PERFORMANCE OF GOLDEN POWER ANTIBACTERIAL BOARD AND ITS APPLICATION IN BUILDING AREAS

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ABSTRACT

To realize green and sustainable development of fibre cement board industry, fibre cement boards are deep processed by painting to reduce VOC pollution to the environment and increase the durability of product. Application of active antibacterial technique to fibre cement boards is a breakthrough in this industry which enhances the environment protection application of fibre cement boards to a new level. Golden Power antibacterial board are widely used in the places where ask the high cleaning environment, such as the operating rooms, clean walkways, sterile rooms, ICU and ward in the hospital since its self-cleaning and antibacterial performances effectively prevent the generation and spreading of bacterial and improve public health. This paper introduces antibacterial performance, mechanism and effect of Golden Power antibacterial boards as well as their application in buildings with high sanitary requirements.

KEYWORDS

Antibacterial boards; antibacterial performance; silver ions

INTRODUCTION

With social development, people have realized that environment pollution becomes increasingly severe and directly affects human, animals, plants and environment. Bacteria, including countless pathogenic ones, are pervasive. Human health is seriously threatened by these wide spreading bacteria. Most diseases are caused by pathogenic microorganism like noxious bacteria, fungus and viruses. In mid-14th century, numerous people were killed by Black Death. The Great Influenza in 20th century slaughtered over 20 million victims. Pandemic pathogenic escherichia coli 0-157 in Japan, BSE and aftosa in Britain, Anthrax in the US and SARS outburst in spring and summer of 2003 in China are all related to pathogenic microorganism directly [1].

According to statistics, about 17 million people died because of infectious diseases mainly consisting of cholera, pneumonia, malaria, tuberculosis and hepatitis [2] in 1995, accounting for 1/3 of all death worldwide. In 1996, nationwide food poisoning due to pathogenic escherichia coli 0-157 in Japan caused worldwide panic [3]. We have to contact with quite a lot of bacteria in daily life, including pathogenic ones which directly threaten our health. To get rid of them, we not only regularly clean articles of everyday use, shared items and public places, but sterilize them by chemical agents and physical measures.

To protect human health, increase life quality and maintain and improve living and working environment, development of novel, environment-friendly, high-efficient, side effect-free, durable and economic antibacterial materials are required for our time. Therefore, development and manufacturing of antibacterial materials have become an emerging sunrise industry which benefits both industry economy development and living environment of human.

GOLDEN POWER ANTIBACTERIAL BOARDS

History of Golden Power antibacterial boards

By in-depth research and discussion on sustainable development of fiber cement board in 1999, Golden Power Group had understood that world famous companies such as Eternit, Nichiha (Japan) and James Hardie coated their products before delivery for such processing improved appearances and durability of their products which were widely used as decorations for interior and exterior walls.

In 2000, Golden Power (Fujian) Building Material Science Technology Co., Ltd., a subsidiary of Golden Power Group, started an R&D project of coating deep processing for boards. Shanghai Huashan Hospital and Shanghai Zhongshan Hospital started to use our products as the first customers in 2001. After 5 years, they demanded more than basic performances like fireproof and easy cleaning performance. SARS breakout in April 2003 makes antibacterial (antimicrobial) performance an urgent need. It took Golden Power Group only one year to develop the first generation antibacterial boards which adopted organic antibacterial agents (aiming at escherichia coli, staphylococcus aureus, Helicobacter pylori and Candida albicans). Though the antibacterial agents can kill bacteria fast and efficiently, they had shortcomings such as short antibacterial effect, toxicity, poor heat resistance and easy decomposition [4]. To solve these problems, Golden Power Group started the development of the second generation antibacterial board in 2010, aiming at reducing VOC in the organic solvent which may harm air and human health. Therefore, we used solvent coatings with high solid content and non-volatile solvent coatings. In 2013, inorganic antibacterial boards were certified by test institutions in Taiwan. The second generation products showed excellent performance in killing MRSA (superbacteria).

MRSA methicillin resistant Staphylococcus aureus is a special strain identified by British researchers in 1961 which resists most antibiotics. It is called superbacteria due to its wide spreading, especially to patients who have already been infected by other viruses. 18,000 patients die from MRSA every year in the US while 16,000 patients killed by AIDS in 2005 [5].

