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# Antimicrobial Protection for Touch Surfaces to Reduce Hospital Associated Infections

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[4]Liverpool University Hospital Foundation Trust, Liverpool, United Kingdom

Touch surfaces play a crucial role in the transmission of bacteria and pathogens, especially in hospital and healthcare settings. There are many pathogens which are commonly found in patient wards and public areas throughout hospitals that lead to Hospital Associated Infections (HAI) which can have a devastating effect on the physical, mental, and financial health of a patient. In addition to this, HAIs cost the healthcare system billions of dollars a year in added expenditure. Furthermore, it has been found that a growing number of the pathogens detected have become resistant to the antimicrobial medications typically used to control them.

This work presents novel magnetron sputtered coatings have been developed with very high levels of biocidal efficacy. Sputtered antimicrobial surfaces have been produced in industrial PVD systems, including box coaters and Roll-to-Roll machines. 2D and 3D components were coated, as well as transparent flexible films. The surfaces have been deployed in the Royal Liverpool University Hospital in the United Kingdom. Flexible films were adhered to patient self-check in kiosks, and push pads and handles were installed throughout busy wards. This paper presents results from standard antimicrobial tests conducted over a 24-hour period, and long term data acquired during the regular monitoring of the surfaces.

**https://www.svc.org** **DOI: https://doi.org/10.14332/svc24.proc.0065**

GENCOA

TechCon 2024 Chicago

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# Outline

- Introduction: ESKAPE(e) Pathogens & Hospital Associated Infections
- Gencoa's iCnano Technology
- Development of Material and Deposition
- Surface Characterisation
- Standard Antibacterial Results from Liverpool School of Tropical Medicine
- *In situ* long term testing by Liverpool School of Tropical Medicine
- Summary and Conclusions

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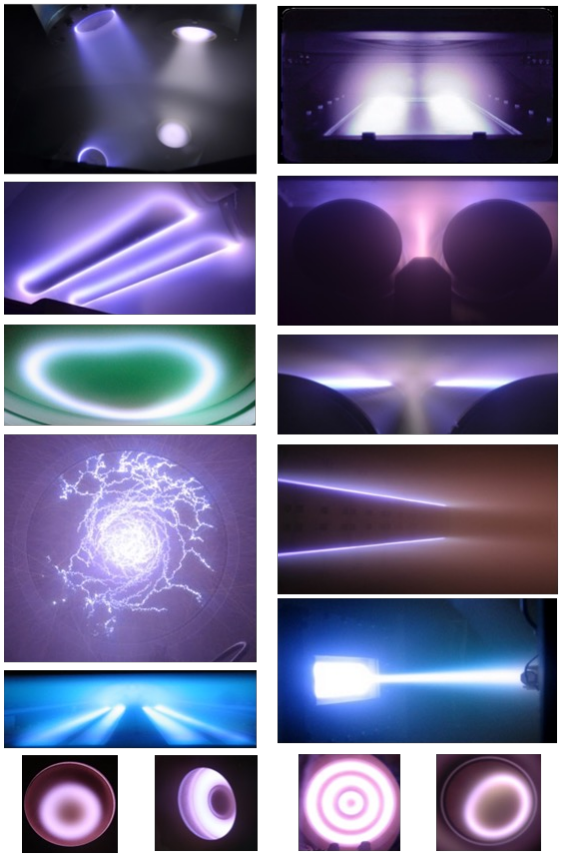
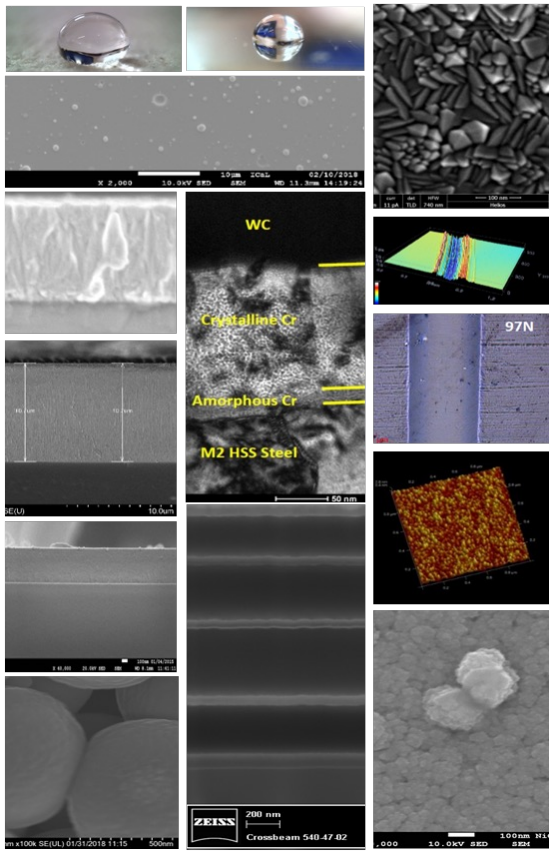
# 28 Years of Products and Technology from Gencoa

