RESEARCH ARTICLE

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Performance Analysis of Carbon Nanotubes as Monopole Antenna

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Abstract

In this paper, I explore carbon nanotube (CNT) composites' use in the monopole antenna structures as an efficient alternative for copper. I explore the use of CNT material for GSM applications. An attempt has been made to investigate monopole antenna for GSM Applications. Monopole antennas are designed for 900 MHz. Designed CNTs antenna Compared to that of the copper antenna. Different parameters, like return loss, gain, and radiation pattern, are evaluated for a designed antenna. The antennas are modeled with HFSS™ v13, and the simulation results are presented.

Keywords: Antenna, Carbon nanotube (CNT) composites, Monopole antennas, HFSS.

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Introduction

Copper are commonly used in antenna structures for the radiating elements, feed lines, and ground plane. Looking at outdoor antennas, it's easy to see why the combination of lightweight, strength, conductivity, cost, and the way copper oxidizes make it perfect. It is an excellent conductor of electricity and heat;[1] you can find copper all over the place. In your home, it is hidden away in everyday objects, including phones, water pipes, locks, electrical wiring, and antenna.

However, for some applications fabrication procedures, weight or corrosion resistance can limit the usefulness of copper antennas. Some recent studies have used various composite materials as replacements for copper. One of them is CNT material.[2,3]

Since this date, CNT have been fertilized fields of research. CNTs were discovered experimentally in the early 1990s by lijima of NEC. Carbon nanotubes are generally classified under two distinct categories: Single-Walled Carbon Nanotubes (SWNT), and Multi-Walled Carbon Nanotubes (MWNT)[4]. The sphere of potential applications is broad due to their superior mechanical, thermal, and electrical properties. The potential applications of single-walled carbon nanotubes in three areas: passives (interconnects), actives (transistors), and antennas. In the area of actives, potential applications include transistors for RF and microwave amplifiers, mixers, detectors, and filters. However, an application that has until received relatively minor attention is in the area of high speed (RF, microwave, mm-wave, and THz) electronics.[5,6]

In this paper, I explore CNT composites' use in the monopole antenna structures as an efficient alternative for copper.

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One of the oldest and simplest types of antennas is wire antennas. In many applications, which are the most versatile, monopoles and dipoles are two of the most widely used in wireless mobile systems. Monopoles are usually used in handheld and mobile devices. The radiation efficiency and gain characteristics of monopole antennas are strongly influenced by their electrical length.[7] A monopole antenna is one half of a dipole antenna, almost always mounted above some sort of ground plane. The case of a monopole antenna of length *L* mounted above an infinite ground plane is shown in Figure 1.

Design Parameter

Figure 2 shows the front view geometry and the structure designed on HFSS™ v13 software of the half-wave Monopole antenna for GSM application. The dimensions and parameters for the proposed antenna have been optimized to get the best possible impedance match to the antenna. The following parameters are used for design of proposed antenna.

A prototype of the proposed half-wave monopole antenna of length 72.42 mm, radius 2.232 mm and feed gap 2.232 mm, ground plane width is 223.23 mm was designed and constructed to resonate at 900MHz frequency.(Figure 3–8)

Simulation Result

A. 3D Gain

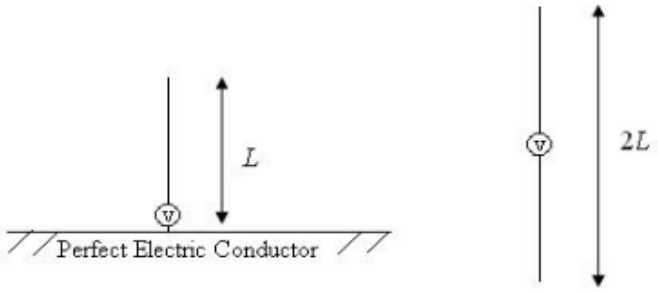


Figure 1: Monopole antenna [7].