Key innovations of Golden Power antibacterial boards

The key innovation of Jinqiang antibacterial boards is applying inorganic silver-carrying antibacterial ions to coating of fiber cement boards, enabling the boards to kill over 600 bacteria including escherichia coli, Candida albicans, staphylococcus aureus, spirillum and pneumobacillus, even superbacteria like MRSA. Increasing microbial drug resistance caused by abuse of antibiotics and sanitizers threatens health and living environment of human. Developing novel antibacterial materials is an inexorable trend in prevention of microbiological hazards. Inorganic silver-carrying antibacterial materials boast following advantages: excellent safety, durability, heat resistance and unlikely to induce drug tolerance. Development and application of such materials started in 1980s, among which

the inorganic silver-carrying antibacterial materials are the most widely used due to their outstanding antibacterial effect, broad antibacterial spectrum and low toxicity [6]. As antibacterial effect based on silver ion exchange will not fade with repeating use, such materials will maintain stable antibacterial effect during service life.

Problems solved by Golden Power antibacterial boards

Golden Power antibacterial boards mainly solve short antibacterial effect, toxicity, poor heat resistance and easy decomposition problems of organic antibacterial and boast following advantages: excellent safety, good processability, broad antibacterial spectrum, good heat resistance and unlikely to induce drug tolerance.

Antibacterial mechanism

The antibacterial mechanism of ions in the top coating of Golden Power antibacterial boards is described below. Silver has pretty good catalytic capability due to its chemical structure. Highly oxidized silver have reduction potential high enough to generate atomic oxygen around it. The atomic oxygen kills bacterial by its strong oxidability while silver ions (Ag+) fast and tightly bond with sulfydryl (-SH) of protease in bacteria to kill bacteria by inactivating the protease. Silver ions will leave the dead bacteria and continue the cycles. This is why silver can keep on killing bacteria and be considered a permanent sterilizer [7].

Silver is one of the metals found and made use of by human in early times. Back to 2500 year ago, Cyrus the great demanded that all troops must hold water by silver pots in which water could be cleaner. Silver nitrate had been used as a medicine in ancient Rome according to Rome Pharmacopoeia made in 69 BC.

Chinese ancestors also knew about silver's magic purifying function. Herdsmen living in Inner Mongolia hold mare's milk by silver bowls to prevent spoilage. Silver chopsticks protected users from food poisoning caused by spoilage. Flower preserved by water in silver vase could last for a long time with fresh leaves. When proper water source is not available during journey, potable water can be made by stirring random water with silver jewelry or silver items. It is obvious that silver had been widely used as a sterilizer in the ancient time. Though our ancestors did not figure out its mechanism, they understood its benefit to health and nobody got hurt by using silver. Therefore, they considered silver a safe metal [7].

Performance comparison of silver ion sterilizer and organic sterilizer:

Effect	Silver ion sterilizer	Organic sterilizer
Antibacterial mechanism	Sterilize by contacting	Sterilize by dissolution
Antibacterial performance	Broad antibacterial spectrum and lasting effect	Narrow antibacterial spectrum and short effect
Safety	Nontoxic and not harmful to health and environment	Toxic, harmful to health and environment and carcinogenic
Stability	Good heat resistance, acid and base resistance and poor light aging resistance	Not heat resistant and easily influenced by pH
Drug tolerance	NA	Easily cause drug tolerance

Table 1 Performance comparison of silver ion sterilizer and organic sterilizer

Advantages in performance

Selling points of Golden Power antibacterial board popular are as follows:

· Active surface antibacterial effect

· Formaldehyde-free material

·Scratch resistant and power-free surface

·Good durability

·Easy assembly and environment-friendly

·Proper price

·Mould resistance, moth resistance, ant resistance and rot resistance

·Applicable to ceiling and wall and good decorative effect

Test result of antibacterial property

Test institution: SGS Taiwan Ltd.			
Test Item: JIS Z2801 antibacterial test Tested strain Escherichia coli ATCC 8739			
Processing method	CFU/ml	Log	R (remark 2)
A	$9.5x10^5$	5.88	4.05
B	$2.7X10^7$	7.43	

C	$2.4X10^3$	3.38	
Tested strain Staphylococcus aureus 6538P			
Processing method	CFU/ml	Log	R (remark 2)
A	$2.9x10^5$	5.46	5.18
B	$1.6X10^6$	6.18	
C	<10	<1	

Remark: 1. this test report is made by SGS food test lab – Taipei.

