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Optically Transparent Antenna for Smart Glasses

[1]Prof. Ravi Kiran R and [2]Chandana V
Professor, Department of Electronic and Communication[1]
Student, Department of Electronic and Communication[2]
SJC Institute of Technology, Chikkaballapura, India

Abstract: *Optically transparent antenna technology has attracted the attention of the consumer electronics industry for its ability to embed limited antennas into compact mobile devices. Initial research focused on the integration of transparent antennas into guidelines for smartphone applications, for example, to improve 5G mmWave spatial coverage charging on the forehead side. To our knowledge, the application of transparent antenna technology in smart glasses and virtual reality glasses has not yet been explored, especially given the limitations of integration with optical properties in lens clusters. Therefore, we first wanted to find a solution to the presence of RF lossy layers in the antenna and lens group to reduce the negative performance of the antenna. A metal mesh-based transparent antenna film and a ring antenna made of a metal glass frame were investigated. Testing the results of this antenna on a phantom human head shows an overall better than -4.5 dB in the 2.4 GHz band. While it is recommended for eg 2.4 GHz antennas, the same principle can be used for other sub-6 GHz antenna applications, for example.For example, LTE, Wi-Fi, GNSS etc.*

Keywords: Smart Glasses

I. INTRODUCTION

Our future immersive wearable computing platforms will connect peopletonew experiences, from inclusive learning and education to healthcare and new talent in the workplace. Augmented reality (AR) and virtual reality (VR) tools are required to deliver these experiences. The electronics industry has invested heavily in existing products from Meta (formerly Facebook), Google, Microsoft, and others. Despite being an important market, technology is still needed to develop thetechnologies needed to support3D virtual experiences and to package them in lightweight, thin, durable, stylish and socially portable models.Especially for the antennas of smart glasses, antennas are usually placed in forms such as printed circuit board (PCB), laser direct configuration (LDS), flexible printed circuit (FPC), chip, metal plate, metal wire, and thus transparent antenna. It is used as a solution to achieve limited volumeanda high level of design freedom. This attracted attention in the industry. Many transparent antenna research and applications in electronics are focused ontransparent antennas andintegration for smartphones [1],[2],[3],[4],[5],[6], smart watches [7]],[8] One. Antenna efficiency design, antenna efficiency, antenna gain, bandwidth, antenna separation, tuning ability, polarization, etc. It requires a largearea or freedom of placement, such as In particular, the integration of transparent antennas and displays provides an option for full-screen mobile phones to achieve 5G mm-wave coverage on the forehead [1].other things

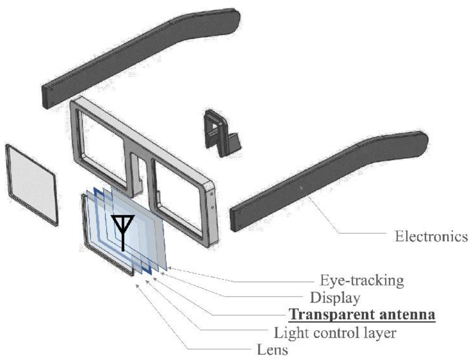

FIGURE1. TransparentantennaandARglassfeaturescoexistenceongenericglassframe[15],[16].

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Applications of transparent antennas in industries include, but are not limited to automobile [9], [10], solar panels [11], [12], [13], [14] applications. The antenna design is one of the most important engineering challenges in smart glasses hardware design - antenna design is limited bydesign standards, while antenna wire performance is affected by body weight, including detuning, attenuation and shadowing effects. From a phase perspective, AR applications must be sensitive and low latency, while the power of the antenna port is limited bybattery life and human electromagnetic exposure requirements (eg Specific Absorption Rate (SAR)).It helps to connect people from the real world to the virtual world for a better experience. The main difficulty in realizing the Transparent antenna is the coordination of the transparent antenna layer with other functions that already exist in the lens group. In other words, the transparent antenna should ensure that theoptical performance degrades while exhibiting the performance of the antenna compared to the conventional antenna at all times in the mirror (for example, LDS or PCB antenna on glass) in the temple or frame area.Although optically functional layers in lens stacks are still under development and their optical performance is facing major challenges, the light control layer (LCL) is considered a material that has a major impact on most antenna performance of current data. function and coexistence produce lossy LCL and

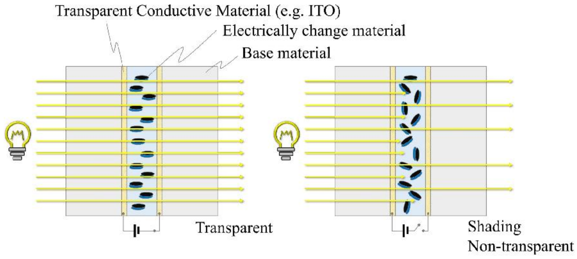

FIGURE2.ALCL;(a)Onstateand(b)Offstate[17],[18],[19],[20].

