Effect of Different Semi Conductive Substrate Materials on a P shaped Wearable Antenna

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Abstract- This paper presents the effect using different semiconductive substrate materials on a P shaped wearable antenna. This P shaped wearable antenna is designed for Body Centric Wireless Communication (BCWC) application at 2.45 GHz. Three types of semiconductive materials were selected : diamond, gallium arsenide, silicon. These three types of semiconductive materials are compared with duroid(tm) substrate. The results demonstrated a good agreement between simulated return loss, radiation pattern of all three substrates used for this wearable antenna. The simulated return loss and radiation pattern characteristics for all three types of substrates agreed reasonably well with this P shaped wearable antenna. Numerical study has been carried out, by using Ansoft HFSS V13 simulating software.

Keywords- Wearable antenna, body centric wireless communication, substrate materials, return loss, radiation pattern.

1 INTRODUCTION

Recent years the demand for reconfigurable antennas have observed; these are used in a variety of applications, including sensors, filters, frequency meters and tuned amplifier etc [1]. These are generally used in many commercial applications in the industry, such as mobile satellite communications direct broadcast satellite services etc. Many researchers use the wearable antennas to demonstrate the BCWC applications as well as to investigate the performance of various types of wearable antennas in BCWC. In [2] design the first wearable active receiving antenna operating at 2.45 GHz is addressed for use in personal area networks. Slotted antennas for the application of WLAN become an important research point in the past decades and many different technologies for miniaturized antenna have been proposed [3]-[6], slotted antennas for ISM band become a hot research point in the past decades and many technologies for miniaturized antenna have been proposed [7]. Dimensions of the microstrip patch has been calculated, based on transmission line model [8]. The width and length of the microstrip patch has been estimated by [9], the substrate based on duroid(tm) of dielectric constant 2.2 has been taken in this design. It is very helpful to understand the interaction and performance of the antenna and the communication system for BCWC. In this paper a new wearable antenna is used for BCWC operating at the frequency 2.45 GHz as a P shape wearable antenna with micro strip line feed. A numerical study has been done, to find out the exact feed location, this feed location is found at (-44.59,1.85,0).

Figure 1: Geometry of the P-shaped wearable antenna.

BCWC has been given a great attention in recent years, due to the advances of wireless technology. The advent of textile antennas has open doors for the emergence of body-worn antenna systems embedded in known as “smart clothes”[10]. Textile antenna is very suitable for on body radio communication as it is very flexible, comfortable to be integrated into clothing[11] and also offers a low cost and easy to manufacture. This research focuses on the investigation of the effect of different semiconductive material based substrates on the performance of a wearable antenna in terms of return loss and radiation pattern characteristics. The performance of the wearable antenna is compared to a conventional duroid(tm) based substrate antenna at 2.45 GHz. Three types of semiconductive materials were selected : diamond, gallium arsenide, silicon. This results may be happened due to the relative permittivity characteristics of these materials. The relative permittivity of
duroid (tm), diamond, gallium arsenide, silicon are described below in TABLE 1.

<table>
<thead>
<tr>
<th>Substrate Material</th>
<th>Relative Permittivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroid (tm)</td>
<td>2.2</td>
</tr>
<tr>
<td>Diamond</td>
<td>16.5</td>
</tr>
<tr>
<td>Gallium arsenide</td>
<td>12.9</td>
</tr>
<tr>
<td>Silicon</td>
<td>11.9</td>
</tr>
</tbody>
</table>

II RESULTS AND ANALYSIS

TABLE 2 summarizes the comparison of centre frequency between simulated wearable antenna using different types of substrates. From TABLE 3 and Figure 2, it can be observed that some amount of upward frequency shift occurred with the utilization of different types of substrates. Gallium arsenide based antenna showed the worst upward frequency shifting than conventional antenna.

<table>
<thead>
<tr>
<th>Substrate Material</th>
<th>Centre Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroid (tm)</td>
<td>2.325</td>
</tr>
<tr>
<td>Diamond</td>
<td>2.24</td>
</tr>
<tr>
<td>Gallium arsenide</td>
<td>2.525</td>
</tr>
<tr>
<td>Silicon</td>
<td>2.61</td>
</tr>
</tbody>
</table>

From Figure 2, it can be seen that there is a good agreement between diamond, gallium arsenide, silicon substrate based antennas and conventional antenna. However, diamond, gallium arsenide, silicon substrate based antenna produced 11.75 dB, 13.5 dB and 13.25 dB lower than conventional antenna respectively. From TABLE 3, the result exhibited that three substrates based antennas (diamond, gallium arsenide, silicon) produced -5.75 dB, -4 dB, -4.25 dB return loss respectively. This results may be happened due to these substrate materials relative permittivity characteristics. Figure 3, Figure 4, Figure 5 and Figure 6 show the simulated radiation patterns for diamond, gallium arsenide, silicon substrate material based antenna respectively.
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REFERENCES


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