Study on a Composite Fiberboard with Multiple Electromagnetic Shielding Effectiveness

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Abstract: Based on the reflection, absorption and multiple reflection attenuation principle of composite shielding, composite fiberboard with multiple electromagnetic shielding functions was developed according to the structure design, which was made by filling with mineral powder and stainless steel nets, and then sprayed single face with conductive paint. The results show that: electromagnetic shielding effectiveness of the product is above 60dB and reaches the better grade in 18.85MHz-1.46GHz; the product filled with magnetite powder has better comprehensive mechanical properties than the product filled with barite powder, and its modulus of rupture, modulus of elasticity, internal bonding strength and thickness swelling rate of water absorption all reach the Chinese national standards.

Keywords: Electromagnetic shielding, mineral powder, stainless steel net, conductive paint, composite fiberboard.

1. INTRODUCTION

With the effects of electromagnetic radiation and electromagnetic interference for people's health and society increasing, it was very imperative to study new electromagnetic shielding function materials, and wooden electromagnetic shielding materials was one hot point of the study. Xianquan Zhang and Yixing Liu [1] had studied the ratio of stainless steel fiber which had affection on the electromagnetic shielding effectiveness of steel/wood composite fiberboard, and the results showed that: when the steel/wood composite fiber was on the bilateral surface layer of fiberboard with the proportion of 1:3, the electromagnetic shielding effectiveness could reach above 55 dB in 0-1.5 GHz. Xianquan Zhang and Yixing Liu [2] researched on the property of wood fiber-copper wire net composite MDF, and discovered that the effectiveness could reach above 60dB in 9kHz-1.5GHz when copper wire net whose mesh was more than 60 was placed on surface layer. Xiansen Liu and Feng Fu [3] made three-layer compound larch plywood by adding respectively brass fiber and stainless steel fiber to urea-formaldehyde resin as conductive unit, and the effectiveness was in the range of 6.34 dB to 28.76dB when added with brass fiber and 13.63-21.14dB when added with stainless steel fiber in 9kHz-1.5GHz. Xiansen Liu and Feng Fu [4] made three-layer compound Larch plywood by adding respectively super fine copper powder, super fine nickel powder and super fine graphite powder to urea-formaldehyde resin as conductive unit, the effectiveness was respectively 0dB, 0.00-10.10dB, 5.28-13.13 dB in 9kHz-1.5GHz. Jintian Huang and Guangjie Zhao [5] had studied the electromagnetic shielding effectiveness of veneer plated with Ni by chemical method and discovered that the effectiveness could reach 30-60dB in 0Hz-1.5GHz. Qiutie Zhi [6] made wooden electromagnetic shielding materials by magnetron sputtering and discovered that the effectiveness could reach above 30dB in 30Hz-1.5GHz. Keyang Lu and Feng Fu [7] had researched the property of electromagnetic shielding plywood laminated with conductive membrane; and discovered that when copper fiber was 200g /m^2, the effectiveness was 39.30-61.75dB and the average was 49.65dB in 9kHz-1.5GHz. Jiaqi Zhu *et al*. [8] had researched the composite of metal mesh and wood veneer, the results showed that the effectiveness could reach above 40dB in 1MHz-1GHz. Junling wang and Hongsha Guo *et al*. [9] have studied on wood-based panel whose surface was separately pasted with Ni-plated fabric and coarsening copper; the effectiveness of the wood-based panel whose surface was pasted with Ni-plated fabric was about 60dB and the other one was above 70dB. Effectiveness grades was divided into five grades by Chohachiro N [10-12] in frequency of 50MHz-1GHz: ①under 10dB: no effectiveness; ②10-30dB: bad; ③30-60dB: medium; ④60-90dB: good; ⑤above 90dB: excellent.

In summary, currently, low effectiveness is seen in most of the current wooden electromagnetic shielding materials, and the better materials are very expensive because of using precious metals. This study, aiming at making a new kind of electromagnetic shielding function composite fiberboard, uses inexpensive natural ore powder (barite powder, magnetite powder) and two layers 80 mesh stainless steel nets and plated with copper-silver conductive paint.

2. TEXT MATERIALS AND METHODS

2.1. Test Materials

Barite powder: purchased from Guilin Brothers Mining Investment Co., Ltd, natural, 2000 mesh; contains barium elements (heavy metals element); effective in absorbing some harmful rays, such as x-rays [13].

Magnetite powder: purchased from Hechi Jinchuan Mining Co., Ltd, natural, 400 mesh; magnetite has a certain shielding effectiveness in the microwave frequency band,