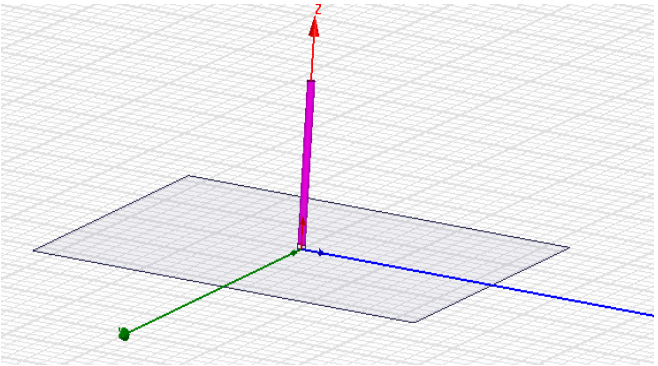


Figure 2: Ansoft-HFSS Generated Monopole Antenna

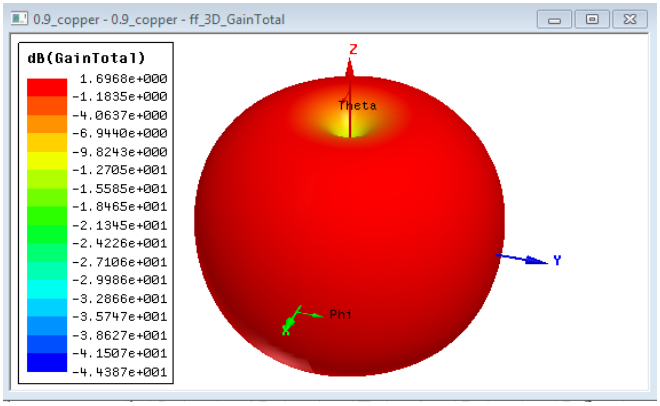


Figure 3: 3D Gain of Monopole antenna using copper.

Table 1. Design Parameter for Monopole Antenna

Resonant frequency	*900 Mhz*
Monopole length	72.42 mm
Monopole radious	2.232 mm
Feed gap	2.232 mm
Ground plane width	223.23 mm

B. Radiation Pattern

C. Return Loss

Discussion on Result

There is good agreement is found between the CNT antenna and copper antenna for monopole antenna. Simulated results

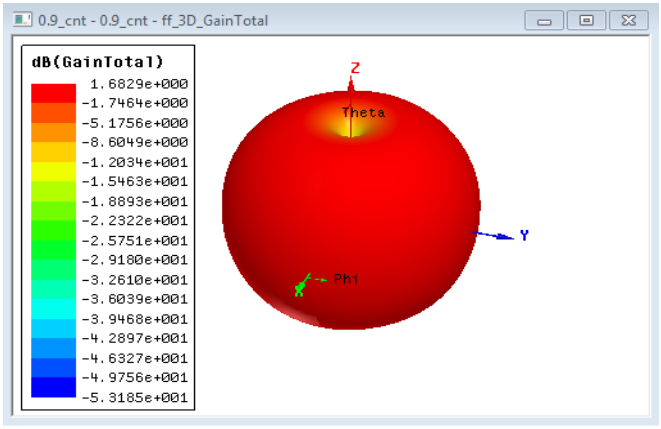


Figure 4: 3D Gain of monopole antenna using CNT.

