

Wearable Antenna for Medical Application

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Abstract - The proposed technique for producing substrates for flexible antennas based on the use of an already existing and widely used substrate material. Polydimethylsiloxane (PDMS), where the dielectric properties of the substrate are adjusted by loading the PDMS with low or high permittivity inclusions. Polydimethylsiloxane belongs to group of polymeric organic compound. We incorporated this PDMS material for medical applications and for military purposes because of its non-toxic, non-flammable and for its flexible in nature. Here PDMS + glass are used in the substrate. When Relative permittivity and loss tangent value are reduced to low range, this enhances the antenna's performance. PDMS + glass substrate resonant at the frequency range of 2.8GHz, through this design can obtain better performance of the antenna. In addition stimulated results are also discussed for these antennas, which further underline the importance of material selection.

Key Words- PDMS + glass, flexibility, wearable antenna, patch antenna, non-toxic, medical and military applications.

1. INTRODUCTION

Flexible antennas are light-weight antennas which might stand up to mechanical strain up to an exact extent. Electronic devices usually involve a communications component for transfer of amusement media, data sources and social interaction. Communication may occur between devices through associate on-body channel or to external devices. Flexible, conformal antennas are essential to produce an unassertive answer implantable antenna in operation within the Industrial, Scientific, and Medical (ISM) band (2.4-2.4835 GHz) for medicine applications, to form the designed antenna applicable for implantation, it's embedded in biocompatible Polydimethylsiloxane (PDMS).

Implantable devices are becoming wide researched for numerous fields of applications, wirelessly transferring diagnostic data from a device established within the body for human care and safety, little implantable medicine devices placed within the body could improve the lives of diverse patients. A home care unit is placed inside the patient's

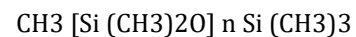
home. The unit will communicate with the medical implant and may be connected to the phone system, or the web, and send knowledge frequently to the person at the hospital [2]. Microstrip patch antennas have found intensive application in wireless communication system because of their blessings like low-profile, conformability, affordable fabrication and simple integration with feed-networks [2]. However, standard microstrip patch antenna suffers from terribly slender information measure, with relevancy the middle frequency.

For the convenience of the user, wearable antennas got to be hidden and of low profile. Today, processors are reaching 3.8 GHz or higher speeds with multiple cores. This work intends to present recent types of antenna and other considerations that have to be investigated, including suitable material selection, fabrication methods and analysis required for a wearable antenna design.

In this paper, circular patch antenna are designed, varies design analysis are carried out, to establishing the importance of material used in the antenna design.

1.1 Material Description

PDMS is that the most generally used silicon-based organic compound, and is especially well-known for its uncommon natural philosophy (or flow) properties.



PDMS is elastic that means that at long flow times (or high temperatures); it acts sort of a viscous liquid, like honey. This surface will appear metallic and shiny, although the substrate is clear, PDMS structures can be used in combination with water and alcohol solvents without material deformation. PDMS is also used as a component in silicone grease and other silicone based lubricants, as well as in defoaming agents, mould, damping fluids, heat transfer fluids, polishes, cosmetics, hair conditioners and other applications [3].

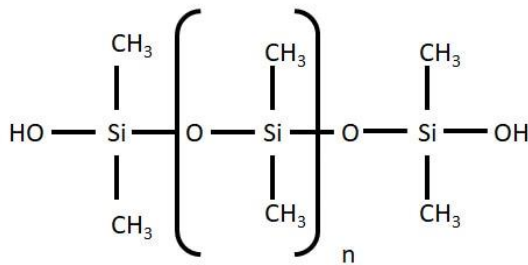


Fig-1 : Chemical formula of PDMS

However, if identical PDMS is rolled into a sphere and thrown onto identical surface (short flow time), it'll bounce sort of a rubber ball. Although the elastic properties of PDMS are often intuitively ascertained exploitation the straightforward experiment delineated higher than, they'll be a lot of exactly measured exploitation dynamic mechanical analysis.

Solid PDMS samples (whether surface alter or not) won't permit liquid solvents to infiltrate and swell the fabric. Thus PDMS structures are often employed in combination with water and alcohol solvents while not material deformation. However most organic solvents can diffuse into the fabric and cause it to swell, creating them incompatible with PDMS devices. Despite this, some organic solvents lead to sufficiently small swelling that they can be used with PDMS, for instance within the channels of PDMS micro fluidic devices. The swelling magnitude relation is roughly reciprocally associated with the solubility parameter of the solvent.



Fig-2: PDMS cylinder on the glass of a stereomicroscope light

In this paper PDMS + glass mixture are used as the substrate material, in order to control flowing nature of PDMS material [4]. Because PDMS has stable characteristics of flowing nature. It can easily dissolve from its structure,

and so maintain its stability glass substance is getting mixed with the PDMS material.

Since glass and PDMS are the silicone polymers, there is no variations chemical in their characteristics. Substrates flexibility is maintained.

