Biocides in antimicrobial paints

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There is a real need to take all means possible to control the spread of pathogenic bacteria and fungi in health facilities. The use of biocide containing antimicrobial surfaces is one additional option being strongly promoted to complement the standard cleaning and disinfection practices. The emergence of multidrug-resistant bacteria in medical facilities has resulted in significant media attention and the widespread dissemination of information to the general population. The fear of germs, fuelled by headlines of 'superbugs' plus recent viral pandemics, is also being used to support advertising campaigns to sell similar products for household use.

Microorganisms are endemic in the environment and will grow on most surfaces, provided there is a source of nutrients and sufficient available water. Fungi are the most likely organisms to grow; however, bacteria and viruses will survive on dry surfaces for some time[1]. The use of antimicrobial surfaces is claimed to kill these organisms so they can't be transmitted to other people and don't grow and cause odour and staining problems.

Biocides

A number of different biocide actives have been used to impart antimicrobial activity to surfaces. The most commonly used actives are shown in Table 1. Triclosan was initially used and over time was replaced by zinc pyrithione. Silver is now the main biocide offered for sale and is available as nanosilver, silver chloride, silver nitrate and colloidal silver-based products.

Antimicrobial products

There are an enormous number of products currently available that claim to be antimicrobial, including paint and coatings, carpets, adhesives, sealants, soaps and hand washes, facial tissues, paper towels, linen, clothing, bench top material and all things made of plastic, such as shower curtains, toilet seats, computer keypads and chopping boards. Antimicrobial surfaces are also being supplied on medical devices like catheters, guide wires, sutures, wound dressings and stent delivery systems to reduce the chance of infections or biofilm formation.

Paints

Painted surfaces are able to support the growth of fungi provided there is sufficient water activity at the surface, and this may be provided by vapour or condensation. Fungi utilise water soluble components of the paint film, such as surfactants and flourish on damp surfaces causing significant disfigurement, mainly due to spore production which makes the growth easily visible. Fungal growth occurs in wet areas such as kitchens or bathrooms, where there is insufficient ventilation or where water leaks allow the surface to remain damp. Bacteria require a higher water activity and do not usually grow on painted surfaces.

Figure 1. Surface fungal growth on a bathroom ceiling.

Table 1. Biocide actives used in antibacterial products.

Triclosan	Zinc pyrithione
Octylisothiazolinone	Dichloro octyloisothiazolinone
Quaternary ammonium compounds	
Silver	Copper and copper alloys

Table 2. Trade names of some antimicrobial suppliers.

Antibac®	PaintPRO®	Microban®	Sanitize®
WithStand™	SmartSilver™	Biocote®	SteriTouch®

Paints which contain biocides to control the growth of fungi and algae have been available on the market for over 20 years but are not usually marketed as antimicrobial. Paints that claim to control fungal growth are not generally regulated, but any claim for algal protection may require registration with the Australian Pesticides and Veterinary Medicines Authority (APVMA). The increased awareness of the existence of drug-resistant bacteria in medical facilities and a desire for improved hygiene in households has led to the marketing of paint with antimicrobial claims. Many of these paints are produced by ethical manufacturers reacting to a market need, but there are also a number of producers who use exaggerated claims to sell their products.

Antibacterial paints generally are clearly marked with a biocide supplier trade name that is used as part of the marketing plan, often with dedicated internet sites. Examples of some trade names are set out in Table 2. Antimicrobial paints are marketed to hospitals, schools, kindergartens, restaurants and households. The sales of antibacterial paints are supported by advertising to convince people that there is a real risk to our health that can be solved by the use of their products. The advertising often includes a picture of a baby or rather exaggerated claims with many scientific inaccuracies and errors, such as the following examples:

"... combined with a scientifically formulated non-toxic ionic silver additive to deliver an antibacterial paint that prevents and kills bacteria, mould, mildew and fungus growing on painted surfaces. PaintPRO® significantly minimises the spread of disease and infection including antibiotic-resistant 'Super Bugs' like MRSA, *Salmonella*, *E. coli* and others.

"PaintPRO® kills bacteria on contact and prevents odours and bacteria from infecting work, living, recreational, medical, care, dining, hospitals, restaurants.