Transparent antennas become the key to integrating transparent antennas into modern smart/AR glasses. This document first describes LCLs and transparent materials made from metal mesh. From the examination of various simple antennas, the concept of transparent antenna is the best choice for the integration of transparent antenna and lossy LCL. The design is simulated and validated by the model.

II. TRANSPARENT MATERIALS

This section examines the Light Control Layer (LCL) and examines why it has the greatest impact on antennas. This chapter also examines the techniques developed to produce invisible films and thin films.

A. LCL

The generic LCL shown in Figure 2 is also called the "active dimming layer." The main types are PDLC (Polymer Dispersed Liquid Crystal) [17], [18] which is good at controlling dispersion, and GHLC (Guest-Host Liquid Crystal) [19], [20] which is good at controlling light transmission.In both cases, the liquid crystal (LC) is sandwiched between two transparent conductive films (usually indium tin oxide: ITO), and the direction of the LC can be changed using contrast, which allows the optical properties of liquid crystals. It is converted to electricity. Selection PDLC versus GHLC depends on the application, eg PDLC versus AR. VR and the optical devices they need to integrate.At radio frequency, ITO in LC has a big impact on the performance of transparent antennas because ITO always has a high form factor. For example, the normal resistance of ITO to protect optical devices is around 10 to 500 ▲/Sq. Due to the small difference between the vertical and horizontal Dk and Df of the LC, the RF interference between the LC and the hybrid LC is very small even if the bias of the LC is on or off. Proximity to ITO loss can cause serious damage if the clear antenna of the lens is not suitable.

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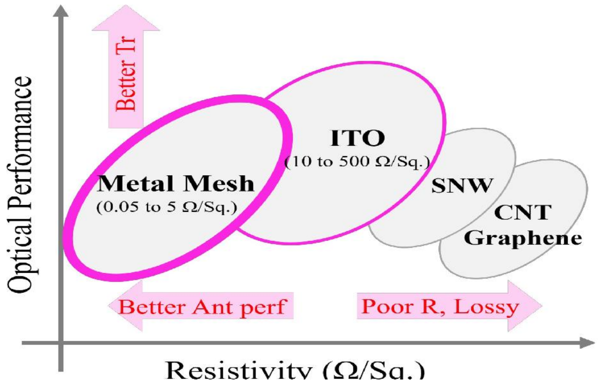

FIGURE3.Generaltransparentconductivematerialmappingshowstradeoffbetweentransparency andresistivity.

TRANSPARENT CONDUCTING FILMS AND METAL MESH

Transparent Conductive Films (TCFs) are very thin and the material itself is both optically transparent and electrically conductive. Many transparent antennas have been developed using TCFs [21], [22], [23] before. ITO is the most widely used TCF in electronics. Silver Nanowires (SNW) consist of a network of silver wires shorter than the wavelength of visible light. Graphene and carbon nanotubes (CNTs), one of the promising TCFs, are still under development in recent years.On the other hand, Metal Mesh (MM), one of the TCFs, is mostly used for touch sensors and electromagnetic shielding of previous products. Recently, the design of transparent antennas using MMs has received more attention in the industry due to the weakness of MMs [1], [2], [7], [8]. MM can be made into by photolithography extraction, galvanic additive method, printing, transfer method and other production methods with a quality similar to PCB or integrated circuit (IC) technology production. In all TCFs mentioned above, there is always a balance between poor electrical and optical properties, as shown in Figure 3.

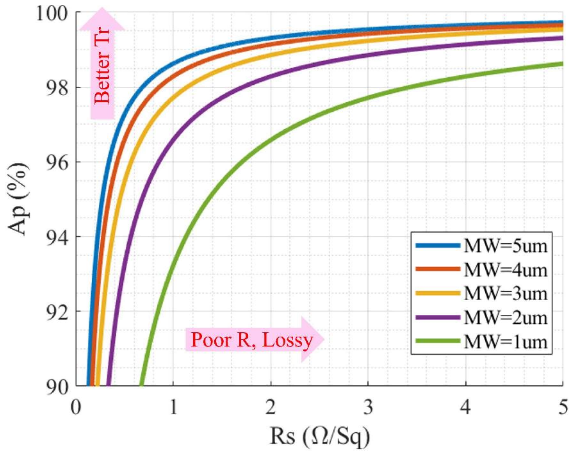

FIGURE4.SheetresistanceRsandapertureratio*Ap*ofmetalmesh,where*MT/MW*=1.0,σ=5.8×10^7×0.5,*MP*isparameterinequation(1)and(3).