1.2 Theoretical Background

To develop a flexible antenna, there are several crucial factors that must be taken into considerations. The substrate or the material to build the antenna should have insulation characteristic and flexible enough to accommodate changes due to movements, stress or strains and non-conformal shapes of any devices. The conductive material on the other hand, must be properly chosen to get good impedance matching. Furthermore, the geometry of the antenna must suits to the requirements of the devices or applications. The fabrication process also needs to be cheap and easily reproducible. Ideally, we want an antenna that is highly flexible, supports bending and twisting at certain strain levels but still functions efficiently without compromising its RF characteristics [5]. The common requirements of a flexible antenna for wearable and implantable medical devices are low-maintenance, light, small, no setup requirements, and high durability.

1.3. Simulation using HFSS

Stimulation is done by using HFSS software, the acronym stands for high-frequency structure simulator. HFSS is one of several commercial tools used for antenna design, and the design of complex RF electronic circuit elements including filters, transmission lines. In medical field, flexible antennas can be used in implantable devices and wearable applications. It is crucial to use suitable biocompatible material for these applications. While the most commonly used material is pure PDMS.

1.4. Conductive materials

There are many conductive materials such as Cu sheet, silver, electro textile and conductive sewing thread that can be used in designing flexible antenna. Despite its inherently unstretchable properties, Cu for instance, is a low-cost metal and has excellent conductivity for microwave frequency application.

1.5. Design Analysis

Various design analysis carried using different types of material. To justify that, our designed antenna is resonating at desirable range. Designing where done by using several materials and with several designs, each design possessed with their unique features. But desired range of output is obtained with PDMS+GLASS. Materials involved in the analysing of results are polyamide, graphite, glass, mica. And where designing are done by using rectangular patch, double slotted circular patch, single slotted circular patch, and circular patch with strips[6].

Table -1: Analization result

DESIGN	MATERIAL	FRQ (GHZ)	RETURN LOSS	VSWR
Rectangular patch	polyamide	2.4	-0.18	4
Double slot circular patch	graphite	2.5	-0.013	10
Single slot circular patch	Glass	2.7	-0.23	79
Circular slot with strips	Mica	2.87	-0.29	58

There are several differentiation process where carried out to finalize the efficiency of material and antenna design.

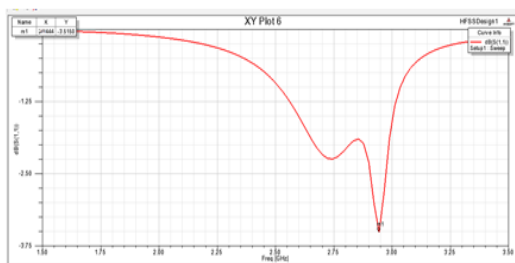


Fig-4 :Return loss of using polyamide

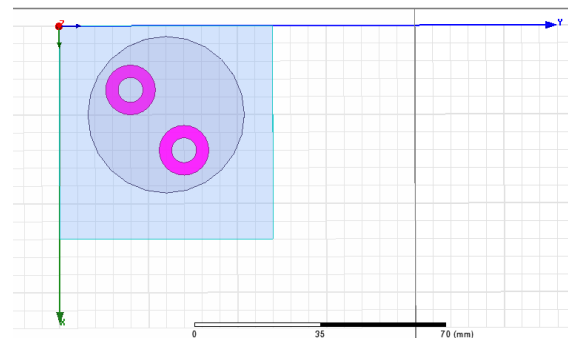


Fig- 5 :Circular patch with doubled slotted

Circular patch antenna with double slotted is designed by graphite, here two circular slots are designed. Which are get resonated at frequency 2.5GHZ, but their return loss and VSWR are not at desired range.

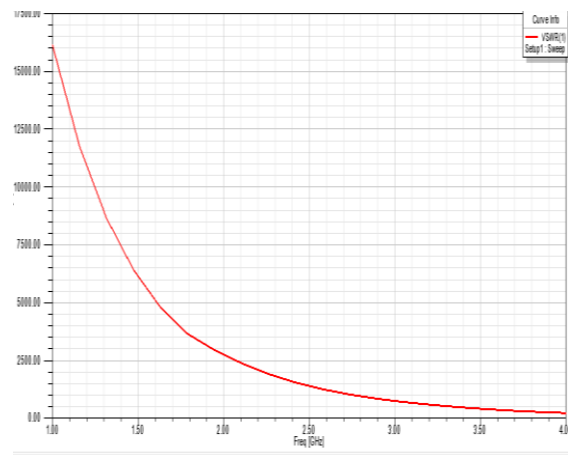


Fig-6 :VSWR of double slotted antenna

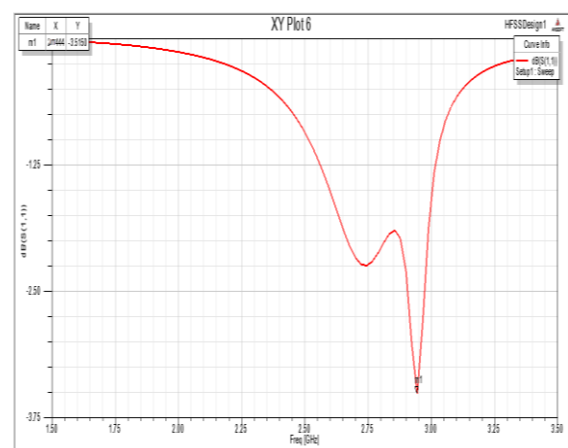


Fig-7 :Return loss of doubled slotted antenna

The above results are the some of the examples from analyzed results. Through these results the desired output are categorized.

