A Honeycomb–Shaped Planar Monopole Antenna for Broad Band Application

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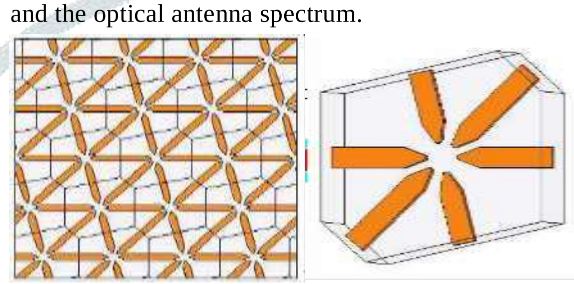
***Abstract*- A monopole antenna is a class of radio antenna consisting of a straight rod_ shaped conductor which is mounted perpendicular over conductive surface called ground plane. The proposed antenna has an ultra- wideband impedance response for a hand held communication device. The proposed system with extreme bandwidth is one of the prospective systems of modern high capacity communication. Speed data transmission in broadband technology can deliver hundreds of Mb/s. For 5G communication system the antenna designs must be such that it should provide significant amount of bandwidth for data transfer. The proposed antenna also has a unique hexagonal honeycomb structure which has a low profile of 56mm2 on Rogers substrate of 0.254 mm thickness. A honeycomb shaped structure provide a material with minimal density, the peak gain provided by the proposed antenna isof about 4.15dBi also the efficiency is extended from 90% to 93% of the central frequency also the design could be extended to 8x1 array element with maximum gain of 127dBi.**

***Index Terms*- Broadband, Honeycomb Structure, Monopole Antenna and 5G communication.**

I. INTRODUCTION

The technology is advancing in the wireless communication with the frequencies of the order of GHz and THz. We still need more compact antennas with wide band radiation patterns[1]. The mobile system of future envisioned to adopt 5G standards, the main objective of this proposed design is to provide an extremely high data rate of 5Gbps and above. This design is also to ensure that it provides significant bandwidth for demanding data transfer. Theoretical and practical feasibility studies have been carried out in order to pave the way implementing wireless communications in millimeter-wave bands [2]. The proposed antenna achieves a wide band performance that can fulfill 5G bandwidth requirements with high data transfer.

In the design of the antenna reflectors the honeycomb cores are used in field of aerospace engineering. The paper also illustrates a new strategy to fabricate cross-section honeycomb with advanced composite materials [3].Having a relative dielectric constant in the range of 1.0 to 2.0. This type of material can be air, polystyrene Foam, or dielectric Honeycomb [4]. The monopole antenna has been widely used in high performance satellite and wireless communication devices because of low cost, low profile and compatible with circuit technology [5]. Antennas can be fed by different feeding approaches like, coaxial feed, proximity coupled micro strip feed and aperture coupled micro strip feed. Examples of use of shape memory materials in honey- comb structures is fairly limited, a shape memory alloy cellular structure that exploits the auxetic nature of the chiral configuration has been developed to create monopole antenna [5]-[6]. In addition to the unidirectionality of optical antenna radiation fields, there is an approach to implement plasmotic antennas in solar cells which is the spectral match between the incident solar spectrum and the optical antenna spectrum.



(a) (b)

Fig1. (a) A schematic illustration of the honeycomb plasmonic nano antenna array. (b) An asymmetric Wigner-Seitz unit cell which forms the building block of the honeycomb plasmonic nano antenna array

In order to improve the efficiency of the photovoltaic devices, optical nano antennas should be operational in the spectral region where the majority of solar energy is present and the absorption efficiency of semiconductor device is low [7].

Antennas reflectors are typically manufactured by fabricating low-temperature concave molds from a master convex pattern. For example, the rigid substructure and flat panels are constructed with epoxy honeycomb sandwich panels could be adhesive bonded to flat panels. These reflectors are accurate, lightweight, and dimensionally stable. The main approach is to design, analyse, and fabricate precision antenna reflectors for ground-test systems and for low-cost proof of feasibility models of monopole antenna systems. Antenna performance is predicted through the use of a computer model based on Model expansion theory and results are plotted in the series of graphs that describes the limitations of the proposed antenna designs. The radiation pattern of a monopole array element is relatively wide and typically has low gain. In order to achieve higher directivity and additional gain, antenna elements can be arranged in honeycomb shape to form linear or planar arrays [8]. A regular, hexagonal grid of cellular base-station sites is conceptualized for stations at the corners of the hexagons. The area within each antenna radiation pattern has different users being assigned different frequencies and their signals combine to form a single perceived colour in that instant.

