# Basic Study of Optically Transparent Functional Wall Having Absorption and Permeation Effect

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*Abstract* – **Indoor use wireless telecommunication systems such as WLANs (Wireless Local Area Networks) or UHF-RFID (Radio Frequency Identification) are becoming increasingly popular. The indoor telecommunication environment is deteriorated by multiple reflection interference. The ultrathin microwave absorber in consideration of indoor use is developed for reduction of the multiple reflection. Unfortunately, this absorber causes shielding fault for other UHF band, it is pointed out that deteriorate wireless communication environment.**

*Index Terms* — **Tag identification probability, Transparent, UHF-RFID system, Ultrathin microwave absorber.**

## 1. Introduction

The wireless telecommunication environment in indoor locations is adversely affected by multiplex reflection interference. Especially, because the propagation distance of UHF-band microwave is long, this influence is serious. In particular, it is essential to improve the multipath environment to realize reliable UHF-RFID systems. To reduce precision deterioration, ultrathin microwave absorber that considered in distribution and production places is developed [1]. However, it is thought that the existence of this absorber causes shielding obstruction for microwaves other than the frequency of the target. This is a problem that cannot be disregarded in diversifications for communication systems. Therefore, the bandpass characteristic addition to the ultrathin microwave absorber for UHF-RFID is attempted in this report. Concretely, the FSS (Frequency Selective Surface) technology is applied to the component of ultrathin microwave absorber. As a result, the achievement of a functional wall with the bandpass and the microwave absorption is expected.

## 2. Shielding Disorder Due to The Structure of Absorber

Figure 1 shows the configuration of ultrathin microwave absorber as the developing base. The microwave absorber shows different properties depending on the incident direction of wave. If microwave resonates to the patch array, that wall will bring out the absorption property for microwave incidence to the patch side. Though the absorption property strongly depends on the incidence microwave frequency. In contrast, all the microwave incidences from the back of absorber wall will be reflected. Unfortunately, it does not show the transmission properties regardless of the incidences direction. Consequently, it is likely to become a barrier for a lot of RF communications gears. Therefore, it is necessary to set up loopholes for microwave of the frequency other than being used with UHF-RFID systems on the reflector and patch elements.

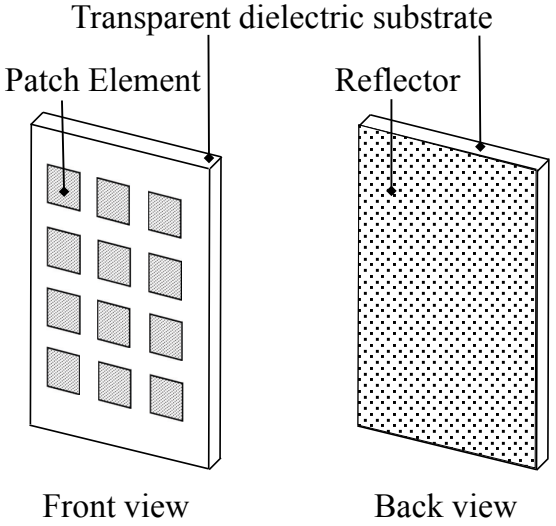


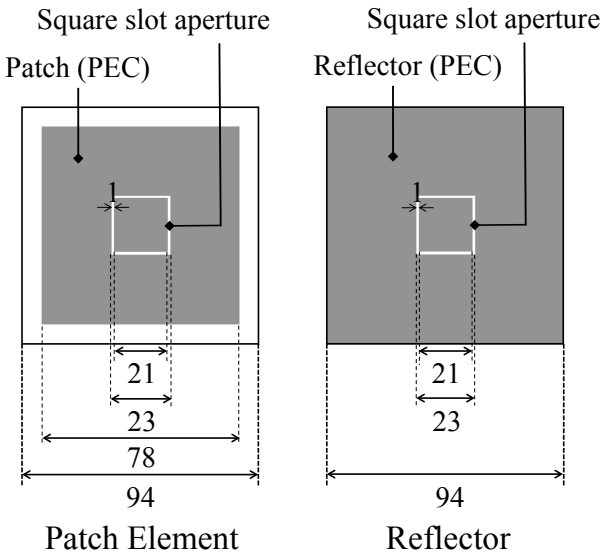

Fig. 1. Structure of ultrathin microwave absorber as developing base

## 3. Design of Functional Wall Having Absorption and Permeation Effect.

The functional wall proposed in this report is incorporate a structure of the FSS to microwave absorber. The shape parameter of the absorber wall optimized for UHF-RFID systems is adopted as initial data for loopholes establishment with the FSS technology [1].

The structure for one cycle in the repetition structure of the absorber wall is shown in Figure 2. The sizes of the patch element and the interval have been optimized to 920 MHz. FSS incorporates a structure of the hole type FSS to operate for a permeation filter for the resonant frequency. FSS shown in Figure 2 is a structure that square slot aperture is established on metal plate [2]. This square slot aperture operates as the loophole for microwave when the center perimeter of slot and design example at Fig. 2, the square slot aperture operates as the loophole for the incidence wave of 2.45 GHz. Therefore, it is expected that this functional wall not only operates for UHF-RFID system as the absorber but also operates for wireless LAN as the loophole for microwave.

