NATO ASI "Defense Related Intelligent Textiles and Clothing
for Ballistic and NBC (Nuclear, Biological, Chemical) Protection

COMMUNICATION THROUGH TEXTILES FOR INTELLIGENT PROTECTIVE CLOTHING

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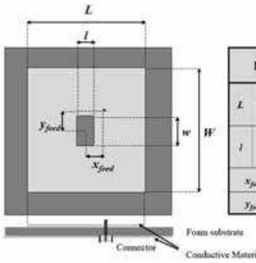
1. INTRODUCTION

With the introduction of intelligent textile systems, the functionality of personal protective clothing is further enhanced. High tech fabrics protect the wearer from harsh environmental conditions, while monitoring systems provide information about his physical state during operation. A wireless communication device between the wearable system and an external base station is required. In this work, a protective foam-based antenna for integration into intelligent protective clothing is developed.

2. ANTENNA SPECIFICATIONS AND DESIGN

The antenna is designed to operate in the 2.45 GHz ISM (Industrial, Scientific, Medical) band where a bandwidth of at least 83.5 MHz is to be obtained. Furthermore, the antenna has to radiate 90% of the incoming power in this frequency range. The rectangular ring topology has proven to be suitable [1]. As antenna substrate material, flexible pad foam was selected because it is commonly available in protective clothing and it does not hinder the wearer in his movements. This foam is 5.5 mm thick. All details of the antenna dimensions and characteristics are given in Figure 3.



Patch (mm)				Substrate	
L	52	W	48	h (mm)	5.55
l	9	w	15	ε_r	1.12
x_{feed}	12			tan δ	0.003
y_{feed}	8				

Figure 3. Topology and characteristics of the antenna

On the backside of the antenna, a ground plane is placed in order to prevent radiation towards the body. Antenna patch and ground plane our manufactured out of e-textiles, which are electrically conductive fabrics.

To improve overall flexibility, the antenna is fed with a coax cable that is attached with conductive glue to the antenna patch and to the ground plane.

3. ANTENNA PERFORMANCE

Figure 4 shows that the design criterion of reaching a return loss of less than -10 dB (90% radiation) in the entire ISM band is largely fulfilled. Moreover, a bandwidth of over 280 MHz is achieved. This contributes to the robustness of the antenna since it becomes less vulnerable to frequency shifts due to e.g. manufacturing inaccuracies or bending.
In a transmission measurement set-up, the textile antenna is applied as receiving antenna with a standard gain horn as transmitting antenna. An antenna gain of 6.7 dBi was found, which guarantees a good communication link during real-life operation.

When designing an antenna to be applied in a protective garment, sensitivity to humidity has to be taken into account. To do so, a foam material with a very low moisture regain of 0.84% was chosen. To examine the influence of humidity changes, the antenna was conditioned in a climatic test cabinet for 24 hours in a temperature of 23°C and a relative humidity of 30, 50, 70 and 90% respectively. Fig. 3 shows that for this kind of material the frequency shift is only limited, especially when compared to natural fibre based materials that have a much higher moisture regain (up to 8%) as analysed in [2].

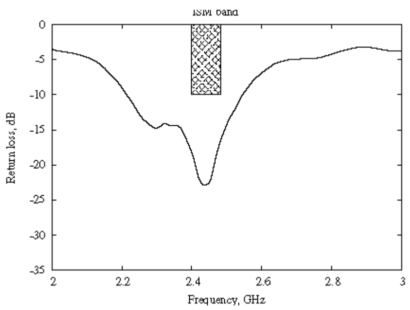


Figure 4. The entire 2.45 GHz ISM band is covered

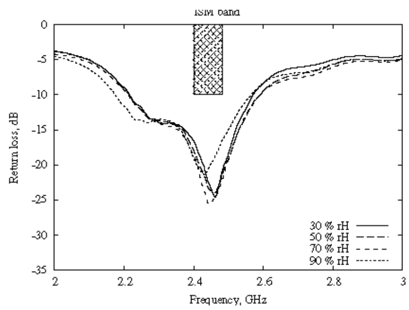


Figure 5. Changing environmental humidity only slightly influences the return loss

4. CONCLUSIONS

A flexible pad foam material is applied to design and manufacture a robust antenna for integration into intelligent protective clothing. The proposed antenna has a sufficiently large bandwidth of 280 MHz and a high gain of 6.7 dBi to establish a good off-body communication link. Given the small moisture regain of the foam material (0.84%), the antenna provides a stable return loss characteristic in changing environmental conditions.

5. REFERENCES

1. A. Tronquo, H. Rogier, C. Hertleer, L. Van Langenhove, A Robust Planar Textile Antenna for Wireless Body LANs Operating in the 2.45 GHz ISM band, *IEE Electronics Letters,* 2006, 42(3), 142-143.
2. C. Hertleer, A. Van Laere, H. Rogier, L. Van Langenhove, Influence of Relative Humidity in Textile Antenna Performance, *Textile Research Journal,* Vol.80 (2), 177-183.