2. A: immediate test average value of live bacteria of non-processed specimen

B: average value of live bacteria of non-processed specimen after 24h culture

C: average value of live bacteria of processed specimen after 24h culture

R (antibacterial value)=[log(B/C)]. Antibacterial effect can be confirmed if R is larger than 2.0.

Test institution: SGS Taiwan Ltd.

Item:

ASTM G21 mould resistance test

Aspergillus niger ATCC 9642

Penicillium pinophilum ATCC 11797

Chaetomium globosum ATCC9645

Aureobasidium pullulans ATCC 15233

Test result

Item result

ASTM G21 Mould growth on specimen: NA

Level: 0 (remark 3)

Remark: 1. This test report is made by SGS food test lab – Taipei.

2. Culture time is 28 days.

3. Level growth status

0 Nill

1 trace (mould area<10%)

2 slight (mould area 10-30%)

3	moderate (mould area 30-60%)
4	severe (mould area>60%)

Test institution: Food Industry Research and Development Institute	
Item	Result
Antibacterial test (JIS Z 2801)	According to evaluation criteria of JIS Z 2801: 2010 antibacterial method, Golden Power antibacterial board 6mm (unpacked) specimen shows an antibacterial value larger than 4.84 against MRSA (MRSA BCRC 15211). See test details in Annex Blank blow

Table 2 - Test result of antibacterial property

COATING PROCESS

The coating process is as follow:

Fiber cement board→ sanding and determining thickness→ closed roller coating→ roller painting of primer→ roller painting of topcoat → curing→ antibacterial boards

Roller coating is the most common technique and normal rollers are shown in the picture below. The lifting roller gets the paint from the paint tank and conveys it to the coating roller and the coating roller coats surface of the fiber cement board evenly. According to requirement on coating thickness, the board may be coated repeatedly with different coatings. For first few times, coating without antibacterial particles can be used and the last layer should contain antibacterial particles. Figure 1 shows a double roll coater.

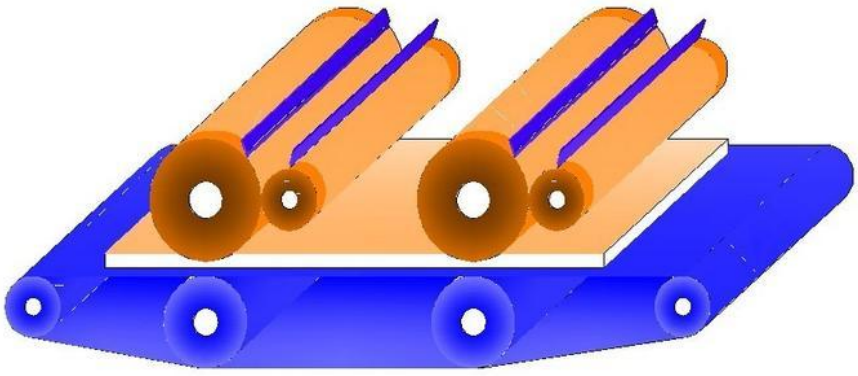


Figure 1 – Structural diagram of double roll coater

APPLICATION AND CASES

Excellent air tightness of modern buildings results in inefficient air exchange and heat insulation, causing wall condensation and dampness. Such environment is the favorite of microorganisms like fungus. Researches have proved that bacteria in air may cause eye congestion, asthma, fatigue and headache. Nosocomial infection refers to people infected by bacteria and other microorganisms from medical environment when they (especially patients) are in hospitals. The great number of patients, surgery equipment and dressings bring much more pathogenic microorganism to hospitals than public places while patients are vulnerable, so nosocomial infection occurs quite frequently. Though it is a worldwide concern and all countries including China is struggling to prevent it, it is still a serious problem. Ministry of Public Health of China finds that the nosocomial infection rate of inpatients reaches 9.7% by monitoring of 800,000 inpatients every year. There are about 50 million inpatients a year, that is, about 4.8 million of them suffer from nosocomial infection. 1/4-1/3 of death in hospitals are directly caused by nosocomial infection, quite shocking.

Besides hospitals, damp places like kitchens and bathrooms are most likely to be polluted by bacteria [4].

Application area

Golden Power antibacterial boards have been widely used in operating room, ICU, clean corridors and ward corridors as well as washing rooms in metros and shopping malls, family kitchens and bathrooms. They have made great contribution to the improvement of public health and prevention of pathophoresis.