"We have full independent laboratory testing (JIS Z 2801:2000) certificates which indicate that DrainPRO® and PaintPRO® will kill common bacterial like MRSA, *E. coli*, *Salmonella* and Aspergillus (99.995% certified)[2]."

"Our amazing silver ion technology works by sterilising the toxins generated all around us, by materials we come into contact with every day, toxins generated from reinforced concrete, veneer board, wallpaper, adhesives and all types of other materials.

"It is completely safe to use and will actually make your environment cleaner and toxin free like a breath of fresh air on a lovely spring morning, helping you to feel healthier and refreshed. Due to its special silver ion technology, it creates an extra ordinary hygienic wall surface, which is 10,000 times more efficient against bacteria, microbes, algae's and fungus. Our anti-bacterial paint neutralises these toxins to give you clean, toxin free surfaces, it will inhibit commonly known bacteria such as *E. coli, Staphylococcus aureus, Aspergillus niger* and many, many others. The silver ions will start to act as soon as they come into contact with the bacteria on the wall, even after they have sterilised the bacteria, the ions will stay there forever[3]."

Figure 2. Advertisement for antimicrobial paint.

As well as walls and furniture, laboratory equipment is also available coated with antimicrobial paint. One study claims that antimicrobial-coated bench top equipment harbour 96.6% fewer microbes than standard lab equipment: "Contaminated testing can lead to anomalies in data results and the need for re-testing, consequentially delaying research schedules, increasing lab costs and damaging the integrity of the lab. Contamination can also cause illness of laboratory staff[4]."

Testing

There are a number of test methods used for determining the effectiveness of antimicrobial paint. The simplest and often used test method is a zone of inhibition test. This method is used with the claim that the larger the clear zone, the greater the antimicrobial effectiveness of the test paint. However, the size of the zone is dependant on both the efficacy of the biocide but also on the water solubility of the biocide as this will determine the concentration that will leach into and through the agar and impact on the zone size. In fact a bigger zone may indicate a shorter period of protection as the biocide will be lost from the surface at a much faster rate.

Two Japanese standards were developed for testing textiles and plastics for antimicrobial activity. The plastics test method, JIS Z 2801:2000, is also used for testing paint films. It has now been converted to an ISO standard ISO22196:2007 Plastics – Measurement of antibacterial activity on plastics surfaces, and is considered the most appropriate method to test antimicrobial paints. The method requires that a defined number of organisms are placed onto the paint film, a plastic overlay is placed over

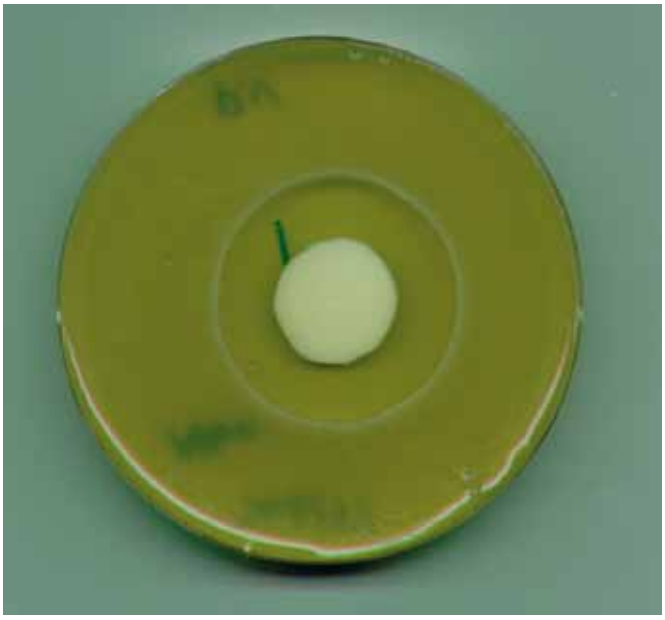


Figure 3. Zone of inhibition assay.

the film to maintain moisture, and surviving organisms are enumerated 24 hours later. The original Japanese standard required a 2-log reduction, while the ISO standard does not define a required reduction.

