Dual Band Textile Antenna on EBG for WiFi Applications

M. Mantash, A-C. Tarot, S. Collardey and K. Mahdjoubi

IETR (Institute of Electronics and Telecommunications of Rennes),
University of Rennes 1, Campus de Beaulieu, bat.11D, 35042 Rennes Cedex, France
Fax: + 33–223236963; email: mohamad.mantash@univ-rennes1.fr, tarot@univ-rennes1.fr

Abstract

A complete study of a dual band textile antenna on Electromagnetic Band Gap (EBG) for WiFi applications is presented. A CPW G-shaped monopole antenna on EBG for dual band operation on textile (denim) is designed and characterized. Finally, experimental results for the antenna on EBG prototype using Shieldit Super electro-textile are presented and show that both the lower and the upper WiFi frequency bands are covered.

1. Introduction

Wearable and flexible antennas [1,2] are becoming more and more attractive since the recent developments in wearable computing which have opened several possibilities to integrate wireless functions to clothing. Wearable antennas need to be low profile and be hidden as much as possible. This requires the integration of these antenna elements within the everyday clothing. In addition, these antennas are to be placed against the body and hence it is important to reduce the backward scattered radiation as much as possible. This can be accomplished by placing the antenna over an Electromagnetic Band Gap surface (EBG).

The authors have previously studied a dual-band antenna on EBG [3] in the WLAN band using a rigid substrate, NELTEC (NY9220) having a permittivity of 2.2 (εr). Simulation and measurement results for the antenna on EBG exhibit a gain enhancement by almost 4dB over the WiFi frequency bands (the lower: from 1.97 to 2.378 GHz and the upper: from 5.24 to 7 GHz).

2. Choice of Textile and electro-textile

Electro-textile, which are conductive fabrics obtained by interleaving normal fabrics with conductive metal/polymer threads, make possible manufacturing antennas which can be integrated into clothing. According to this, the selection of an appropriate electro-textile is an important step in the design of a textile antenna: Shieldit Super and Pure Copper Taffeta Fabric were chosen for the application.

Denim fabric ($\varepsilon r = 1.7$) has been preferred to other fabrics like felt or foam because the latter have a very low dielectric constant ($\varepsilon r \cong 1.0$) and lead to unpractical narrow slots for the 50 Ω CPW feeding line.

3. Textile EBG

A dual High Impedance Surface (HIS) or EBG consisting of a concentric squares array [4] is used as an artificial Magnetic Conductor (AMC) for the antenna (Fig.1). The inner square patch is responsible for the upper resonance frequency whereas the outer one is responsible for the lower resonance frequency. The EBG unit cell dimensions are optimized to be manufactured with denim fabric. The HIS used for this application is shown in Fig.1a.

To obtain the dual band characteristics around the required frequency bands, the unit cell for this HIS is simulated and optimised using periodic boundary conditions in HFSS (Fig.1b). This allows to obtain the reflection coefficient of an infinite HIS. The dimensions of the HIS were optimised to achieve the 0° phase around 2.48 GHz and 5.6 GHz. (Fig.1c).

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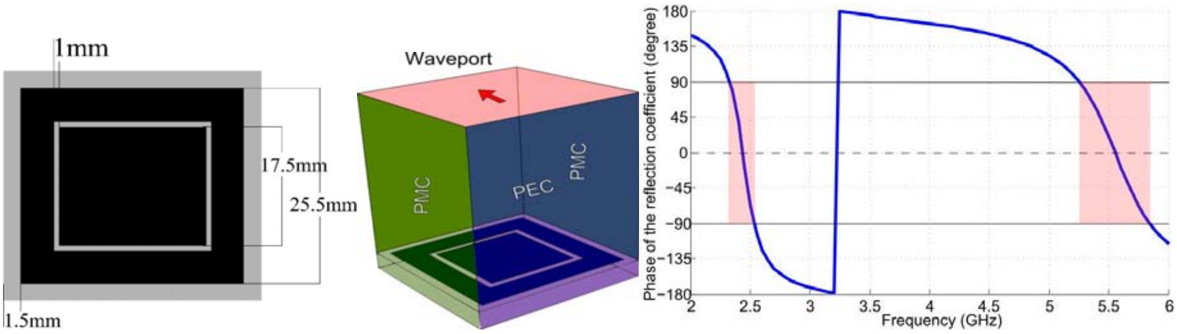


(a) (b) (c)

Fig. 1 The unit cell of EBG structure - simulation with boundary conditions - Simulated band gap response of double square HIS

4. Textile antenna

A G-shaped monopole antenna [5] for dual band operation is used to be proper for being manufactured on denim fabric using the two different electro-textiles described in section 2. The dual band CPW G-antenna dimensions are respectively L1 = 17.15 mm and L2 = 28.85 mm (Fig.2a).

