International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com || Volume 02 - Issue 10 || October 2016 || PP. 41-44

Polyaniline Based Monopole Antenna for Broadband Applications

Neeraj K Pushkaran, Libimol V A, Sreekala P S, Sreenath S, C K Aanandan, Tessamma Thomas
Department of Electronics, Cochin University of Science and Technology, India

Abstract: This paper presents the implementationof aPolyaniline (PANI) based pellet monopole antenna for broadband applications. Polyaniline is synthesised by oxidative polymerisation and the conductivity is enhanced by secondary doping. The antenna is designed for an operating frequency of 6.8GHz. and it has a bandwidth of 1.42GHz .The dielectric substrate used is FR4 which has a dielectric constant of 4.4 and a loss tangent of 0.001.The conducting polymer used has a conductivity of 2000 S/m.The proposed antenna shows a gain of -2 dBi for a PANI thickness of 1.2mm.

Keywords*:* Broadband antenna, ConductingPolymer, Conductivity, Monopole antenna, Polyaniline (PANI)

I. Introduction

Metals are commonly used to realise radiating structures, transmission lines and ground planes. However there are a few drawbacks such as high cost, larger weight and inability to withstand extreme weather conditionsand corrosion associated with it. There are some interesting replacements for metals to overcome these disadvantages [1].Conducting polymers can be a promising candidate among them. Conducting polymers or conjugated polymers having spatially extended π -bonding system with delocalized electronic states [2]. They were treated as insulators until the mid of twentieth century [3].Shirakawa and co-workers introduced a new concept of doping that created a boom in the field of conducting polymers. Unlike doping in semiconductors, here we are introducing defects into the structure which will lead to the formation of quasi particles such as polarons, bipolarons or solitons which are the source of conduction in conjugated polymers. Conducting Polymers, by virtue of their light weight and ease of fabrication are replacing metals in several areas of applications.

Polyaniline (PANI) and polypyrrole (PPy) are the most commonly used conducting polymers because of high conductivity and easier manufacturing process [4]. Here Polyaniline is preferred toPolypyrrole because the aniline monomers are cheaper and easily available [5]. PANI is known as a mixed oxidation state polymer composed of reduced benzoid units and oxidized quinoid units [6-7]. Here the conductivity is not only due to the conjugated backbone but also by the Pz overlap of nitrogen orbitals. Among three forms of polyaniline, emeraldinebase (half oxidised form) is the only useful form which is considered here. The low conductivity associated with polyaniline can be overcome by the process of secondary doping. In secondary doping, the polymer chain is transferred from compact coil to expanded coil with the occurrence of free carrier tail. The free carrier tail is due to the delocalization of electrons in the polaron band and will result in increasing the conductivity.

In this paper we present a monopole antenna made of Polyaniline for broadband applications. The antenna is designed for a centre frequency of 6.8GHz. Polyaniline (PANI) nanofibers were chemically synthesized by a rapid mixing polymerization with aniline concentration of 1 M. In rapid mixing method we are introducing excess amount of oxidant at a reduced temperature. The polymerization occur in a faster way and the effect of side reactions are suppressed [8].

II. Synthesis

Oxidativepolymerizationis used to synthesis nanostructures of polyaniline. Aniline monomers are distilledand then dissolved in 1M HClsolution. Excess amount of oxidant ammoniumperoxydisulphate (APS) dissolved in water is added rapidly to the solution under constant stirring and the solution is stirred for 30 minutes [8] Proper ice bath is provided for the reaction to absorb the heat formed in the exothermic reaction. The PANI precipitate was collected on a filter, washed with 0.2 M HCl, and with acetone in order to filter away the unreacted aniline monomers. Then the powder is mixed with 1M ammonium solution for dedoping. Finally the secondary doping is done with1M HCSA for an enhanced conductivity [9]. The PANI precipitated was again filtered and washed and pelletized under a pressure of 2200 Kg/in^2

III. Antenna design

The dielectric substrates used is FR4 which has a dielectric permittivity of 4.4 and a loss tangent of 0.001at 6.8 GHz (operating frequency). The PANI used has a conductivity of 2000 s/m .The thickness of the conductor can have an influence on the conductivity and hence the antenna performances. Athickness of 1.2 mm which is far greater than the skin depth is chosen for the pellet. The RF power is fed to a 50 ohm micro stripfeed on which the pellet is fixed. The length of the micro strip line is optimised to14mm to get good matching. The radius of the monopole is 6.3mm.

