

compounding WORLD

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ANTIMICROBIALS BATTLE BACTERIA

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Banishing the bugs

Antimicrobial additives compounded into plastics are used to prevent the growth of microbes, such as fungus, bacteria or algae. Although large volumes of biocides still go into protecting flexible PVC in a range of applications from shower curtains to roof membranes, many of the new products in the market are focused on creating “hygienic surfaces” on a wide range of polymers used in everything from medical devices to cutting boards.

Demand for such antimicrobial protection continues to grow, and ongoing research points to the effectiveness of antimicrobials embedded in plastics. However, companies must be careful to stay within the appropriate regulations for marketing claims on consumer and healthcare applications.

Healthcare applications

Antimicrobials are playing an increasing role in healthcare facilities and medical devices, where the problem of hospital-acquired infections (HAIs) and antibiotic-resistant pathogens, such as MRSA and CRE, is ongoing. Early in 2015, for example, an outbreak of CRE in a California hospital was traced to specialized endoscopes that were contaminated even though they had been disinfected according to manufacturer’s standards, indicating a need for further layers of protection. Another problem area is high-touch surfaces, such as hospital bedrails, which are difficult to keep clean because of frequent use.

Lise Moloney, director of business development for healthcare at **Sciessent**, which supplies Agion silver-

Jennifer Markarian examines recent developments in antimicrobial additives for plastics used in a variety of applications from medical devices to consumer goods

based antimicrobial technology, says: “A multifaceted approach to combating antibiotic-resistant infections, including surface cleaning, hand washing and several other strategies, is required. Yet as a means to limit the population of microorganisms between cleaning, surfaces containing silver antimicrobials could be used on bedrails, door handles, mobile diagnostic equipment and other high-touch surfaces that are close to susceptible patients.”

High-touch surfaces might be cleaned once a day or more with disinfectants, but the surface is quickly repopulated with bacteria, adds Ivan Ong, vice-president of research and development at **Microban**.

“Normal disinfection practices are limited, and this situation calls for intrinsic, built-in protection that can be an effective complement to disinfection practices.” Although there are some current uses of antimicrobial surfaces, the healthcare area is open to further development, says Ong.

Much focus is on silver-based antimicrobials, which



Parx Plastics' Sanipolymer technology is being employed to make a WPC building material resistant to bacteria

have a good safety profile and can be used in high-temperature polymers. Microban recently introduced a next-generation SilverShield additive technology, which is one of many in the SilverShield family. "This technology provides quick-kill against bacteria, with kill speeds approaching disinfectants. The additional advantage is that by embedding these additives into the polymer, there is long-term microbial control," explains Ong. The technology has been in development for more than three years, and Microban has conducted extensive research, particularly in food and medical applications, as well as its core consumer product area.

In addition to silver, antimicrobial technologies using copper, zinc, and quaternary ammonium salts are being considered. **QTek's** new, patent-pending Surfion copper-based antimicrobial additive, for example, is a mineral powder that releases ionic copper via a diffusion mechanism to restrict reproduction of microbes on the surface of a plastic part.

The additive is effective against bacteria and fungi, and is cost-effective compared to other antimicrobials, says the company. It does not affect polymer mechanical properties, and can be used to partially replace inorganic pigments and fillers. Surfion has been tested in several polymers, and has no processing temperature limits. The additive is available as a powder and in a masterbatch form from QTek's pilot plant. QTek is in the process of registering with the EPA and expects to soon build a commercial-size production line at its Michigan facility.

Parx Plastics says its Sanipolymer technology, which is based on elemental zinc, has been demonstrated to

make a wood-plastic composite (WPC) building material resistant to bacteria. The WPC can be used, for example, to make walls for semi-permanent hospitals in disaster-relief efforts. Antimicrobial tests on the surface of the wood fibre composite were performed by the University of Ferrara, Italy, using ISO 22196 with *Staphylococcus Aureus* (gram+) and *Escherichia Coli* (E. Coli, gram-). They produced a result of 95.73% based on ISO 22196, which is defined as the difference in the logarithm of the viable cell counts found on an antibacterial-treated product and an untreated product after inoculation with and incubation of bacteria.