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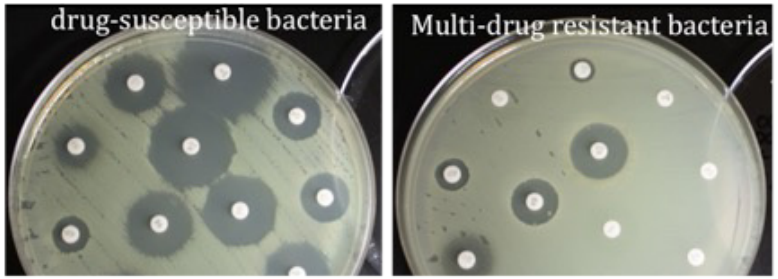
# Introduction

- It is estimated that there are at least **100,000 cases of hospital acquired infections (HAI) in England each year**.
- In American hospitals alone, the Centres for Disease Control (CDC) estimates that HAIs account for an estimated 1.7 million infections and 99,000 associated deaths each year.
- **HAIs cost the healthcare system billions of dollars** a year in added expenditure.
- Furthermore, it has been found that a growing number of the pathogens detected have **become resistant to the antimicrobial medications** typically used to control them.


https://e-gis.no/ru/what-are-nosocomial-infections/




**Testing the resistance of microbes in the lab.** These Petri dishes contain lawns of bacteria (cre my yellow) cultured from two different clinical samples. The white discs each contain different a tibiotics. Where clear zones appear a ound the d scs, bacterial growth has been prevented by the antibiotic. This image has been provided courtesy of Dr. Manfred Brigl and Esperanza Aibano of the Clinical Microbiology Laboratory at the Brigham and Women's Hospital, Boston.

https://sitn.hms.harvard.edu/flash/2011/issue103/

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# Hospital Associated Infections – ESKAPE(e) Pathogens

- **ESKAPE(e)** pathogens can exacerbate existing or underlying conditions, delay recovery and adversely affect quality of life.

- In 2007, methicillin-resistant *Staphylococcus aureus* (MRSA) bloodstream infections and *Clostridium difficile* infections were recorded as the underlying cause of approximately **9,000 deaths** in hospital and primary care in England. **MRSA** causes more the **80,000 infections** and more than **11,000 deaths** annually in the United States.

- These harmful infections can be contracted through invasive surgical devices such as catheters, however, a large percentage of HAI's are transmissible through **touch surfaces** throughout healthcare settings.


