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A Simulation and Property Analysis according to Electromagnetic Wave Absorber Shape

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Abstract

The property of magnetic field and properties of EMW(Electro Magnetic Wave) absorption with multi-shaped EMW absorber was simulated. As a magnetic field having high density was showed at bottom of EMW absorber, simulation showed that overall EMW was absorbed at the bottom of multi-shaped absorber. The absorption properties of EMW according to thickness of absorber showed that it enhanced about 50-60 percent. Also, EMW absorption properties was checked with surface area of EMW absorber. A cylinder-shaped EMW absorber exhibited good property among multi-shaped EMW absorber based on these result.

Keywords: *Electromagnetic wave Absorber, Absorption quantity, shape and Magnetic field.*

1. Introduction

The electronic industries have had great impact on life of humans. Recently, low-power and high-performance devices have emerged as extensive digital technologies were converged to mobile equipment, IoT(Internet of Thing), digital appliance, electric vehicles and semiconductor. Although the devices had good properties with low-power, high-performance and multi-function, it was confronted with minimization of EMI(Electro Magnetic Interference). A high density process and fabrication are essential to above-mentioned fields and a noise of devices was caused by EMI because operating frequency increased to HFB(High Frequency Band). This noise of devices make performance deterioration and malfunction. Furthermore, it might affect to entire industry system. To prevent noise of devices, importance of EMI shielding technologies was mentioned at all times [1,2].

There are various techniques on EMI shielding that has principle to absorb EMW(Electro Magnetic Wave) by forming the shielding layer. The formation methods include spray coating, sputtering and taping. A spray coating is technique that shield EMW by using conductive coating materials combined metal

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materials and synthetic resin. This method has advantage at productivity due to applying conductive resin with easy spray way, but it has disadvantage influenced by handling. A sputtering method shield EMW by forming metal thin film. Though sputtering is used for semiconductor packaging, it has disadvantage due to difficulty and specific order of process. Taping method that is technique using conductive tape is advantage to shield in a short time [3].

In this paper, we apply taping method among mentioned EMI shielding techniques. We also research absorption properties with diverse shape and thickness of EMW absorber. This study show magnetic field property according to shape of EMI absorber designed with a cuboid, cube, cylinder and hemisphere. FEA(Finite Element Analysis) tool was used for analysis with shape of EMI absorber..

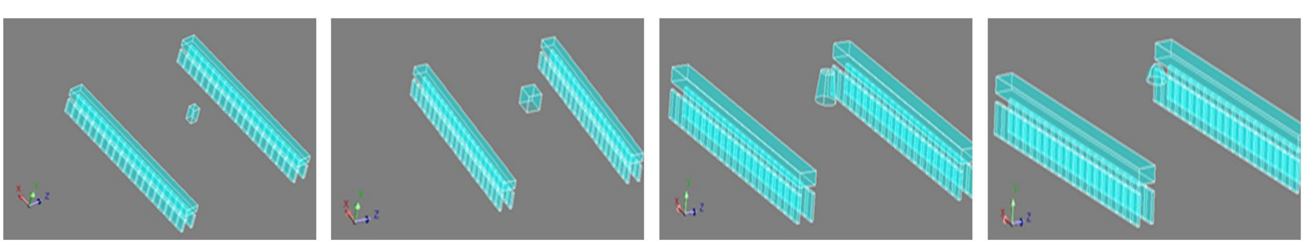
2. Modeling of electromagnetic wave absorber shape

We simulated magnetic field according to shape and thickness of EMW absorber to analysis properties of EMW absorber. Then, EMW absorption of absorber was analyzed using the magnetic field gained by simulation. A table 1 shows specification of models with shape of EMW absorber.

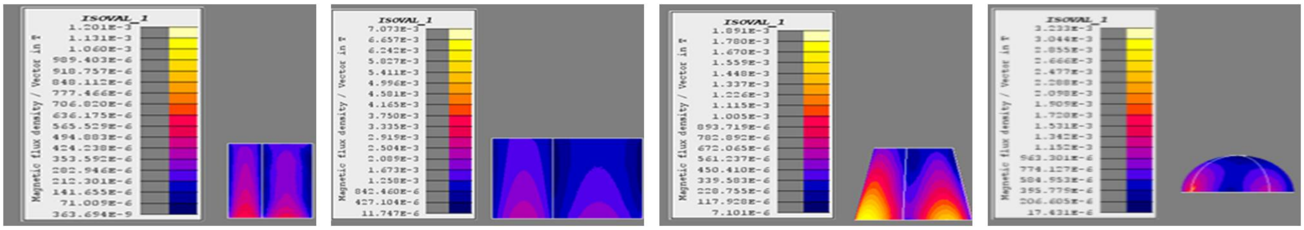
Table 1. The specifications of the EMW absorber