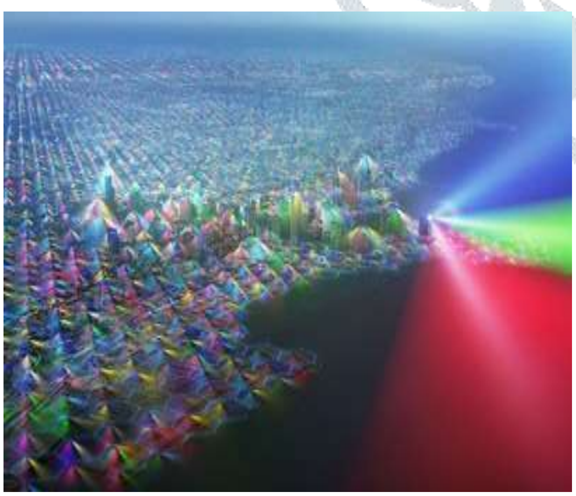


Fig2. Cell phones signals from antenna with different radiation pattern

Different channel combinations from sector to sector are indicated by different colours. The channel combinations shown above are not static, but rather change rapidly in time as different users are assigned different channels. Antenna signals extending beyond the original cells provide maximum coverage.

II. ANTENNA DESIGN

The proposed antenna is mainly constructed on the substrate known as Rogers RT duroid 5880 substrate of height 0.254mm. VSWR is quite less than 2 for RT-duroidie., around 1.196 and 1.369 also less than 2. Antenna gets back less voltage towards the source and receives the maximum.

Also the dielectric constant is 2.2 and loss tangent tanδ is around 0.0009 as discussed earlier in introduction the antenna consists of six hexagonal parasitic structure as shown in fig.3.

At a distance h above the truncated ground, the central hexagonal structure is placed, from its edge. Each side of the central hexagonal, which is the radiating element, the replicated hexagonal structures are placed except the side that is towards ground plane. The replicated elements at each side of original structure are placed at distance d from each other. The number of replications here is of about 5 times that resulted in accuracy .It should also be noted that increasing the number of replication results in low accuracy. The feed excitation from the non-contact sides gives a benefit of a very high bandwidth. The array formed from the parasitic structures around the radiating element enhances the overall gain.

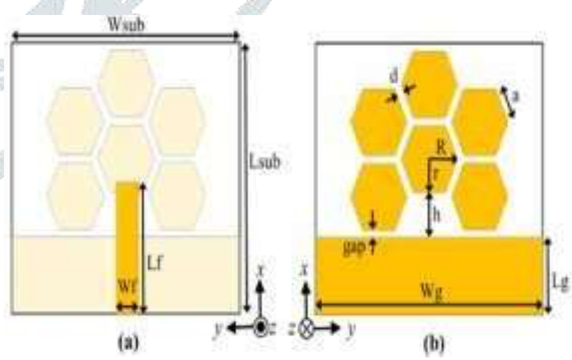


Fig.3. back and front view of geometry of proposed antenna

III. FINAL DESIGN PARAMETERS OF THE ANTENNA

Lsub =7mm	R=1mm
Wsub = 8mm	r=0.866
Lg=2mm	a=0.866
Wg=8mm	d=0.241
Lf=3.4mm	gap=0.134
Wf=0.78mm	h=1.134

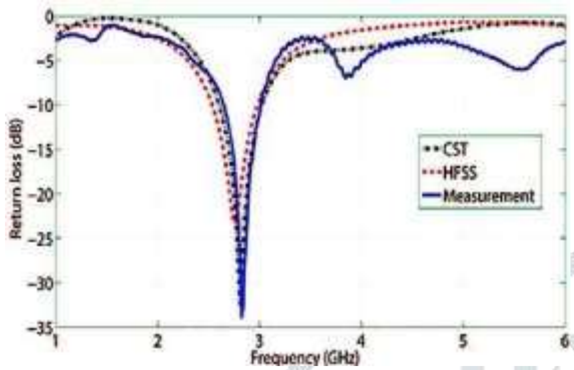


Fig.4. results of frequency and return in loss(Dbi)

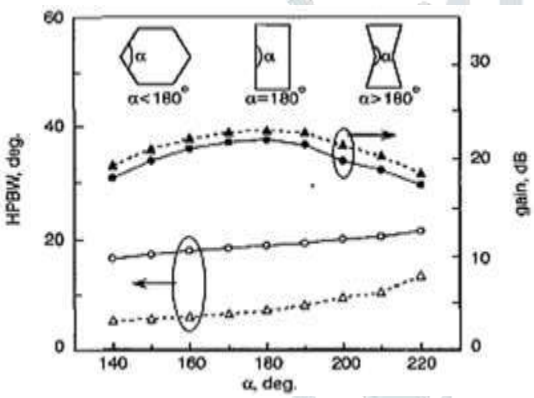


Fig.5. efficiency and maximum gain of an antenna

The proposed honeycomb antenna is a lossless dipole antenna that has a gain 4.1 Db, the relation between these units is for frequency the antennas' effective area is proportional to the power gain. Also the directivity is a different measure which does not take an antenna's electrical efficiency into account.