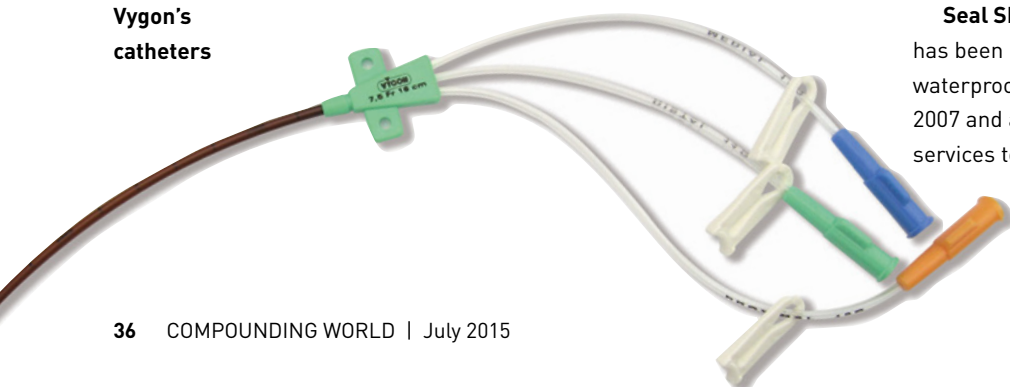
Gelest supplies its Biosafe HM4100 condensed silane quaternary ammonium salt as an active ingredient in the form of a dry powder. It says that the additive is being used commercially in the healthcare, medical device, and food and water markets as an alternative to silver-based antimicrobials.

"We are aggressively pursuing regulatory approval for and expect to have several food and water contact products on the market within the next 12-18 months," says Donald Wagner, technical marketing manager at Gelest, which licensed the Biosafe technology in January 2014.

Time, temperature, and the presence of oxygen should be considered in processing the product. "Biosafe can break down if held at temperature for long periods of time or if temperatures exceed its thermal stability [such as in 'post cure' of moulded silicone parts at 400°F (200°C) in air]. On the other hand, injection moulded TPU and PA6 work well with Biosafe HM4100," explains Wagner.

Seal Shield, which is registered with the US EPA, has been producing antimicrobial products, such as waterproof keyboards, for healthcare markets since 2007 and also provides antimicrobial consulting services to product designers. In January, 2015, the company announced that its Seal Shield solution is available as a liquid, powder, or masterbatch that can be used in various

Sciessent's study of medical-grade plastics with silver-based antimicrobials included Vygon's catheters



Specimens tested		Staphylococcus aureus (CECT240, A TCC 6538P)		Escherichia coli (CECT 516, A TCC8739)		Aspergillus niger (CECT2807, A TCC 6275)	
		R	Effectiveness	R	Effectiveness	R	Effectiveness
Test A	Nano technology antibacterial	3.13	99.93%	5.67	100%	2.03	99.06%
Test B	BA-950 Pellet 10% 100% Natural antimicrobial	4.69	100%	5.67	100%	2.03	99.06%
Test C	Benzisothiazolinone at 20%	4.69	100%	5.50	100%	2.03	99.06%
Test D	Blank	2.53	99.70%	2.25	99.43%	0.35	55.17%
Test E	Silver base	3.59	99.97%	5.50	100%	2.03	99.06%

Test results based on JIS Z2801 for PE water tanks made by rotational moulding. First Quality Chemicals' citrus-based additive is Test B. R is a value of antimicrobial activity; if $R \geq 2.0$, the specimen is considered to present bactericidal properties.

Growing applications in this region include compounds for water tanks and filters, medical applications, and food packaging. Compounders in Mexico and Latin America are selling in these regions and also exporting directly or indirectly to the US and other countries around the world, which is one of the reasons they are looking for alternatives, explains Arellano. "Up to now, I believe that some compounders haven't operated in these markets because they haven't found the right biocide solution, but this is beginning to change."

First Quality Chemicals recently introduced a broad-spectrum antimicrobial based on a natural compound derived from citrus. For plastics compounding, the product is available as a powder in a silica carrier with 50% active ingredient, or as a 5 or 10% masterbatch in a range of polymer carriers. The product can be used as a broad-spectrum antiseptic, antibacterial, or antifungal. It also has antioxidant properties. The antimicrobial can resist temperatures up to 400°C. "It doesn't affect the appearance of the final product, unlike other solutions which can cause spotting," says Arellano. "Our products can be used in transparent applications, which have proven to be a difficult hurdle for the majority of biocides."

The citrus-based antimicrobial was tested in rotomoulded polyethylene water tanks and found to have better results than competing antimicrobials (see table). The product is being used in Mexico and Latin America and is being tested in the USA, where it is qualified as a minimum-risk pesticide (under the criteria for FIFRA 25(b) exemption).

Processing antimicrobials

Antimicrobial additives are widely used by moulders as masterbatches, says Microban's Ong, which is beneficial because some antimicrobials have safety concerns when handling the powdered additive. Isothiazalones, for example, can be sensitizers. In addition, it is easier for plastic processors to achieve accurate, low dosage

levels using a masterbatch. "Compounders must be careful not to deteriorate the antimicrobial during processing, with careful attention to temperature and equipment parameters," says Ong.

