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Nano Silver Based Low Profile Folded Dipole Paper Antenna for High Frequency Application

[1]J. Arul Linsely and [2]Dr. A. Shajin Nargunam

[1]*Asst. Prof, Electrical and Electronics Engineering Department, Noorul Islam University Kumaracoil, Thucklay, Tamil nadu, India*
[2]*Prof. /Dept. of Computer science and Engineering, Noorul Islam University Kumaracoil, Tamil Nadu, India*

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ABSTRACT

The rapid growth of wireless technologies need compact, easily designed and fabricated high frequency antennas. Here the antenna is designed by using nano silver material that is coated on a flexible cellulosic paper and then sintered to make a folded dipole antenna for Ultra High Frequency and Very High Frequency applications. Previously metal antennas were used for receiving the signals and lately they have been replaced by nano material antennas. The antenna thus developed will be flexible, cost effective, bio degradable and easy to fabricate. Nowadays, due to the rapid development in the communication field, flexible antennas are used for RF applications. This antenna is an eco friendly and bio degradable antenna. This antenna is tested by using ATS-2002 (Antenna Training System) developed by FALCON. The results are discussed in this research work.

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INTRODUCTION

Design of a compact antenna to support wireless devices is an interesting research topic. As the electronic technologies have progressed, market demand devices are smaller and lighter than ever before, which is a promising area of research. This has led to the development of technologies to fabricate the antennas on low cost substrates such as organic cellulosic material.

This paper aims at developing a compact folded dipole antenna by coating the nano silver material mixed in organic additives over cellulosic paper and sintering it to increase the conductivity of the antenna designed for 850 MHz This antenna is cost effective, eco friendly and easy to fabricate.

Methodology:

Materials:

Nanosilver materials mixed with an organic additive are coated on a cellulosic paper to get a folded dipole antenna in the frequency range of about 2 MHz to 10 GHz.

Antenna design and fabrication:

The organic cellulosic paper used to fabricate the antenna is cut as a square measuring 7 cm to 7 cm. Two cellulosic papers with 7 cm to 7 cm size are pasted by using glue to make a thick base and to give mechanical support as well. This organic cellulosic paper is then pre heated by using a hot air oven at a temperature of 60^0C for 30 minutes.

The nanosilver powder is then made as a paste by mixing it with organic additives which has non polar solvents that have long alkyl chains and is used to stabilize the nano particles. This paste is applied to the cellulosic paper to a length of 17.64 cm to form a folded dipole antenna using a thin brush.

It is then sintered by using a hot air oven for about 1 hour at 80^0 C; by this process the conductivity is gradually increased, as the contact between the particles becomes better.

$$c = \vartheta\lambda$$

Where, C is about $3*10^8$ m/s and ϑ is selected as 850 MHz. Since it is a dipole antenna having half wavelength, the total length of the folded dipole antenna that should be pasted is 17.64 cm .c.nano silver antenna characterization

After fabrication, the processed cellulosic paper antenna is tested for its properties. The characteristics of the antenna showed the properties of a folded dipole antenna with a frequency of about 850 MHz .This antenna has a very good radiation pattern. The characterization was done by ATS-2002 developed by FALCON.

Corresponding Author: J. Arul Linsely, Asst. Prof, Electrical and Electronics Engineering Department, Noorul Islam University Kumaracoil, Thucklay, Tamil nadu, India
Tel: 0091-9994081081

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Results:

Elevation pattern of a dipole antenna

Sl no:	Angle in degree	Output power
1	15	22.5
2	30	22.9
3	45	22.6
4	60	22.9
5	75	23.8
6	90	21.5
7	105	21.1
8	120	19.8
9	135	19.6
10	150	18.7
11	165	17.5
12	180	18.1
13	195	17.5
14	210	17.1
15	225	17.8
16	240	17.3
17	255	18
18	270	19.9
19	285	1.5
20	300	19.5
21	315	20.1
22	330	20.7
23	345	21.2
24	360	21.8