Zone of inhibition assays only really measure inhibition, so give no indication if the coating will kill organisms that land on the film. It is usual to be able to isolate surviving organisms from within the zone of inhibition and even from the test piece at the completion of the test. The Japanese/ISO standards allow 24 hours' contact under moist conditions for the biocide in the surface to kill the inoculated bacteria. Neither method give any indication that pathogenic organisms placed onto a surface will be killed before they can transfer to the next person touching the surface.

Problems

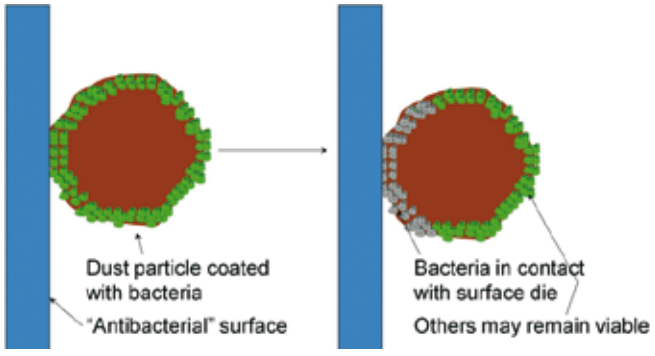
There are some concerns with the use of antimicrobial paints. They may give a false sense of security resulting in less frequent or less thorough cleaning. Organic matter, such as food or body fluids, on the surface may protect bacteria by stopping the biocide from reaching the microbial cells and protect them from injury or death. They may also protect the bacteria from very low concentrations of biocide that may migrate from the coating.

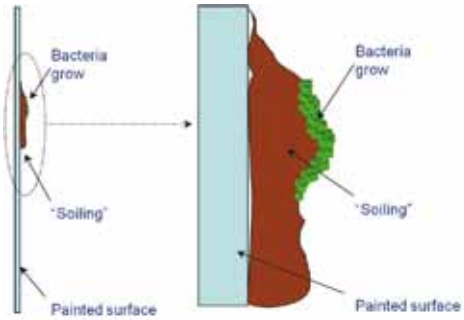
There needs to be contact between the biocide active and the microbial cell for there to be any effect on the cell. Traditional belief is that this would require migration of the biocide from the coating into the microbial cell, usually with moisture present to allow the movement of the biocide. Several suppliers of paint film biocides liken the action of their products on bacterial cells to a balloon landing on a rose thorn, piercing the cell and causing death, resulting in no loss from the coating and no toxicity to humans. Another product claims that the biocide sits on the surface like rows of outward-facing swords that pierce any cells coming into contact, the cell is then electrocuted and blown apart[5].

It is essential that any soiling (food, body fluids, faeces) is cleaned from the surface and the surface treated with disinfectant to ensure any bacteria contained in the soiling are removed and killed. There is also the real concern that increased use of antimicrobial substances may hasten the development of tolerant or resistant organisms which will be harder to kill in areas where their presence is a hazard to health.

Regulations

Antimicrobial products in Australia are currently regulated by the APVMA or the TGA. The APVMA has determined that antimicrobial





paints and other objects marketed to households are exempt from their regulatory control as they fit the description of household disinfectants and are therefore controlled by the TGA (personal communication). The TGA has advised that household surface building materials with antibacterial claims, such as paints and kitchen cupboard laminates, are not therapeutic goods. These products are considered to be for 'environmental control' and are covered by the Therapeutic Goods (Excluded Goods) Order No. 1 of 2005 item 2.k (2.k sanitation, environmental control or environmental detoxification equipment) (personal communication). However, the use of these products in hospitals is not exempted by either regulator and approval may be required for their use. Labelling or advertising claims for an antimicrobial paint may also make it liable to regulatory control.

Conclusion

Antimicrobial paint can play a part in the overall hygiene planning for health facilities, commercial buildings and households. Their use will result in lower numbers of microbes on painted surfaces but it is doubtful they play an important role in reducing the spread of infection. The use of antimicrobial paint must be seen as an adjunct to usual hygiene practices and not a replacement.

Acknowledgement

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Biography

Kevin Roden is the Regional Technical Manager Asia Pacific, responsible for technical support to the Thor Specialties operating companies in the Asia-Pacific region. Kevin was employed in 1991 by Thor Specialties Limited in the position of Technical Services Manager and established a NATA-accredited Microbiological Testing Laboratory for evaluating the performance of biocides in industrial and personal care products.