More information

Ivan Ong, vice-president of research and development at Microban, will discuss developments in antimicrobial additives at our forthcoming **Compounding World Asia** conference in Singapore and at the **Compounding World Forum** in the USA. His presentations will include guidance on additive selection, recent case studies and provide a regulatory update.

The Compounding World Asia conference takes place in Singapore on 6-8 October 2015. The full line-up of speakers and booking details can be found at <http://bit.ly/CWAsia15>. Book before 4 September to save US\$130.

The Compounding World Forum returns to Philadelphia, PA, USA on 8-9 December 2015. The conference brochure with the complete programme has just been published at <http://bit.ly/CWF15P>.

Click on the links for more information:

- | www.americhem.com
- | www.Biosafe.com (Gelest)
- | www.compoundingsolutions.net
- | www.firstqualitychemicals.com
- | www.heiq.com
- | www.janssenpmp.com
- | www.lawbc.com (Bergeson & Campbell)
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- | www.polyone.com
- | www.rasmaterials.com
- | www.qtekllc.com
- | www.sciessent.com
- | www.sealshield.com

Speakers lined up for the second day of the Compounding World Asia 2015 conference include (from left to right): Dr Wenyu Shang; Rich Weber; Dr Ivan Ong; Dr Jonson Xing; and Jonathan Wee Zi-Ding



than steel by weight, efficiently conducts electricity and heat, and is nearly transparent.

Cabot has been busy developing graphene technology since it signed key license agreements with XG Sciences in 2011. The presentation by Dr Kyrilidis will be a rare opportunity to hear first-hand about the progress that the company has made in harnessing the unique properties of graphene for practical applications in plastics.

Another highlight of the Compounding World Asia 2105 programme is the presentation by **Dr Wenyu Shang**, who is global director of technology, colour and additives at **PolyOne**. He will discuss a range of exciting developments that PolyOne is working on, including 3D printing materials, intelligent packaging and anti-counterfeiting solutions.

Dr Shang is based in Shanghai, China, where PolyOne recently opened its new Asia Innovation Center, underlying the global compounder's commitment to the Asian market.

The future of bioplastics in Asia will be the theme of a presentation by **Rich Weber** who is Asia Pacific commercial director at **NatureWorks**. He will also discuss how compounders can open up new higher value applications and markets for PLA by enhancing the resin's properties and processability.

NatureWorks is the world's leading producer of PLA bioplastics. Following a major investment by Thailand's PTT Global Chemical in 2011, the company has announced that it intends to build an Asian production facility to complement its existing large-scale plant in the USA.

Antimicrobial additives are covered regularly in *Compounding World* magazine (including a special feature in this edition), and always attract substantial interest from our readers. The latest developments in this exciting field will be presented in Singapore by **Dr Ivan Ong**, vice president, research and development at **Microban International**.

He will cover the selection of antimicrobial additives for plastics, as well as providing some application case studies and a regulatory update. Microban is a leading global player in antimicrobial solutions, working with more than 20 different active ingredients in a wide range of polymer types, so Dr Ong is well positioned to discuss developments in this field.

His presentation will be followed by a talk on flame retardant engineering plastics by **Dr Jonson Xing** who is global marketing manager for electrical and electronics applications at **Solvay Engineering Plastics**, and is based in China. In particular, Dr Xing is going to focus on the development of safe and sustainable flame retardant compounds for the Asian market.

The final paper on second day of the conference will be delivered by **Jonathan Wee Zi-Ding**, who is the Singapore-based Vistamaxx business planner for **ExxonMobil Asia Pacific**. He will discuss how metallocene-catalysed propylene-based elastomers can be used to modify the properties of thermoplastic compounds. The talk will include case studies showing how Vistamaxx can be used to improve the impact strength, flexibility and durability of polypropylene, while maintaining or improving clarity.

More information

The **Compounding World Asia 2015** conference is organised by AMI and *Compounding World* magazine, and it is sponsored by Steer and Coperion. In addition to the high-level conference sessions, the event will feature an exhibition area that will be used for networking during the refreshment breaks, lunches and the evening cocktail reception (please note that the exhibition will only be open to conference delegates and speakers).

The conference venue is the Grand Copthorne Waterfront hotel, located in the heart of Singapore. It is well positioned to take advantage of all that this modern cosmopolitan city-state has to offer, including excellent business, dining, sightseeing, entertainment and shopping opportunities.

For more information about participating in the Compounding World Congress as a delegate, exhibitor or sponsor, please contact the conference organiser Giulia Esposito at ge@amiplastics.com, tel: +44 (0)117 314 8111. You can also view the complete conference programme along with booking details at: <http://bit.ly/CWAsia15>