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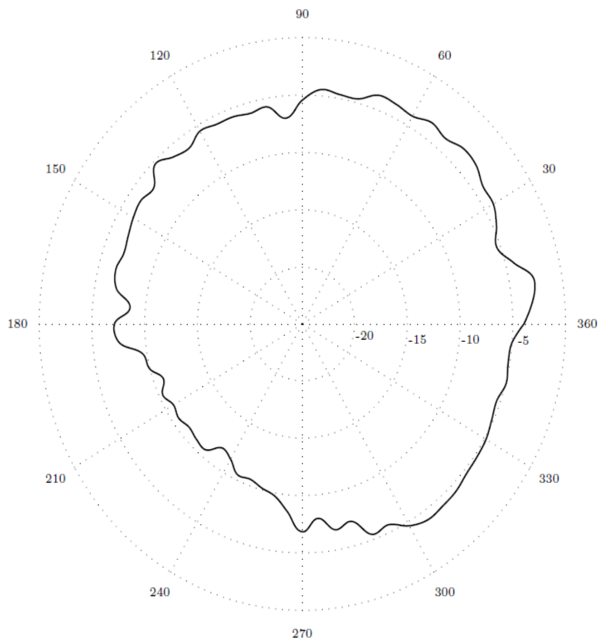

Fig. 1: YZ plane or E-plane.

Azimuth Pattern of a dipole antenna

Sl no:	Angle in degree	Output power
1	20	31.1
2	40	28.6
3	60	24.1
4	80	27.9
5	100	26.6
6	120	29.5
7	140	26.8
8	160	27
9	180	26.4
10	200	26.7
11	220	26.3
12	240	26.5
13	260	26.4
14	280	26.8
15	300	27.8
16	320	27.7
17	340	27.2
18	360	27.8

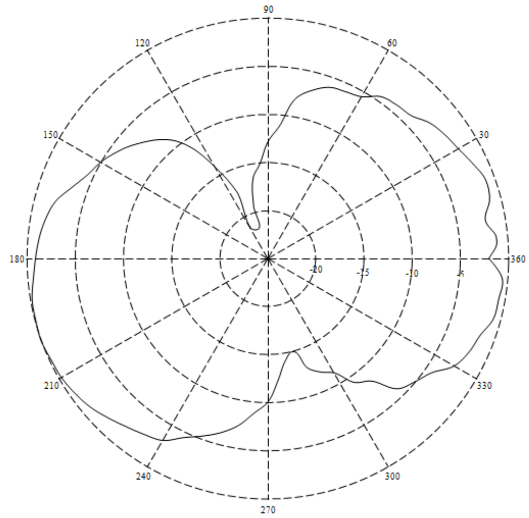

Fig. 2: XZ plane or H-Plane.

Figures 1 and 2 show the output of this prototype antenna which is placed in the YZ plane (E-plane) and in XZ plane (H-Plane) respectively.

Discussion:

Organic substrates offer an unique advantage of being cheaper, lighter and more environmentally friendly in processing and disposal than current substrates like FR4.They also have the additional advantage of providing flexibility.

A new sintering technique has been characterized on paper which allows quicker sintering with little to no substrate heating and much lower energy requirements. This work lays a strong foundation for low-cost, high gain and wideband antenna fabrication with environment friendly substrates by using inkjet printing, Benjamin S. Cook and Atif Shamim (2012)

Paper which holds one among the biggest market shares in the world could potentially revolutionize the electronics market. It can eventually take the first step in creating an environmentally friendly first generation which is truly "green"in RF electronics and modules. In addition, paper is one of the lowest-cost effective materials that can be produced, Amin Rida *et al*. (2012)

The antennas thus developed have the advantages of small size, low profile and simple configuration. The low profile of the antennas makes it a promising device for compact and slim wireless devices of the future, Hattan F. Abutarboush and Atif Shamim (2012)

The present antenna can be employed in several future applications such as wireless broadband networks for rural and regional parts of Australia. Another application is the use of this antenna as an element in frequency reconfigurable array, Yong Cai *et al*. (2012)

This letter is one step ahead towards the development of low-cost, environment- friendly conformal printed antennas for Adhoc wireless sensor networks operating in rugged environments and conditions, George Shaker *et al*. (2011)

This paper presents the design of a low-profile compact printed antenna for a fixed frequency and reconfigurable frequency bands. These antennas consist of a main patch, four sub-patches and a ground plane to generate five frequency bands at 0.92, 1.73, 1.98, 2.4, and 2.9 GHz for different wireless systems, Hattan F. Abutarboush *et al*. (2012)

The realistic optical metallic nano dipole antenna is studied and the classical antenna parameters are considered. The results clearly show that it is absolutely crucial to choose the proper metal in terms of the operation frequency band targeted.