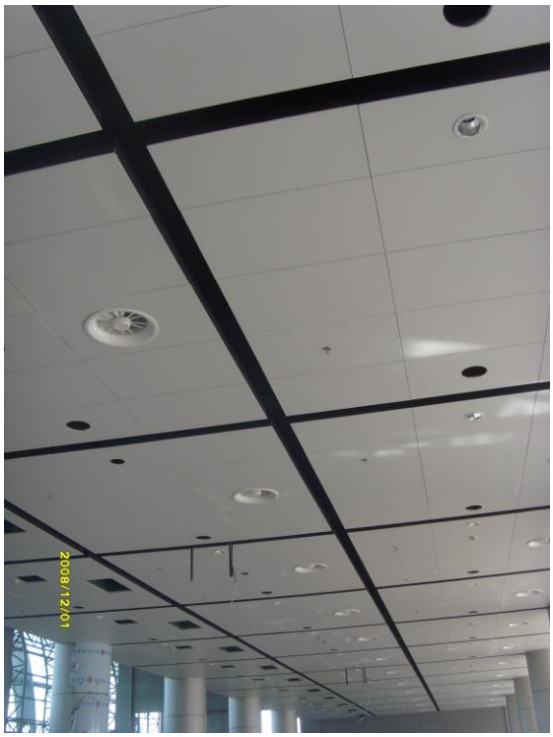
Application cases

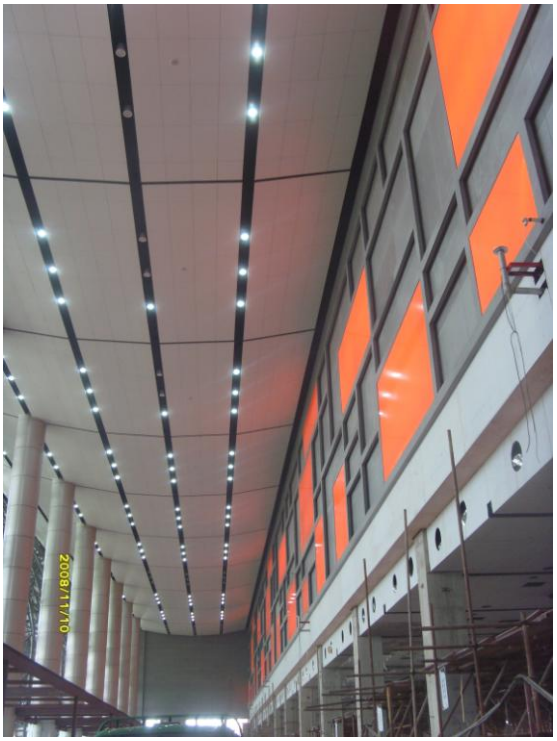
Clean projects

Clean operating room, ICU and clean corridor

Pharmaceutical factory and food factory

Bus station





Installation accessories for Golden Power antibacterial boards

Given that materials for decoration installation release air polluting gases including benzene and formaldehyde, installation accessories (eg. adhesive tape and assembly glue) for Golden Power antibacterial boards are all environment-friendly, formaldehyde-free and pollution-free.

CONCLUSION AND VISION

Conclusion

This paper elaborates the importance of antibacterial performance, history of Golden Power antibacterial boards, their antibacterial mechanism, antibacterial performance and application area. The coating processing of fiber cement board gives us a better understanding of inorganic fiber cement board and provides excellent ideas for sustainable development of fiber cement board industry, reduction of environment pollution caused by VOC and improvement of durability.

Shortcomings

Through inorganic antibacterial boards have made a little bit breakthrough against MRSA, further studies are required for removal of formaldehyde, VOC, (benzene and homolog), ammonia, radon and stone radioactivity.

Promotion plan

A three-stage promotion plan is made.

The first stage: all-round promotion aiming at biological clean projects (hospital, pharmaceutical factory and food factory)

The second stage: promotion aiming at public places like metro, bus station, airport, shopping mall and washing room

The third stage: promotion aiming at family kitchens and bathroom

Vision

Golden Power antibacterial board will definitely be widely used as decoration materials for public places and residence and demand on such product will certainly rise with increasing health consciousness. It is hopeful that they can get rid of more superbacteria like SARS and H7N7 in the near future. Development of antibacterial boards is of great importance and requires joint efforts of all researchers. We will strive for human health and environment protection industry!

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