# Experiments to Investigate Electromagnetic Shielding Performance of Polyaniline-Coated Thin Films

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## ABSTRACT

The electromagnetic wave shielding/absorbing is of increasing important to prevent the performance degradation of electrical system/equipment and health threats from harmful electromagnetic wave [1-4]. Therefore, studies of electromagnetic wave shielding/absorbing materials are required to improve the electromagnetic environment. Many studies on electromagnetic wave shielding/absorbing materials have been performed [5-15]. Recently, the investigation of the electromagnetic wave transmission, reflection, and absorption characteristics of polyaniline-coated thin films was conducted by Kim et al. [1]. In this paper, the investigation on electromagnetic shielding/absorbing characteristics of polyaniline-coated thin films conducted by Kim et al. [1] is introduced and reviewed.

***Keywords***: polyaniline, thin Films, electromagnetic wave, shielding effectiveness, experimental method

## 1 INTRODUCTION

The development of digital communication technologies in modern industry has led to the use of high-performance electrical apparatus and the use of them has been causing artificial electromagnetic environmental pollution called electromagnetic radiation [1, 16]. In these electromagnetic environment, electromagnetic wave shielding/ absorbing is of increasing important to prevent the performance degradation of electrical system/equipment and health threats from harmful electromagnetic wave [1-4]. Therefore, studies of electromagnetic wave shielding/absorbing materials are required to improve the electromagnetic environment.

Many studies on electromagnetic wave shielding/ absorbing materials have been performed [5-15]. As representative shielding materials, the metallic materials such as steel, copper, and aluminum have been widely used due to their high conductivity and dielectric constant [1, 3, 17-20]. However, these metallic materials have disadvantages due to limited mechanical flexibility, heavy weight, corrosion, and poor processibility [1, 3, 19-21]. In this reason, the researches on novel materials have been carried out as an alternative to these metallic materials [1, 22-24]. In particular, the investigation of the electromagnetic wave transmission, reflection, and absorption characteristics of polyaniline-coated thin films was recently conducted by Kim et al. [1]. In Kim et al. [1], the optical transmittance, sheet resistance, and electromagnetic interference shielding efficiency of the polyaniline-coated thin films were systematically investigated. In this paper, the investigation on electromagnetic shielding/absorbing characteristics of polyaniline-coated thin films conducted by Kim et al. [1] is introduced and reviewed.

## 2 EXPERIMENTAL PROGRAM

Electromagnetic interference shielding efficiency (SE) is defined as a measure of the reduction or attenuation in the electromagnetic field strength at a point in space caused by the insertion of a shield between the source and that point and can be expressed as summation of the initial reflection loss ($SE_R$), absorption loss ($SE_A$), and internal reflection loss ($SE_B$) [1, 16]:

$$SE = SE_R + SE_A + SE_B. \quad (1)$$

In Kim et al. [1], the electromagnetic interference SE was measured in a frequency range of 30 MHz~1.5 GHz according to ASTM D 4935-99 [25] which is the suitable method for planar material. The test setup and specimen set (reference and load specimens) are illustrated in Figure 1 and 2.

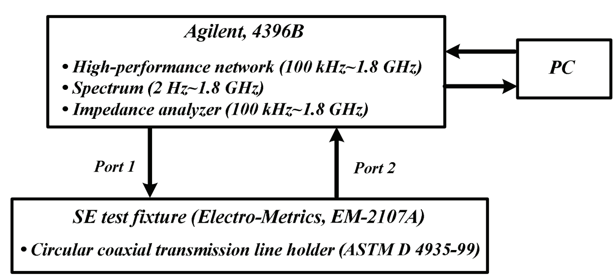


Figure 1: Test setup for electromagnetic interference SE (cf. Kim et al. [1])