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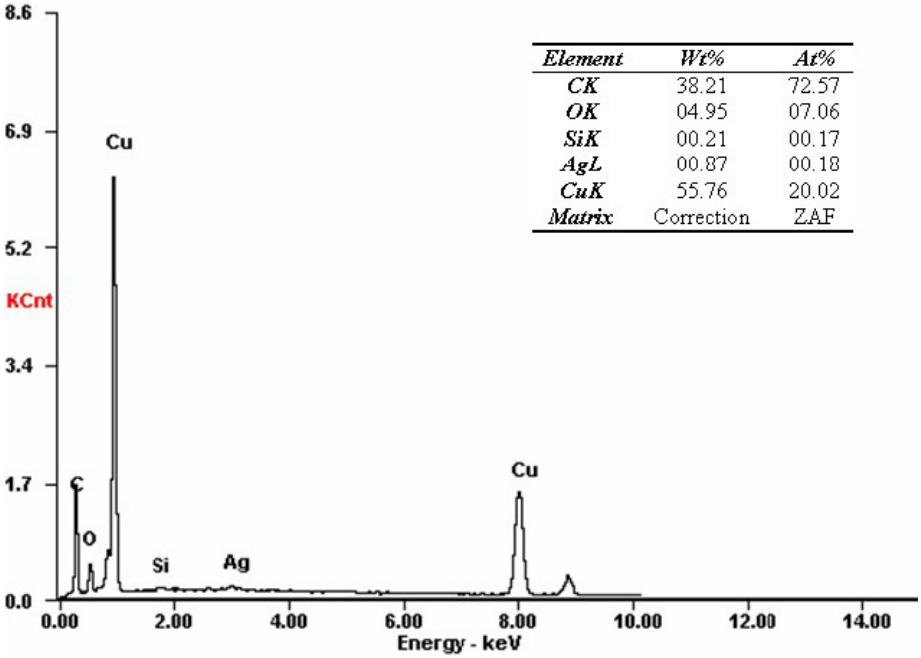

Element	*Wt%*	*At%*
CK	38.21	72.57
OK	04.95	07.06
SiK	00.21	00.17
AgL	00.87	00.18
CuK	55.76	20.02
Matrix	Correction	ZAF

Fig. (6). EDX analysis of conductive paint coating (ZAF, Zero Alignment Feature).

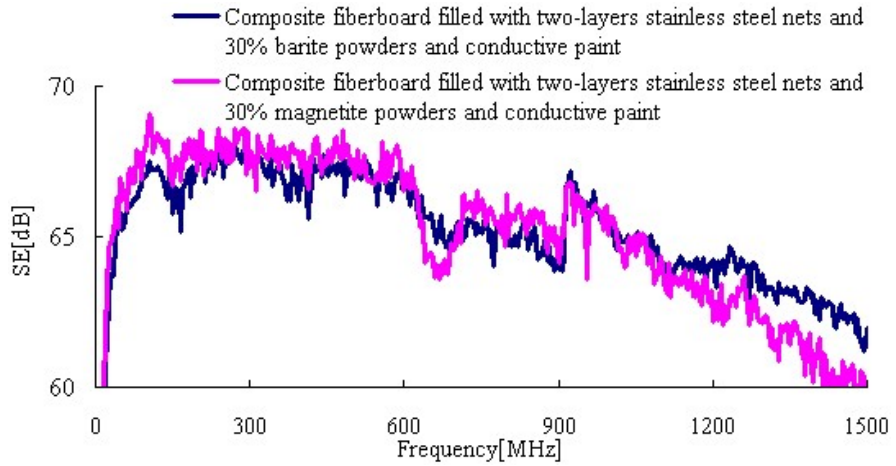

Fig. (7). SE of the composite fiberboards.

added with 30% barite powder and filled with two-layers 80 mesh stainless steel nets have all reached national standard requirements, but *IB* and *TS* haven't reached national standard requirements. The reason maybe that chemical stability of barite powder is good, and thermal conductivity is bad, and the density is relatively small; then the filling amount was more, which decreases the opportunity for mutual agglutination between each wooden fiber, then affects the *TS* property; also the barite powder has better hydrophilicity and higher *TS*.

4. CONCLUSIONS

(1) When the composite fiberboard was filled with the mixture of mineral powder and stainless steel nets,

Table 1. The Physical and Mechanical Properties of Composite Fiberboards

Types of Composite Fiberboards	Sizing Quantity [%]	Data Type	*MOR* [MPa]	*MOE* [MPa]	*IB* [MPa]	*TS* [%]
Composite fiberboard filled with 30% barite powder+ two-layers 80 mesh stainless steel nets	16	Avg.	36.59±1.71	5654.09±280.09	0.38±0.06	25.7±2.3
		CV	4.7	5.0	15.8	8.9
Composite fiberboard filled with 30% magnetite powder+ two-layer 80 mesh stainless steel nets		Avg.	30.32±2.92	4761.03±323.23	0.67±0.05	19.5±0.38
		CV	9.6	6.8	7.5	1.9

MOR, modulus of rupture; *MOE*, modulus of elasticity; *IB*, internal bonding strength; *TS*, thickness swelling rate of water absorption.
Results are averages ± SD (standard deviation).
Avg., average; CV, coefficient of variation [%] (standard deviation/average values×100).

and sprayed with conductive coating on its surface, its electromagnetic shielding effectiveness in the frequency band of 50-1000MHz was respectively up to 60dB, which have achieved a good level; among them, the shielding bandwidth above 60 dB of the composite fiberboard filled with barite powder is 18.85MHz-1.5GHz, and the shielding bandwidth filled by magnetite powder is 18.85MHz-1.46GHz.

(2) When fiber sizing quantity reaches 16%, *MOR*, *MOE*, *IB*, *TS* of the composite fiberboard, which was filled with the mixture of magnetite powder of 30% and two-layer stainless steel nets of 80 mesh together, have basically reached Chinese national standard requirements. The *MOR* and *MOE* of the composite fiberboard, which was filled with the mixture of barite powder of 30% and two-layer stainless steel nets of 80 mesh together, have reached national standard requirements, while its *IB* and *TS* haven't and need further study.

(3) It is a great help to improve the electromagnetic shielding effectiveness of the composites by conducting the reasonable structure design according to the composite shielding mechanism of reflection, absorb and multiple attenuation.

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CONFLICT OF INTEREST

Declared none.

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