Model	Width (mm)	Length (mm)	Height (mm)	Thickness (mm)
1	100	100	200	0.9, 1.8, 2.7, 3.6 and 4.5
2	200	200	200	
3	top : 100 bottom : 150	-	200	
4	200	-	100	

The Fig. 1 is simulation result pertaining to multi-shaped EMW absorber. The FLUX 3D(CEDRAT) was used as simulation tool. All-shaped EMW absorber were located at top of center of EMW source like Fig. 1 (a), (b), (c) and (d). The Fig.1 (e) and (f) are magnetic field analysis result of model 1 and 2 that shows different magnetic density at cuboid and cube-shaped absorber. These figures show that relatively much EMW was absorbed at bottom of EMW absorber considering that magnetic field density large at bottom than top. Fig. 1 (g) is simulation result of cylinder-shaped absorber model 3. This figure shows that high magnetic field density was checked at bottom than top and appear having most high magnetic field density among whole absorber. Fig. 1 (h) present simulation result of hemisphere-shaped absorber model 4. It can be seen from Fig. 1 (h) that most magnetic field was concentrated at bottom and edge of bottom.



(a) (b) (c) (d)



(e) **(f)** **(g)** **(h)**

Fig.1. Simulation result of multi-shaped EMW absorber model (a) simulation of cuboid-shaped absorber (b) simulation of cube-shaped absorber (c) simulation of cylinder-shaped absorber (d) simulation of hemisphere-shaped absorber (e) magnetic field density of cuboid-shaped absorber (f) magnetic field density of cube-shaped absorber (g) magnetic field density of cylinder-shaped absorber (h) magnetic field density of hemisphere-shaped absorber

3. Results and discussion

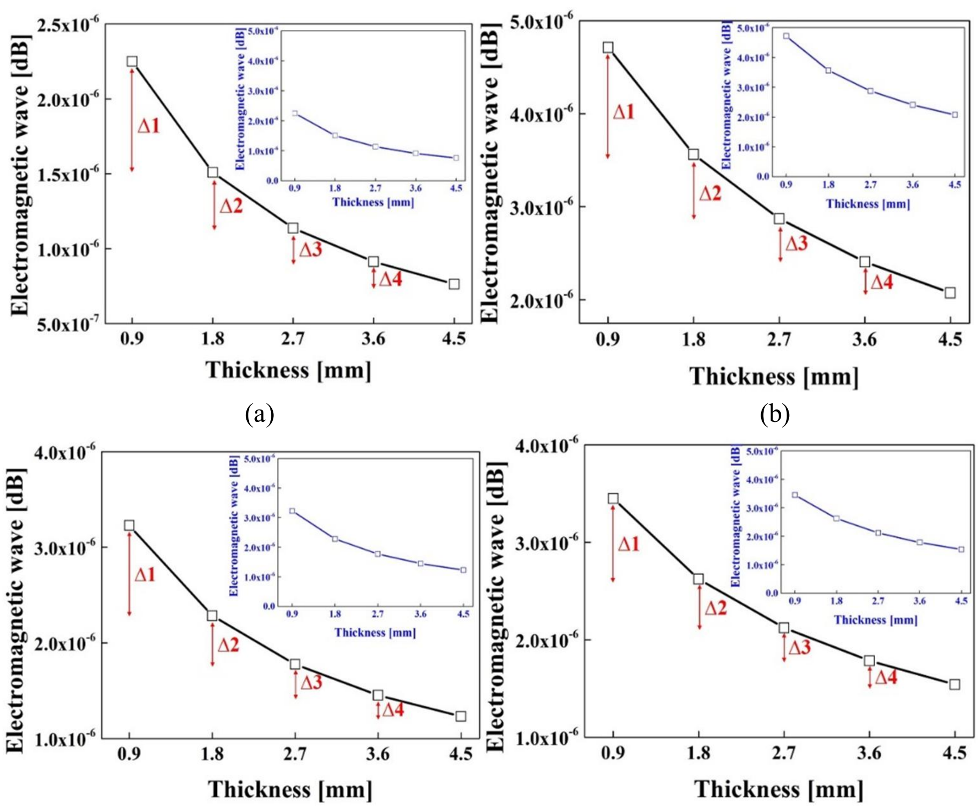


Figure 2. EMW simulation result of absorbers. (a) model 1 (cuboid-shaped absorber), (b) model 2 (cube-shaped absorber), (c) model 3 (cylinder-shaped absorber) and (d) model 4 (hemisphere-shaped absorber)