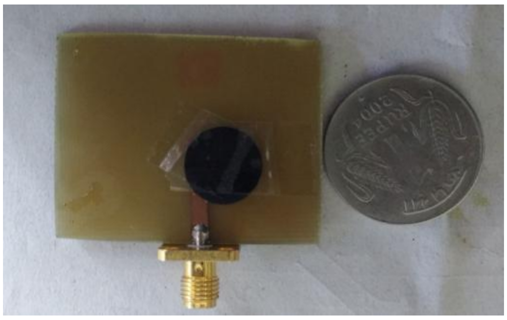

Figure 1: PANI antenna structure

1V. Results and discussions

The conductivity of the polyaniline sample is measured by standard cavity perturbation method [10]. A small cylindrical volume of the sample is inserted into the hollow metallic cavity and the shift in centre frequency is observed. Since the volume is known we can find out the ac conductivity of the sample and for this case it is found to be 2000 S/m.

The antenna radiation measurements are taken using a Rohde & Schwarz ZVB20 Vector Network Analyser in an anechoic chamber. The measured return loss is shown in figure 2.The antenna shows good matching with a bandwidth of 1.42 GHz.

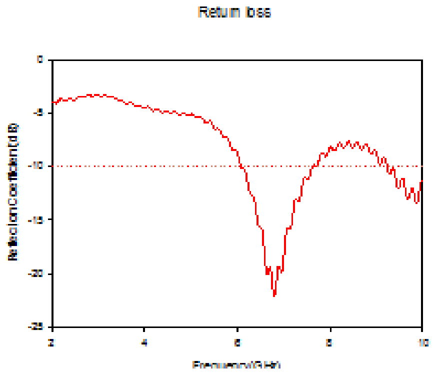

Figure 2: Reflection coefficient measurement

The measured radiation patterns of the antenna in the E-plane and H plane at 6.8 GHz are presented in Fig. 3.

