National Biofilms Innovation Centre

Biofilms & barrier technologies

The future of commercial cleaning

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Trauma Team | Rapid Response | PHC Cleaning Team
Contract & Deep Cleaning Team | High-Level Team

REACT Specialist Cleaning

Introduction

Biofilms are everywhere.

They form in all environments, pose health risks to humans and animals, and can damage buildings.

They're also difficult to remove and prevent using conventional cleaning products, which means the commercial cleaning sector must find new ways to keep workspaces and other public places safe.

In this report, REACT, with support from the National Biofilms Innovation Centre (NBIC), will explore the challenges and risks posed by biofilms and the potential of new 'barrier technologies' to overcome them.

REACT Specialist Cleaning

REACT is a specialist cleaning services provider that goes beyond everyday cleaning to tackle problems that non-specialists can't cope with. The company works in a vast range of environments, from hotels to prisons, crime scenes to cruise ships and public spaces to private hospitals.

Innovation is a huge part of what separates REACT from its competition; its expert team works using the latest techniques and technologies to get the best results for its clients with minimal environmental impact.

National Biofilms Innovation Centre

The National Biofilms Innovation Centre is an Innovation Knowledge Centre (IKC) funded by the Biotechnology and Biological Sciences Research Council (BBSRC) and Innovate UK.

Its mission is to establish a network of research and innovation capacity catalysing collaboration with industry in the study of biofilms to achieve breakthrough innovation.

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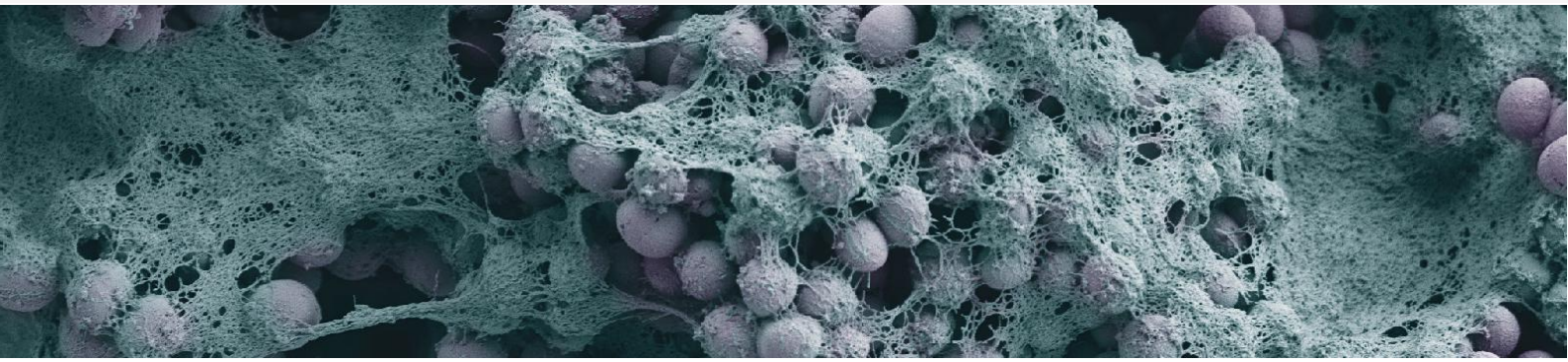
1 | Introducing biofilms

Biofilms are immobile communities of micro-organisms that stick to each other and to surfaces.

They form when free-floating bacteria attach and adhere to surfaces in response to environmental cues such as changes in pH and nutrient concentration. Biofilms mature to colonise surfaces as attached micro-organisms multiply and recruit new members, and they all become embedded in an extracellular, slime-like substance consisting of DNA, polysaccharides and proteins.



2 | Biofilms form everywhere

Almost all bacteria found in homes and workplaces will form biofilms if given enough time and very few surface types are safe. Biofilms even form on and inside humans and animals, and in inhospitable conditions.

Biofilms are challenging to control because, unlike unbound bacteria of the same species, they are resilient to antimicrobials like many cleaning products, antibiotics and pesticides, as these cannot penetrate the outer film layer to reach and kill the bound bacteria inside.

3 | The dangers of biofilms

Biofilms present health risks to humans and animals, largely because they offer refuge for potentially pathogenic bacteria, viruses (including COVID-19) and fungi. Without the right care they can create food safety issues, contaminate water supplies and ultimately cause harmful infections.

Away from health, biofilms can physically damage surfaces by causing discolouration and corrosion, potentially limiting building lifespans and negatively impacting appearance.

Let's be clear: biofilms aren't all bad. They're used extensively in the treatment of industrial waste and wastewater, and biotech researchers continue to find new ways of harnessing their unique characteristics. However, controlling biofilms in workplaces and public spaces is vital to maintain cleanliness and, in turn, restrict the spread of infectious diseases.

This is where barrier technologies have huge potential.

*Biofilms of S. epidermidis growing on a stainless steel surface showing the extracellular matrix.
Image by Julie Fletcher and Christian Hacker, Bioimaging Centre at the University of Exeter.

4 | Tackling biofilms with barrier technologies

Given their biocidal resilience, biofilms are difficult to remove using conventional cleaning products. Most of these products - even many that claim to 'kill 99.9% of germs' - will leave harmful bacteria behind after application. This means we must consider other ways to protect environments and the people within them.

"When biofilms (communities of microorganisms) form they can behave and be more tolerant to the action of cleaning products. This is not always assessed in standard tests and we need more specific testing against biofilms to demonstrate efficacy, along with using realistic experimental conditions.

Additionally, biofilms are often composed of a mix of species and are surrounded by a self-produced matrix; both factors can impact cleaning activity."