If we neglect the oxidation effect of silver and aluminum then silver is the best choice for wavelengths above 500 nm and aluminum has the best performance below 500 nm. By taking into account the oxidation effect, the threshold shifts to about 700nm wavelength. Zhongkun Ma and Guy A. E. Vandenbosch (2013)

The effect of the dispersive properties of some important metals were studied and the input impedance of Ag > Al was observed, F. Pelayo García de Arquer *et al*. (2008)

The excellent conductive values of metallic silver was attained by using very small amounts of organic additives without any strong adsorbing groups such as amines and amides.

Even at low temperatures the conductivity of the printed antennas by using nano materials was dependent on the organic additives used. This low sintering temperature enhances the conductivity of flexible materials, Jolke Perelaer *et al*. (2011)

The advantages of using high impedance surfaces over other potential solutions for the design of low profile dipole antennas have been remarked, Andrea Vallecchi *et al*. (2012)

The proposed antenna with a stacked structure in this letter achieved a low-profile structure with wideband impedance characteristic with equal or exceeding the performance of similar designs. A more uniform gain response has also been obtained in the whole operating band, Fei Gao *et al*. (2013)

A novel technique that enhances the bandwidth of a conventional printed dipole is presented in this communication. By this technique it is possible to achieve a bandwidth of 66% without increasing the footprint of the antenna. The proposed method is simple in comparison to other techniques that are used for bandwidth enhancement, Amiya R. Behera and A. R. Harish, (2012)

Printed antennas have demonstrated that they can be useful not only as a communicating element, but also as a sensor or an energy collector. Strain, gas concentration, bioactivity and a lot of other magnitudes have been measured as a change to the printed antenna parameter, such as input impedance or resonant frequency.

The compatibility of printed antenna manufacturing with different emerging technologies such as RFID allows us to be completely optimistic about the emergence of the new paradigms that are based on the well known antennas, Càndid Reig and Ernesto Ávila-Navarro, (2014)

A wideband and low-profile antenna has been developed and implemented. It is noted that the advantage of the antenna is that it has a wide bandwidth and a low profile. The VSWR of the antenna is less than 2.0 over 0.99–2.08 GHz with a height of only 30 mm. The antenna has appropriate properties for wideband and low-profile applications, Shi-Gang Zhou and Jian-Ying Li (2011)

A compact omni directional printed quasi-Yagi antenna for a Radio Frequency Identification reader application is presented. The size of the antenna and the radiating elements of the quasi-Yagi antenna are replaced by artificial transmission lines. The proposed antenna that operates at a frequency of 915 MHz has a substrate size that is more than 76.24% smaller compared to the previously reported compact Yagi antenna, Parviz Hajizadeh, (2013)

A low-profile magneto-electric dipole antenna composed of a horizontal planar dipole and a vertically oriented folded shorted patch antenna is presented. The antenna is excited by a coaxial feed without the need of an additional balun, Lei Ge and Kwai Man Luk (2012)

By combining a horizontal planar dipole with a vertically oriented folded shorted patch antenna, a low-profile magneto-electric dipole antenna is obtained. This new antenna is simply excited by a coaxial feed and works as a balun, Lei Ge and Kwai Man Luk (2012)

It is now a common practice to integrate several radios in a single wireless platform that uses one antenna or one single radio device to handle multiple air-interface standards. So the antennas need to cover multiple frequency bands.

Multiband, wideband and reconfigurable antennas are three candidates that can be employed. A microstrip antenna is used due to the advantages like low profile, light weight and easy fabrication, Pei-Yuan Qin *et al*. (2010)

Compared to the planar dipole antenna with a flat reflector, this proposed nonplanar antenna makes a good balance between impedance bandwidth and pattern bandwidth, thus the operating bandwidth is improved significantly , Qi Wu *et al* (2012)

Conclusion:

The presently designed folded dipole antenna on a flexible cellulosic base with nanosilver particles is found to be cost effective and easy to fabricate for low number of antennas with minimum time by using simple techniques.

With this simple technique, a normal angle of 80^o is obtained when compared to other nano particle antennas. The feasibility of the antenna is from 2 MHz to 10 GHz. This work will pave the way for fabrication of next generation low cost, biodegradable, eco-friendly folded dipole antenna receivers for RFID applications.

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