As thickness of absorber increase from 0.9 mm to 4.5 mm, A decrease of EMW was checked. A measured EMW at thickness 4.5 mm appeared 66.10% reduced value compared to initial EMW (t=0.9 mm). This is because the most numerous EMW was absorbed at thickness 4.5 mm. Fig. 2 (b) present EMW simulation result of model 2 (cube-shaped absorber) for thickness of absorber. An absorption property of model 2 was identified that decrease of EMW appeared, as increase thickness of absorber. The lowest EMW was measured 56% reduced value than initial EMW (t=0.9 mm). When thickness of absorber was 0.9 mm, measured EMW at model 1 and model 2 were 2.25×10^{-6} dB and 4.71×10^{-6} dB, respectively. While, EMW of model 1 and model 2 were 6×10^{-7} dB and 1.69×10^{-6} dB at thickness 4.5 mm of absorber. In cylinder-shaped model 3, the lowest EMW improved 61.90% against initial EMW (t=0.9 mm). The model 4 present EMW simulation result of hemisphere-shaped model 3 with thickness of absorber. This figure shows 55.30% reduced value than initial EMW (t=0.9 mm) as lowest EMW (t=0.45 mm). Generally, measured value of EMW was similar with model 3 but, widths of decrease for EMW (Δ1-Δ4) were lowest among whole models. As shown in Fig. 1 (e), most EMW was absorbed at edge of bottom and this caused narrow absorption surface area.

Fig. 3 shows Average EMW and EMW absorption quantity. As mentioned earlier, simulation result shows that most EMW was absorbed at the bottom of models. This was implied close relationship between surface area of bottom of models and EMW absorption quantity. The maximum and minimum of average EMW absorption quantity were shown in model 1 and 2 among whole models. Here, surface area of bottom for models are 400 cm^2 and 100 cm^2, respectively. The average EMW absorption quantity was proportional to surface area of bottom and this result coincided with result Fig. 1. A model 1 exhibited maximum of EMW absorption quantity per unit area. While, minimum of EMW absorption quantity per unit area was checked on model 4. As bottom surface area of model is narrow, EMW absorption quantity per unit area increased.

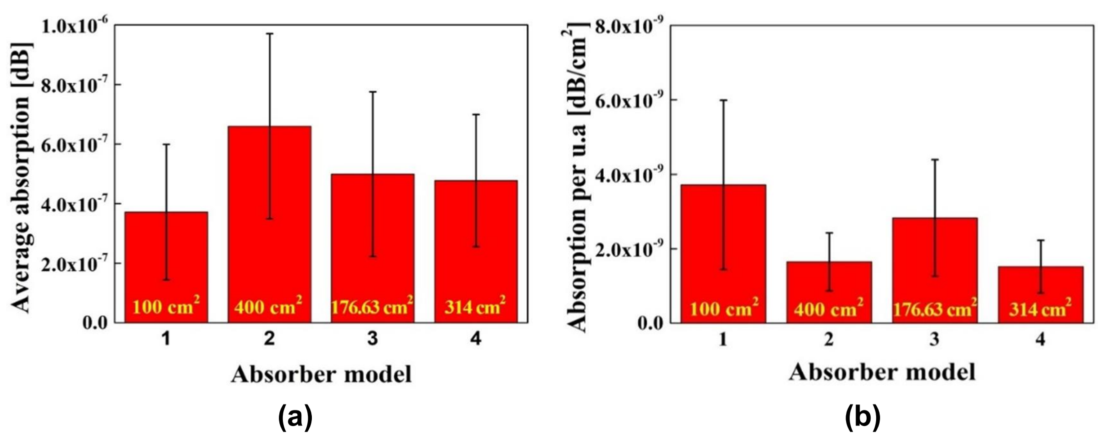


Figure 3. Average EMW and EMW absorption quantity with absorber models. (a) Average EMW and (b) EMW absorption quantity

4. Conclusion

We mentioned properties of magnetic field and EMW absorption with multi-shaped EMW absorber through this research. A magnetic field distribution of each model was checked at the bottom. The EMW absorption properties at thickness 4.5 mm presented maximum EMW absorption at the same time as showing minimum EMW. In aspect of shape of models, model 1 (cuboid-shape) exhibited minimum EMW. However, model 3 showed relatively outstanding properties considering average EMW absorption quantity and EMW absorption quantity per unit area. A Δ mean widths of decrease for EMW and Δ1 was maximum value among all models. As Δ value was went from Δ1 to Δ4, Δ value showed decreasing tendency. This implies that EMW absorption quantity saturated with thickness of absorber. Accordingly, if shape and thickness of

EMW absorber are considered, we can smoothly shield EMW. It is expected to affect electronic industry.

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