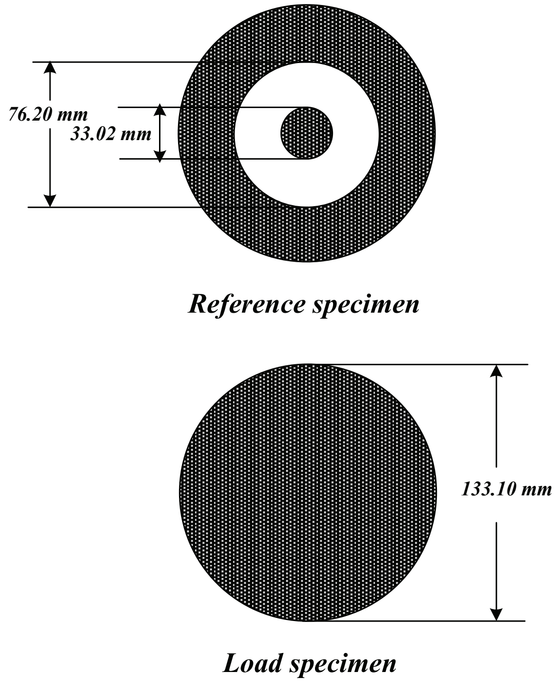


Figure 2: Detailed dimension of test specimen set (reference and load specimens) in accordance with ASTM D 4935-99 [25] (cf. Kim et al. [1])

According to ASTM D 4935-99 [25], the electromagnetic interference SE was calculated as

$$\mathrm{SE(dB)} = 10\log\frac{P_1}{P_2} = 20\log\frac{V_1}{V_2} \qquad (2)$$

where, $P_1$ (or $V_1$) and $P_2$ (or $V_2$) are the received powers (or respective voltage levels) of the load and reference specimens, respectively [1, 25]. Details of test method for electromagnetic interference shielding efficiency can be found in Kim et al. [1]

The polyaniline-coated thin films for test specimens were manufactured based on the newly proposed synthetic method [26] in Elpani, Co. The thicknesses of polyaniline coated in thin films were 229, 366, 640, and 823 nm, respectively [1]. Details of synthesis of polyaniline and manufacturing of polyaniline-coated thin films can be found in Lee et al. [26], Lee et al. [27], and Kim et al. [1].

## 3 RESULT SUMMARY

The investigation of electromagnetic interference shielding performance of polyaniline-coated thin films was carried out by Kim et al. [1] and was reviewed in this paper. According to Kim et al. [1]'s experimental investigation, the overall electromagnetic interference SE values were obtained as 14.28%, 30.68%, 46.50%, and 52.67% with respect to the thicknesses 229, 366, 640, and 823 nm, respectively. It is noted that the research of Kim et al. [1] considered the optical transmittance as well as electromagnetic interference SE.

Kim et al. [1] also investigated the reflection loss and absorption loss of polyaniline-coated thin films. The result of Kim et al. [1] was clear that the reflection and absorption loss increased as the thickness of polyaniline coated in thin films increased. It was emphasized in Kim et al. [1] that the electromagnetic wave absorption characteristic of the polyaniline-coated thin films the unique one that distinguishes from the typical metallic materials (cf. Kim et al. [1] and Avloni et al. [13]). Although the metallic materials are superior electromagnetic interference shielding materials with very high electromagnetic interference SE values, the primary electromagnetic interference shielding mechanism of them is surface reflection of the electromagnetic wave due to their high conductivity [1]. The scattered reflection of electromagnetic wave may also cause electromagnetic environmental pollution together with previously existing electromagnetic wave.

As well as electromagnetic interference SE, the optical transmittance and sheet resistance of polyaniline-coated thin filim were investigated in Kim et al [1]. In Kim et al. [1], the applicability of an SE formula [28-30] was also checked by comparing the experimentally measured SE values with calculated SE values. Kim et al. [1]'s results showed the potential use of polyaniline-coated thin films as an electromagnetic interference shielding/absorbing materials that satisfies both optical transmission and electromagnetic interference SE requirements for transparent bodies such as windows or doorways of buildings. Details of experimental results of polyaniline-coated thin films can be found in Kim et al. [1].

## 4 FORTHCOMING RESEARCH

The authors investigated the electromagnetic interference shielding performance of polyaniline-coated thin films in the previous research [1]. In a forthcoming research, for serviceability of polyaniline-coated films, extensive studies through far-field test and near-field test will be carried out. Also, the authors will conduct the study on polyaniline-coated film systems having the more superior electromagnetic shielding/ absorbing and optical transparent characteristics.

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