Fig. 3(a) shows the absorption of frequencies in the 915-928 MHz was -20 dB or less. In general, -10 dB or less microwave attenuation is required to the absorber for the indoor multiplex reflection interference suppression [3]. Therefore, the absorption characteristics of the proposed functional wall is sufficient.




Unit : mm

Fig. 2. Structure of functional wall

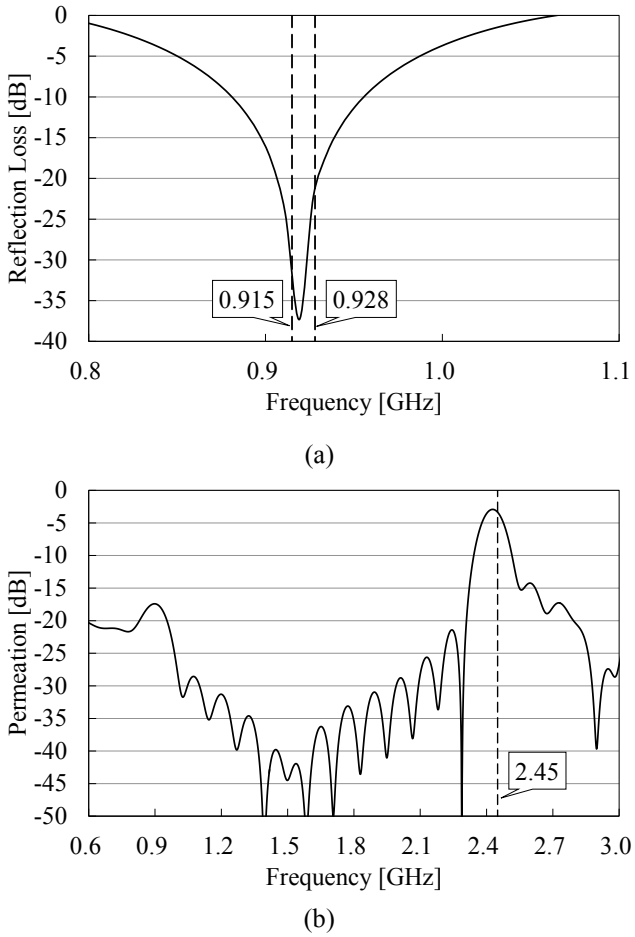



Fig. 3. Calculated characteristics of functional wall. (a) reflection and (b) permeation.

Fig. 3(b) shows the permeation of frequency in the 2.45 GHz was -5 dB or more. Permeation is improved drastically around 2.45 GHz with the establishment of square slot aperture shown in Fig. 2.

The permeation as the function of frequency for an incidence wave from the reflector side is also shown in Figure 4 because of attention though the permeation with an incidence wave from the patch side is shown as for Fig. 3(b). Since wireless LAN is the interactive communication, it is necessary to exhibit similar permeation characteristics regardless of the direction of incidence with functional wall.

Fig.4 shows similar properties around 2.45 GHz regardless of the incidence direction. Therefore, the selective permeability with the proposed structure is found to exhibit similar properties regardless of the incidence direction.

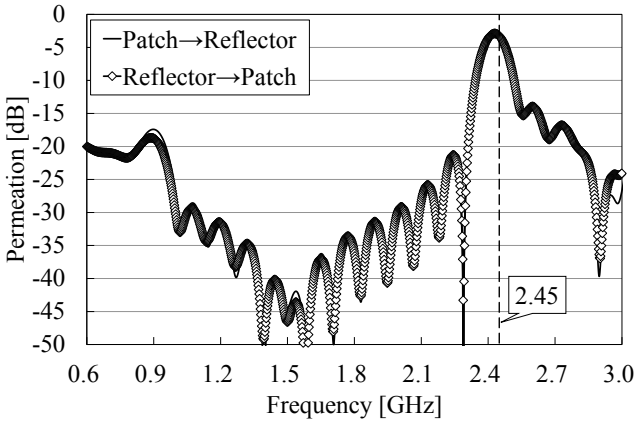



Fig.4. comparison of permeation characteristics the difference in the incident direction

## 4. Conclusion

In a simple structure that combines the structure of transparent ultrathin microwave absorber and the FSS, it was confirmed that could impart selective permeability to absorber. Also, it was confirmed that the selective permeability did not have anisotropy to the orthogonal direction of the proposal functional wall. The angle of incidence dependency of the selective permeability and the absorption will be verified by the experiment in the future.

## References


[1] Y. Okano, S. Ogino and K. Ishikawa, "Development of Optically Transparent Ultrathin Microwave Absorber for Ultrahigh-Frequency RF Identification System," *IEEE Trans. Microw. Theory Tech.*, vol. 60, no. 8, pp. 2456-2464, Aug. 2012.

[2] K. Kumaki, K Sakakibara, K. Tachikawa, S. Hori, N. Kikuma and H Hirayama, "FSS Bandwidth Enhancement and Size Reduction of Period for Dual-band Loop-slot Frequency Selective Surface on Plastic Board," IEICE Technical Report A・P 2012-165, pp. 7-11, Mar. 2013

[3] N. Gejoh and Y. Karasawa, "Multipath Suppression Effect and Digital Transmission Characteristics Improvement by Installing Indoor Wave Absorption Wall Analyzed Based on ETP Model," IEIC-(B), vol. 86-B, pp. 2522-2532, Dec. 2012.