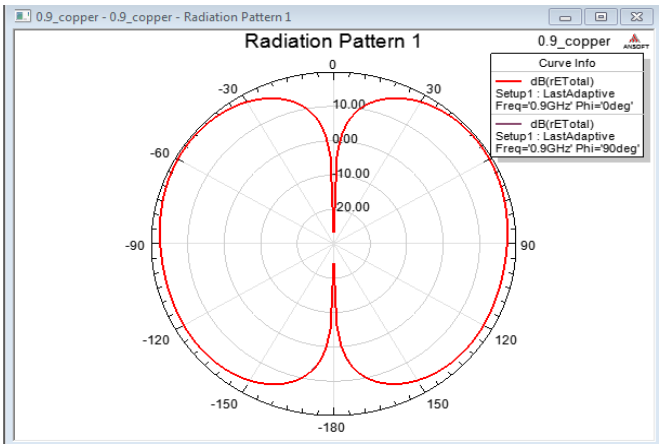
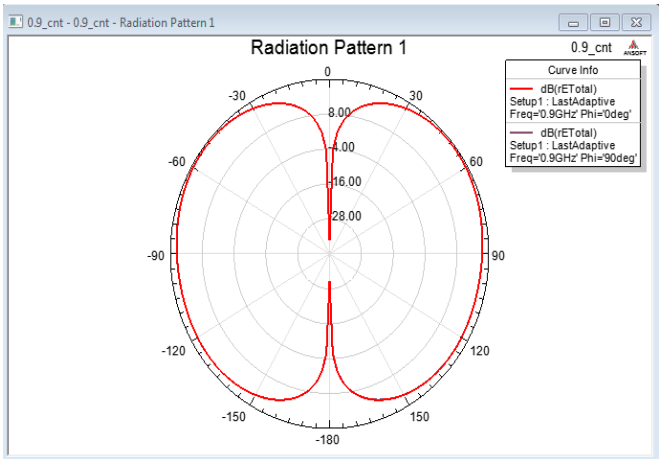


Figure 5: Radiation pattern of monopole antenna using copper



Figurfe 6: Radiation pattern of monopole antenna using CNT

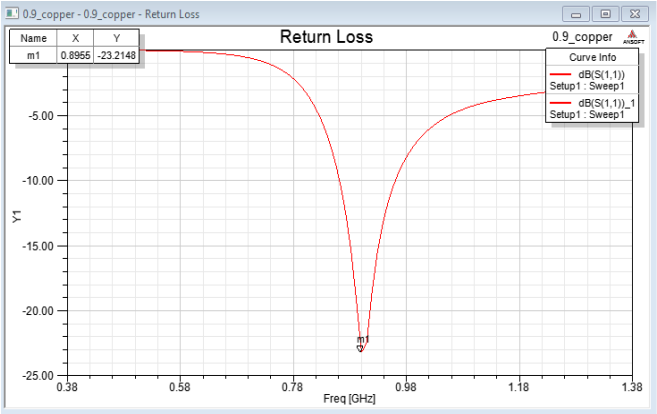


Figure 7: Return loss of monopole antenna using copper

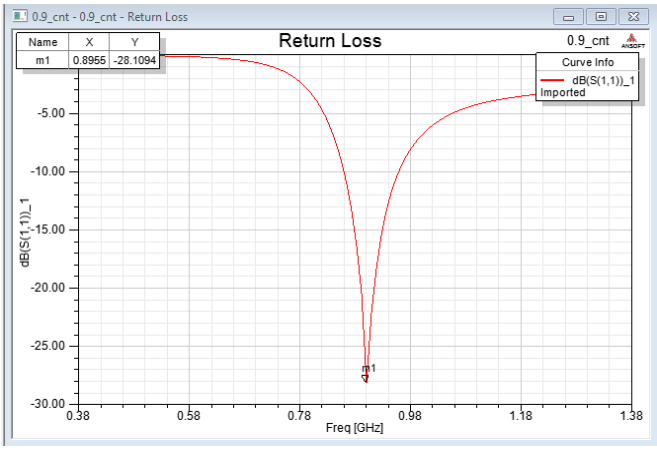


Figure 8: Return loss of monopole antenna using CNT

show that the CNT antenna has good performance over a copper antenna. The antenna performance, such as gain can be adjusted by changing the conductivity of composite, while it is not possible for materials with fixed conductivity such as copper.

Conclusion

Monopole antenna has been designed and simulated using HFSS^{TM} v13 software. Copper materials are replaced by that of the CNT material and results are compared. Designed antenna is operating in GSM frequency range which is suitable for GSM applications. It's easily shown that CNT are good alternative of copper for designing an antenna.

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