III. TRANSPARENTSLOTANTENNAONLCL

Figure 4 shows the calculated Ap and Rs plots for a general configuration. Change AP to MP to see cost only Rs. The thickness of the wire mesh MT depends on the mesh width MW. In this calculation, we assume MT MW, which is normal for generation. The ideal conductivity was set to 50% Cu (i.5.8 X 107 X 0.5). Ap is also related to optical transmission (Tr) and dispersion, denoting a trade-off between Rs and the optical properties of the wire mesh.Forvisual inspection, it is recommended that the mesh width should not exceed 2um. From the AP's point of view, as shown in Figure 4, the wider the network width MW, the better the AP. In terms of Antenna design, it should be noted that there are three main components. form the antenna element: transparent conductive materials, such as a metal mesh antenna layer, and a lossy layer next to the antenna layer.For example, metal or plastic enclosure for ITO and glass for LCL. Figure 4 shows not only the grouping of the transparent antenna and the LCL of the lens, but also the form-fit antenna.

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True coatings require acombinationof base materials and optically clear adhesives (OCAs) for each job. However, they were not included in this study because they were too thin and could not see radio frequency well.

IV. CONCLUSION

Transparent antennas are a good candidate to address the antenna packaging limitations of smart glasses and extra glasses. This article explains the limitations of transparent antenna design and performance with RF lossy optical/lens arrays. The idea of the edge of the antenna was first proposed in to solve the problem of integration with optical equipment and more.

In particular, a metal mesh layer is directly coupled to the light control layer. Using this configuration,RF loss caused by optical signatures can be largely eliminated. Experimental results of the human head phantom validate our simulations with a total efficiency of 4.36 dBat 2.4 GHz.

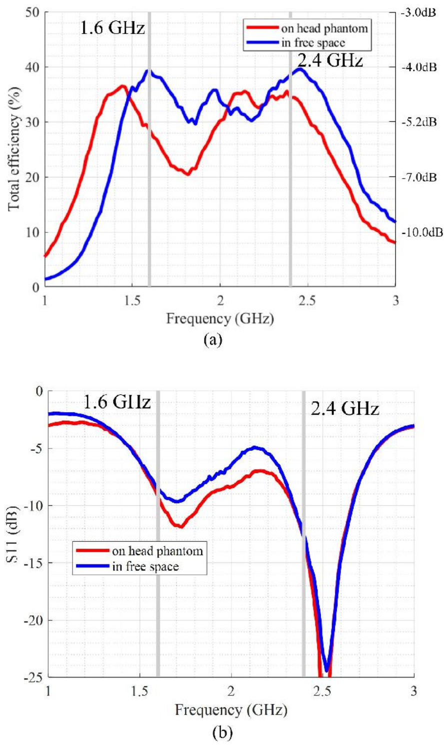

FIGURE5.Measurementresultsofproposededgeslotantenna(a)antennaefficiency(b)reflection coefficient.

REFERENCES

[1]. J. Park, S. Y. Lee, J. Kim, D. Park, W. Choi, and W. Hong, “Anopticallyinvisibleantenna-on-displayconceptformillimeter-wave5G cellular devices,” *IEEE Trans. Antennas Propag.*, vol. 67, no. 5,pp.2942–2952,May2019.

[2]. M.Kimetal.,“Antenna-on-displayconceptonanextremelythinsubstrate for sub-6 GHz wireless applications,” *IEEE Trans. AntennasPropag.*,vol.70,no.7,pp.5929–5934,Jul.2022.

[3]. Y.Oh,J.-Y.Lee,D.Lee,D.Park,andW.Hong,“Broadbandantenna-on-display applicable for WiFi,” in *Proc. IEEE Int. Symp.Antennas Propag. USNC-URSI Radio Sci. Meeting (APS/URSI)*, 2021,pp.61–62.

[4]. T.D.Nguyen,K.Kim,S.R.Yoon,andG.Byun,“Opticallyinvisible artificial magnetic conductor subarrays for triband display-integratedantennas,”*IEEE Trans. Microw. Theory Techn.*,vol.70,no.8,pp.3975–3986,Aug.2022.

[5]. M. Stanley, Y. Huang, H. Wang, H. Zhou, A. Alieldin, and S. Joseph,“A transparent dual-polarized antenna array for 5G smartphone appli-cations,”in*Proc.IEEEInt.Symp.AntennasPropag.USNC/URSINat.RadioSci.Meeting*,2018,pp.635–636.