Dr.Sandra Wilks - Associate Professor of Health Sciences & Biological Sciences,

University of Southampton

A more effective treatment against biofilms is to make surfaces themselves antimicrobial to prevent bacteria from colonising in the first place. Products that do this are known as barrier technologies – or simply 'barrier tech' – and there are two main types.

Antimicrobial activity can be achieved either by:

- Applying a coating that contains microbial materials, such as biocides, copper or silver, to an existing surface; or
- Creating a new surface that prevents colonisation by having a structural make-up that ruptures cells or makes it physically difficult for bacteria to adhere.

Both types of barrier technologies are already commonplace in healthcare settings and medical devices, but their use in workplaces and public spaces, such as buses and trains, is growing.

In 2019, the UK market for antimicrobial surfaces was estimated to be worth £181million.

Both types of barrier tech have huge potential as each can be applied in different circumstances. New buildings that are constructed with biofilms in mind, using new antimicrobial surfaces, will be safer and easier to maintain, while coatings can be applied to achieve the same benefits in existing spaces.

*False-coloured mesoscopic image of two adjacent Escherichia coli biofilms.
Image by Liam Rooney, Strathclyde Insititute for Pharmacy and Biomedical Sciences, University of Strathclyde

5 | Barrier technology: 3 real-life examples

Citrox Biosciences - Citrox Protect Hard Surface Sealant

Citrox Protect Hard Surface Sealant can be used to clean, seal and protect all hard surfaces and touchpoints, offering ongoing protection against the spread of bacteria and viruses such as COVID-19.

The product works in two stages. First, silicon dioxide forms a natural barrier to coat the surface, which prevents bacteria and viruses from being able to bind to it. Second, Citrox, a natural, sustainable Bioflavonoid complex encapsulated in the surface sealant, kills any viruses or bacteria that land on the surface, protecting anyone who comes into contact with it. The Citrox bioflavonoid complex has been proven to break down any biofilm present, as well as preventing biofilm build-up due to its ability to inhibit quorum sensing between microbes.

Citrox Protect Hard Surface sealant is applied by biotechnicians during the cleaning and disinfection process, is touch-dry within minutes, fully sealed in 24 hours and provides antimicrobial protection for up to six months.

The Decontaminator - FTP Wraps n'Pads (working name)

FTP Wraps n'Pads add a layer of infection prevention to break the chain of hand-mediated transmission on surfaces such as door handles - hence the name FTP, which stands for "frequent touchpoint". They are built with antimicrobial chemicals and certified under ISO 22196 to achieve a reduction of bacteria, viruses, fungi and parasites at 99.99%.

Whilst antimicrobial products typically incorporate silver agents, this product utilises zinc pyrithione as its active ingredient and it is encapsulated within the film rather than manifesting as a simple coating on top of the film. As a result, the antimicrobial effect is stable and lasts for up to three years.

Jangro - ntrl

Jangro describes its ntrl (pronounced 'natural') range as "The next generation of cleaning products with the environment in mind". The line's 13 products use biology-based technology to deliver "next-level performance" and health benefits for people and the planet.

Specifically, the range's Washroom Cleaner and Multi-Surface Cleaner contain probiotics that, rather than killing germs with harmful chemicals, colonise surfaces to reduce the presence of harmful bacteria. This barrier solution also continues to work once the surface has been cleaned, for long-term benefits.

REACT Specialist Cleaning is a proud user of the NTRL range - supplied to us by Avica UK - part of the Jangro Group.

6 | Barrier technology: the challenges

Despite its significant potential, barrier technology isn't a flawless solution to the biofilms problem. There are still challenges for cleaning companies and building/FM managers to overcome.

- **Conditioning films**

Antimicrobial surfaces may still require regular attention to prevent what are known as conditioning films, or conditioning layers.

These are layers formed from the remains of cells that have been destroyed by the surface or its coating. If a new layer of these dead cells becomes established on the surface, living cells can avoid touching the barrier tech and still colonise.

- **A lack of regulation**

The regulatory environment for biofilms is not yet fully representative, so there's no standardised procedure for testing the effectiveness of barrier technologies against biofilms. This means any company developing or bringing new antimicrobial products to the market must commission its own tests at an accredited laboratory or university.

- **Limited applications**

Barrier technologies work most effectively on hard surfaces and are less effective - or sometimes not effective at all - on fabrics and other more pliable materials.

Even when using biocide technologies that can work on fabric, achieving adequate coverage on a surface that is flexible, porous and more likely to move can be difficult. There is a sizeable market for antimicrobial fabrics, however. Right now this is more focused on clothing, with antimicrobial sportswear and medical garments both widely available, but interest is growing among public transport operators.

7 | A final word of advice from REACT

All barrier technologies work differently and as the market evolves we'll undoubtedly see even more variation between products. However, there are a couple of general guidelines to follow when using these types of products:

- Always ensure credibility of the products with evidence of scientific research and empirical data demonstrating testing regulation and independent testing results.
- Follow manufacturers' guidelines with any subsequent cleaning to ensure the products you use and the frequency with which you use them don't compromise the protective surface.
- Ensure any risk assessment and method statements are current and available.
- Train operatives and apply best practice, process, and methodology for effective cleaning.
- Follow the 'clean to dirty' pathfrom the cleanest to the dirtiest areas to minimise the risk of cross contamination.
- Always ensure the surface is free of debris and dust free prior to application to give the product a clean surface for application.
- Follow colour coding guidelines to ensure there is no risk of cross contamination.

National Biofilms Innovation Centre

React & NBIC

Working in Partnership

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*Hydrophobicity of B. subtilis is shown by the addition of coloured water drops onto the biofilm.
Cover Images by Maria Paula Huertas Caycedo.

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