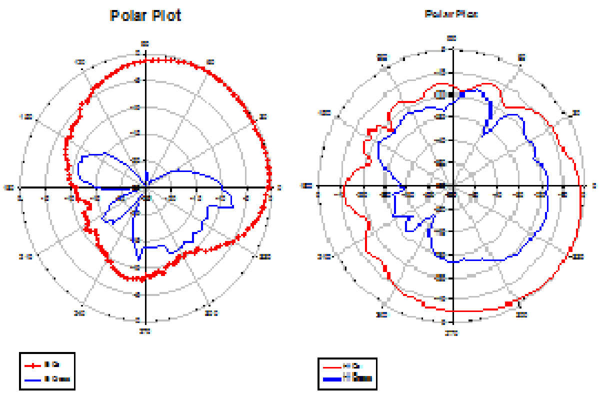

Figure 3: Radiation pattern at 6.8GHz a) E plane b) H plane

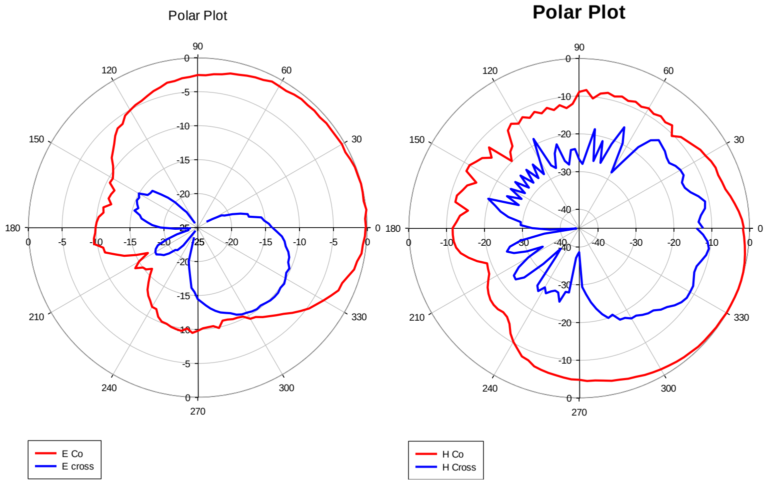

Figure 4: Radiation pattern at 6.5GHz a) E plane b) H plane

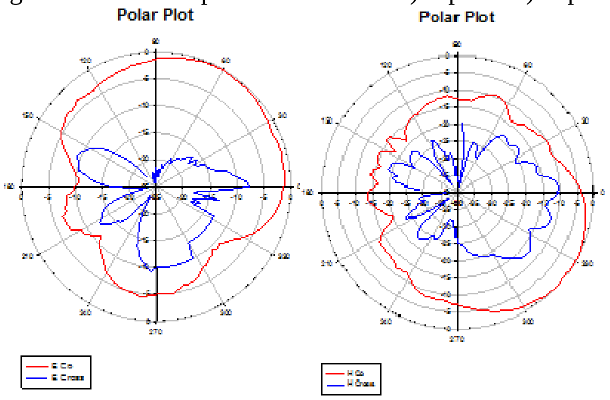

Figure 5: Radiation pattern at 7.2 GHz a) E plane b) H plane

There is a significant isolation of 3 dB between Co and Cross polarisations in each case. The radiation pattern maximum shows a shift from zero degree because the antenna is asymmetrically loaded on the feedline. The gain of the antenna is measured by the help of standard horn antenna and is plotted in figure

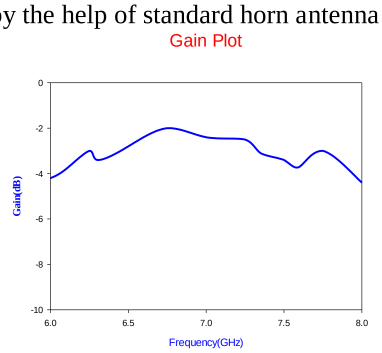

Fig6: Gain plot of the antenna

Comparison between PANI and Cu antenna

Parameter	PANI antenna	Cu patch antenna
Thickness	1.2mm	0.05mm
Radius of the antenna	6.3mm	7mm
Return loss	-23 dB	-13 dB
bandwidth	1.42GHz	350 MHz
Gain	-2dBi	1.8dBi

Table1: comparison between PANI and Cu antenna

V. Conclusion

In this paper it is proposed that conducting polymers can be used to make resonating structures and can be realised into an antenna. Polyaniline nanofibers of conductivity 2000 S/m, is used to fabricate a broadband pellet antenna. The drop in the measured gain for a PANI -antenna is due to the relatively low conductivity. The conductivity of PANI nanofibers can be increased by doping with carbon nanotubes (CNT) or graphene. Conducting polymer resonating structures will be more convenient at higher frequencies (millimetre range) because as the dimensions become smaller the interactions between the material and the microwave field gets reduced and hence the electromagnetic losses gets reduced. The measured results are satisfying with regard to the matching, bandwidth, and gain so conducting polymers are proved to be strong candidate for the development of antenna structuresfor applications where features like low cost and light weight are preferred.

VI. Acknowledgment

Authors would like to acknowledge the financial and infrastructural support from UGC and DST, Government of India.

References

[1]. T. Kellomaki, W. G. Whittow, J. Heikkinen, and L. Kettunen, "2.4 GHz plaster antennas for health monitoring," in Antennas and Propagation.

[2]. A. Heeger,*Synth. Met., 125* (2001) 23-42.

[3]. A.J. Epstein, J.M. Ginder, F. Zuo, R.W. Bigelow, H.Woo, D.B. Tanner, A.F. Richter, W. Huang and G.A. MacDiarmid, *Synth. Met., 18 (*1987) 303-309

[4]. E. Subramanian, R DhanaRamalakshmi," Pristine, purified and polyaniline-coated tamarind seed (Tamarindusindica) biomaterial powders for defluoridation: Synergism and enhancement in fluorideadsorption by polyaniline coating", Journal of Scientific & Industrial Research, Vol. 69, August 2010, pp. 621-628

[5]. M.M. Popovic, et B.N. Grgur, Synth. Met. 143,191, 2004.

[6]. J.Y. Shimano and A.G. MacDiarmid, *Synth. Met., 123* (2001) 251-262.

[7]. A.G. Green and A.E. Woodhead, *J. Chem. Soc., Trans, 101*(1912) 1117-1123.

[8]. JunfengQiang , ZhuhuanYu[b], HongcaiWu[a], Daqin Yun"Polyaniline nanofibers synthesized byrapid mixing polymerization"Synthetic MetalsVolume 158, Issue 13, August 2008, Pages 544–547

[9]. Alan G. MacDiarmid *, Arthur J. Epstein †," Secondary doping in polyaniline", Proceedings of the International Conference on Science and Technology of Synthetic Metals,Volume 69, Issues 1–3, 1 March 1995, Pages 85-92

[10]. D. C. Dube[1], M. T. Lanagan[1], J. H. Kim[1] and S. J. Jang," Dielectric measurements on substrate materials at microwave frequencies using a cavity perturbation technique", Journal of Applied Physics, Volume 63, 2466 (1988)