2. RESULT AND DISCUSSION

The antenna with better performance is designed as circular patch with slots on strips.

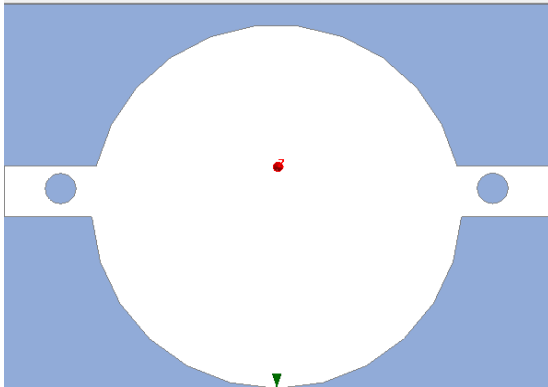


Fig-8: Circular patch antenna with slots on strips

The response for this design is achieved to maximum range of output. And this is considered as the main design.

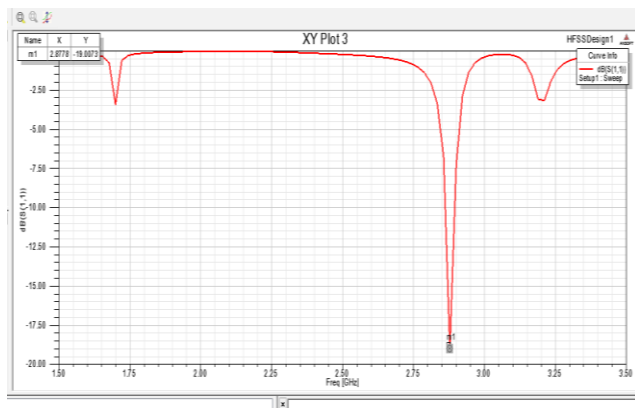


Fig. 9 Return loss using PDMS+GLASS material

This antenna is get resonant at the frequency range of, 2.8GHZ and return loss value is -19.0073.

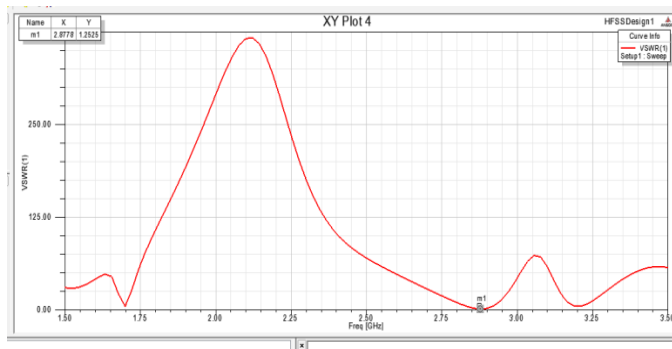


Fig- 10: VSWR of antenna with PDMS+GLASS substrate

For efficient transmission the VSWR range must be between, 1 to 2. Here in our design the VSWR range is 1.2525 which get resonates at 2.8GHZ. To prove our material stability various materials are used and verified their stimulated results. For our main design several materials are used to analyse the stimulated results, such materials are ferrite, PDMS, polyamide, Fr4 epoxy. Using these materials various process were carried out. From the analysed data PDMS+GLASS material are provide the better performance in the efficient data transmission.

Table-2: Analyses using various materials

MATERIAL	FREQUENCY	RETURNLOSS	VSWR
Polyamide	2.2	-2.944	8.8
PDMS	2.9	-3.515	5
Fr4	3.3	-2.94	5
Ferrite	2.5	-1.46	11.8

The above results illustrate the main purpose of this project.

3. CONCLUSIONS

A reliable technique for preparing soft and flexible substrates for antennas has been presented. The method was significant in improving the low adhesion characteristic of PDMS. It is shown that the PDMS+glass antenna with layer performed well with 2.8 GHz resonating frequency and a low return loss of -19.0073dB, and VSWR of 1.2525.

A flexible material substrate for flexible antenna has been prepared. The simulated results exhibits that the realized antenna could achieve the appreciable level of performance

And they are designed to operate between 2.8 GHZ of frequency. It is easy to fabricate and compact with the results and this shows patch antenna with PDMS+glass substrate provides enhanced results.

Relative permittivity and loss tangent value are reduced to low range; this improves the antenna's performance. In future, a new technique of fabrication process can be implemented for further improvements.

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