IV. SIMULATED RESULTS

From the simulated results the antenna maximum gain varies between 2dBi to 4dBi. Therefore this antenna operates in the band of frequencies between 28 to 38GHz. It can be concluded from this distribution that the monopole section from the feed line, lower two elements and central elements provides maximum radiation. Thus radiations occurs from the edges of the lower three parasitic elements and the ground plane.It is clear from the current distribution that contribution to the overall the parasitic elements and ground plane radiate from it. The wavelength in the free space is 28GHz which is of 11mm, and its material wavelength is 7.14mm, and with the higher frequencies the frequency ranges upto 38GHz. The width is approximately 0.16λ for 28GHz and 5.33λ for 38GHz which resulted in good gain.

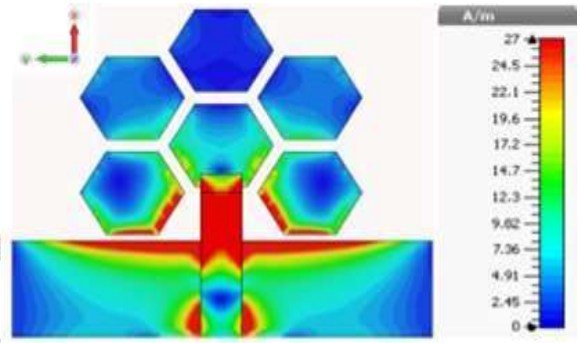


Fig.6. surface current distribution at 32 GHz

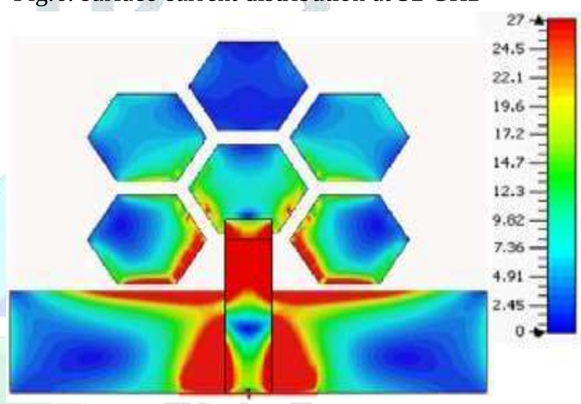
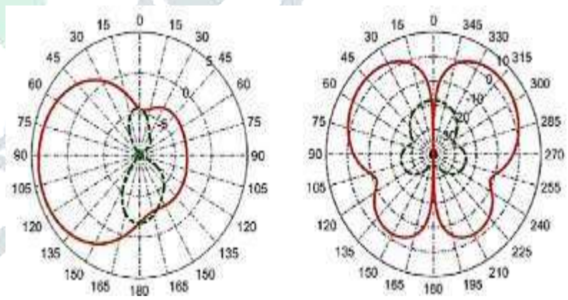


Fig.7. Surface current distribution at 28 GHz



(a) (b)

Fig.8. radiation pattern at 32 GHz , (a) E- plane indicating both Co-pol and Cross – pol (b) H-plane indicating both Co-pole and Cross- pol.

Cross polarization is the orthogonal polarization ie., the field from an antenna are meant to be horizontally polarized as shown in the fig .8. the polarization is LHCP – left hand circularly polarized, this term arises because an antenna is never 100% polarized in a single node. Hence two radiation patterns of an antenna are sometimes presented ie., the co-polarization (also known as desired polarization) radiation pattern and the cross - polarization radiation pattern. The cross polarization in the above figures may be specified for an antenna as a power level in negative dB, indicating the desired polarization power level in decibels.

V. CONCLUSION

The paper is presented with the low profile monopole antenna with radiation pattern obtained through the honeycomb shaped parasitic elements. The antenna also provided broadband response i.e, for 28GHz to 32GHz which covered almost all K-band frequencies.

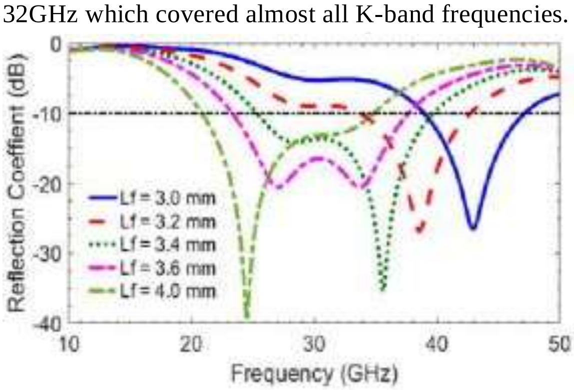


Fig.9. Simulated S-parameter of the array

Also the proposed antenna provided a reasonably good antenna gain of about 4.15dBi alone, also the gain could be extended upto 127dBi gain when used in the form an array of 8x1. The efficiency upto 90% could be obtained. It was also observed that a array has a very good port isolation and maintained the same ultra- wide bandwidth. Is is also concluded from the obtained current distribution, the radiation pattern and the gain is evaluated. In the first mode radiation, the maximum gain is α=180o interior angle. It is also found that the cross polarization components in the two planes are desirably small.

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