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[6]. S. Foo and W. Tong, "AMOLED in-display antennas," in *Proc. 14thEur.Conf.AntennasPropag.(EuCAP)*,2020,pp.1–5.
[7]. W. Hong, S. Ko, Y. G. Kim, and S. Lim, "Invisible antennas usingmesoscale conductive polymer wires embedded within OLED dis-plays," in *Proc. 11th Eur. Conf. Antennas Propag. (EUCAP)*, 2017,pp.2809–2811.
[8]. W. Hong, S. Lim, S. Ko, and Y. G. Kim, "Optically invisible antennaintegratedwithinanOLEDtouchdisplaypanelforIoTapplica-tions," *IEEE Trans. Antennas Propag.*, vol. 65, no. 7, pp. 3750–3755,Jul.2017.
[9]. J.P.Lombardietal.,"Coppertransparentantennasonflexibleglassbysubtractive and semi-additive fabrication for automotive applications,"in *Proc. IEEE 68th Electron. Compon. Technol. Conf. (ECTC)*, 2018,pp.2107–2115.
[10]. O. Kagaya, Y. Morimoto, T. Motegi, and M. Inomata, "Transparentglassquartzantennasonthewindowsof5G-millimeter-wave-connected cars," *IEICE Trans. Commun.*, vol. 104, no. 1, pp. 64–72,2021.
[11]. T. Yekan and R. Baktur, "Conformal integrated solar panel antennas:Two effective integration methods of antennas with solar cells," *IEEEAntennasPropag.Mag.*,vol.59,no.2,pp.69–78,Apr.2017.
[12]. F.Nashad,S.Foti,D.Smith,M.Elsdon,andO.Yurduseven,"Development of transparent patch antenna element integrated withsolar cells for Ku-band satellite applications," in *Proc. LoughboroughAntennasPropag.Conf.(LAPC)*,2016,pp.1–5.
[13]. S. Zarbakhsh, M. Akbari, M. Farahani, A. Ghayekhloo, T. A. Denidni,and A.-R. Sebak, "Optically transparent subarray antenna based onsolar panel for CubeSat application," *IEEE Trans. Antennas Propag.*,vol.68,no.1,pp.319–328,Jan.2020.
[14]. X.Liu,D.R.Jackson,E.Ingram,J.Chen,andM.H.Seko,"Transparent microstrip antennas for CubeSats," in *Proc. IEEE Int.Symp.AntennasPropag.USNC-URSIRadioSci.Meeting*,2019,pp.845–846.
[15]. Y.-Y.Wang,Y.-L.Ban,Z.Nie,andC.-Y.-D.Sim,"Dual-loopantennafor4GLTEMIMOsmartglassesapplications,"*IEEEAntennasWirelessPropag.Lett.*,vol.18,pp.1818–1822,2019.
[16]. Y.-Y. Wang, Y.-L. Ban, and Y. Liu, "Sub-6GHz 4G/5G conformalglassesantennas,"*IEEEAccess*,vol.7,pp.182027–182036,2019.
[17]. J. Xu et al., "Study on the preparation and performance of an electri-callycontrolleddimmingfilmwithwideworkingtemperaturerange,"
[18]. *J.Mol.Liquids*,vol.367,Dec.2022,Art.no.120408.
[19]. L. Chen, Y. Yang, X. Xia, M. Ju, and Z. Wu, "Design of intelligentdimming glass system," *World Sci. Res. J.*, vol. 4, no. 4, pp. 9–15,2018.
[20]. J. Kim, S.-W. Oh, J. Choi, S. Park, and W. Kim, "Optical see-throughhead-mounteddisplayincludingtransmittance-variabledisplayforhighvisibility,"*J.Inf.Display*,vol.23,no.2,pp.121–127,2022.
[21]. J. Lee, S. Nam, and S. S. Choi, "Design of chiral guest-host liquidcrystals for a transmittance-tunable smart window," *Opt. Mater. Exp.*,vol.12,no.7,pp.2568–2583,2022.
[22]. H.J.Song,T.Y.Hsu,D.F.Sievenpiper,H.P.Hsu,J.Schaffner,and
[23]. E. Yasan, "A method for improving the efficiency of transparent filmantennas,"*IEEEAntennasWirelessPropag.Lett.*,vol.7,pp.753–756,2008.
[24]. Y. Koga and M. Kai, "A transparent double folded loop antenna forIoTapplications," in*Proc.IEEE-APSTopicalConf.AntennasPropag.WirelessCommun.(APWC)*,2018,pp.762–765.
[25]. S.Hakimi,S.K.A.Rahim,M.Abedian,S.Noghabaei,andM.Khalily,"CPW-fed transparent antenna for extended ultrawideband applica-tions," *IEEE Antennas Wireless Propag. Lett.*, vol. 13, pp. 1251–1254,2014.