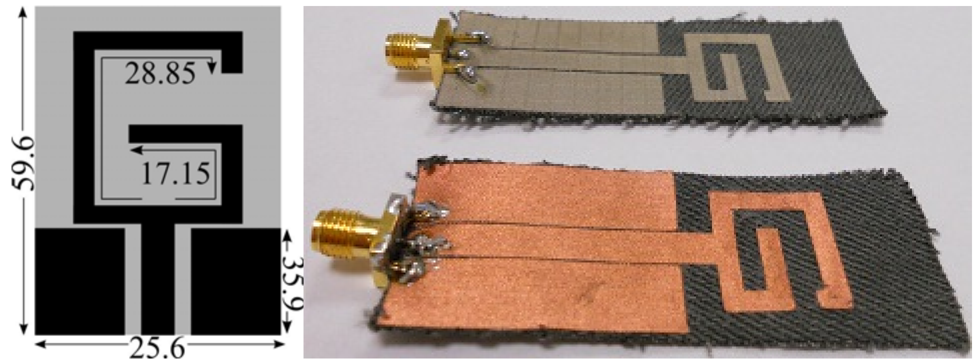


Fig. 2 CPW G-shaped dual band antenna prototypes on denim using electro-textiles: Shieldit Super (up) and Pure Copper Taffeta Fabric (down).

These dual band antennas were measured in return loss: they are matched over the Wifi frequency bands (from 1.77 to 1.96 GHz and from 5 to 6 GHz). Besides, measurement of both prototypes exhibits a better return loss for the antenna prototype using Shieldit Super electro-textile.

5. Antenna on EBG

The aim is to obtain an antenna on EBG covering the WiFi bands: the lower band from 2.3 to 2.7 GHz and the upper band from 5.15 to 5.875 GHz. The G-antenna is placed at 2 mm from an HIS of 3x3 unit cells with a size of 85.5×85.5 mm2 (Fig. 3). Regarding the manufacturing process of the textile antenna on EBG prototype, the key fact is how the antenna is cut and placed on the EBG.

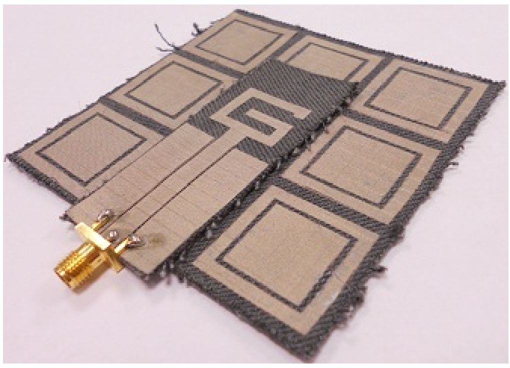
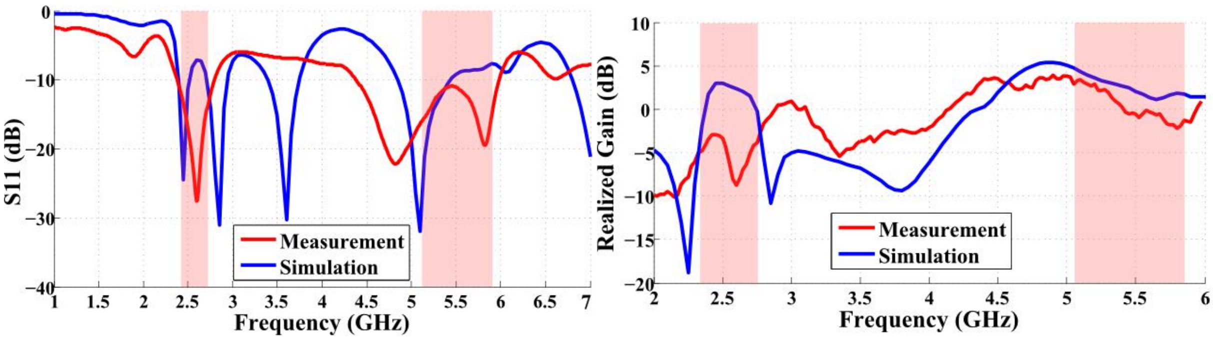


Fig. 3 Electro-textile dual band antenna on EBG using Shieldit Super on denim fabric.

Fig 4a shows the measured return loss for the G-antenna on EBG using denim fabric: all the WiFi frequency range is covered. Simulation and measurement are in acceptable agreement considering that the differences are explained by manufacturing errors. Gain measurements have been performed using Satimo SG32 antenna measurement system. Both simulations and measurements of the gain are shown in Fig. 4b being more similar for the upper WiFi band.



(a) (b)

Fig. 4 reflexion coefficient and realized Gain of the textile antenna on EBG.

6. Conclusion

A dual band textile antenna on EBG for WiFi applications has been presented in this contribution. Prototypes of CPW G-shaped monopole antenna have been manufactured using denim textile substrates. In addition two different electro-textiles, Pure Copper Taffeta Fabric and Shieldit Super, have been tested to be used as conductive parts for the antenna and the EBG. From the measurements, the antenna on EBG prototype using Shieldit Super electro-textile on denim fabric, which covers the WiFi band, exhibits better performance regarding return loss than the one using Pure Copper Taffeta Fabric on denim.

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