrate with approximate structure of ITO (48 nm)/Ag (17.5 nm)/ITO (42 nm)/ Glass (0.7 mm) as reported in [1], where a transparency of 88% and sheet resistance of 3.1 Ω/sq are achieved. A Corning Eagle XG glass substrate is used, having a relative permittivity of 5.27, loss tangent of 0.001, and thickness of 0.7 mm.

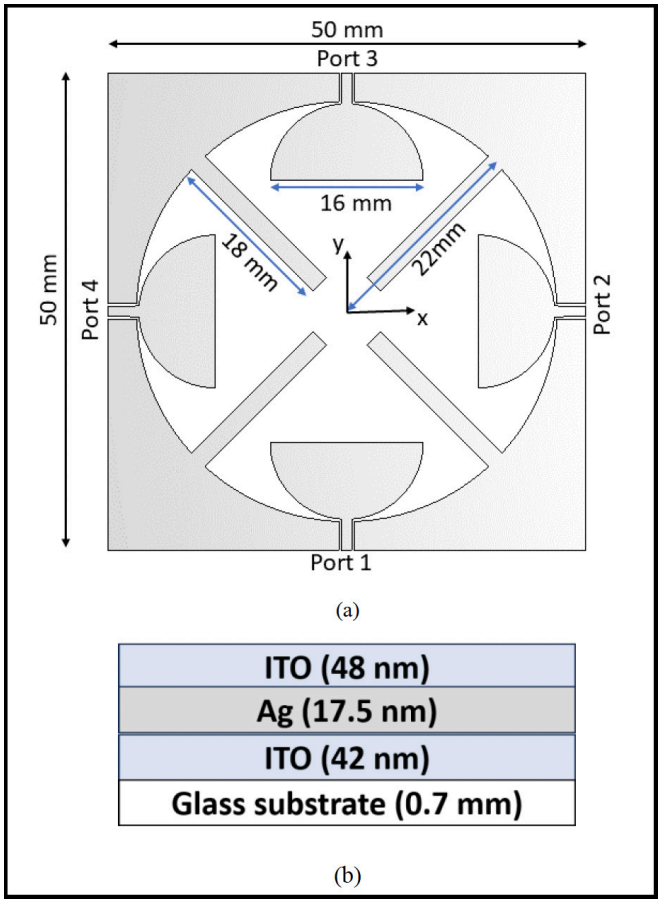

Figure 1: Structure of the proposed antenna. a) Perspective view and b) side view of the antenna design.

The proposed structure has been fabricated in the Cornell NanoScale Facility (CNF) and a picture of the fabricated antenna is included in Figure 2.

The fabrication process began by first, cleaning the glass substrate with acetone and isopropyl alcohol, then prebaking it before coating it with LOR-3A and S1813 photoresists. The antenna design was then exposed onto the substrate using a contact aligner and the pattern was developed. ITO was then sputtered onto the glass substrate on one side using an Indium-Tin target in a Kurt J. Lesker PVD 75 sputtering tool with a partial pressure of oxygen and a substrate temperature of 100°C. The composition of the ceramic sputtering target used is 90% Indium/10% Tin.

After sputtering the ITO, a layer of Ag with thickness of 17.5 nm was e-beam evaporated using a CHA evaporator. Later, the process of ITO deposition was repeated.

Subsequently, the substrate was soaked in Microposit Remover 1165 and sonicated to lift-off the photoresist and achieve the desired pattern. The substrate was then diced in a Disco wafer saw to extract the precise square antenna piece.

As a final step, 50 Ω SMA ports were connected to the antenna CPW feed lines using a conductive epoxy to prepare the antenna for measurement.

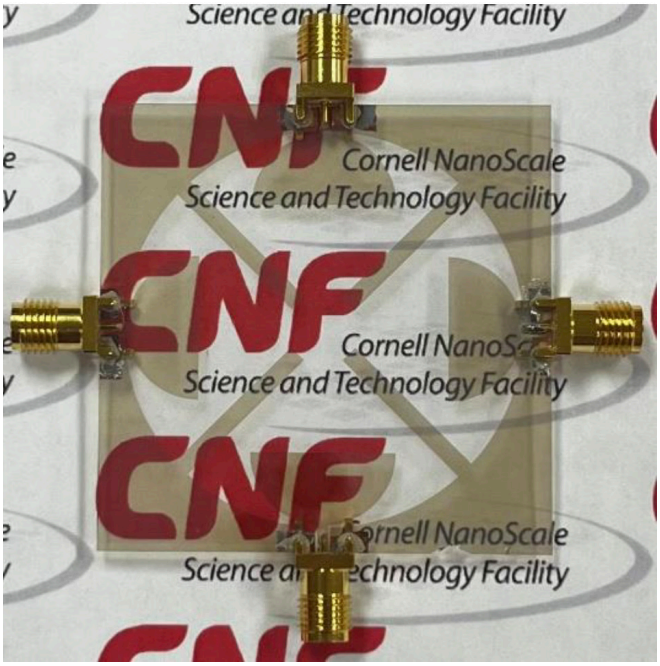

Figure 2: Image of the fabricated transparent antenna prototype.

Conclusions:

An ultra-wide band transparent antenna with features suitable for MIMO is proposed for various applications across automotive, IOT, and medical industries, among others. The performance of the antenna has been proven through simulation as well as primarily measurement results with return loss below -10 dB and an isolation level of 20 dB. The proposed antenna provides high transparency, a symmetric and compact structure, dual orthogonal polarization with similar radiation patterns, and diversity characteristics with ECC less than 0.0016 and DG on the order of 10 dB over the entire UWB.

References:

[1] J. -W. Kim, J. -I. Oh, K. -S. Kim, J. -W. Yu, K. -J. Jung and I. -N. Cho, "Efficiency-Improved UWB Transparent Antennas Using ITO/Ag/ITO Multilayer Electrode Films," IEEE Access, vol. 9, pp. 165385-165393, 2021, doi: 10.1109/ACCESS.2021.3131868.