https://cloverbiosoft.com/the-eskape-bacteria-group-and-its-clinical-importance/

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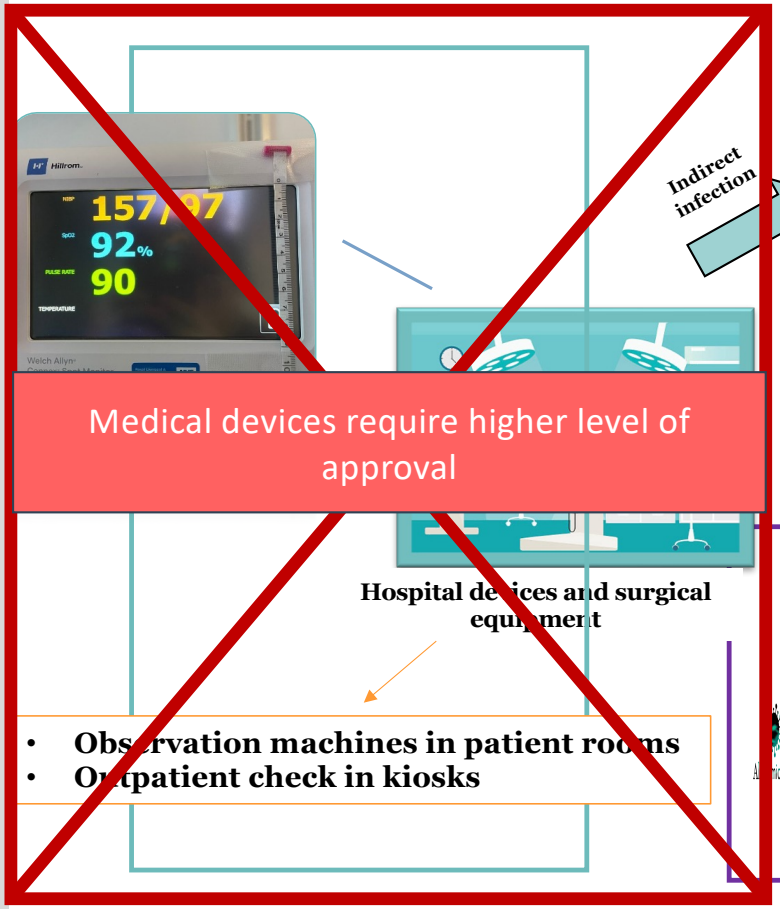
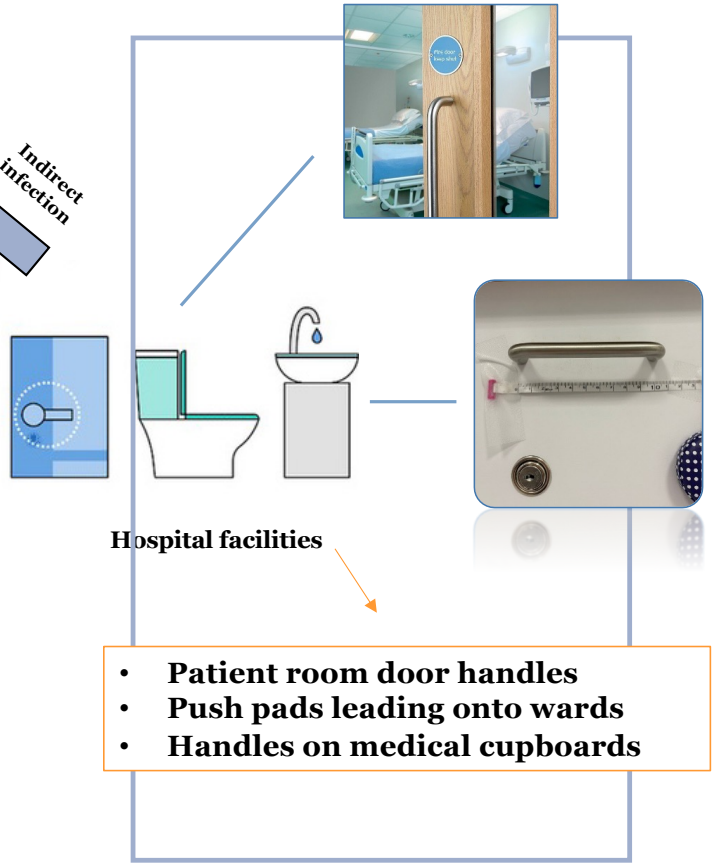
# Antimicrobial Protection in Healthcare Settings



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# Antimicrobial Protection to Reduce HAI's

AIM - To develop a highly biocidal coating by sputtering in industrial PVD systems, including box coaters and Roll-to-Roll machines. These coatings can be applied to door handles/3D parts and flexible thin plastic films which will be adhered to high touch areas and surfaces throughout a healthcare setting.



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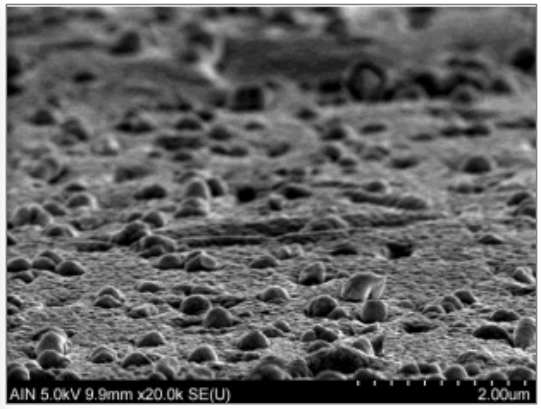
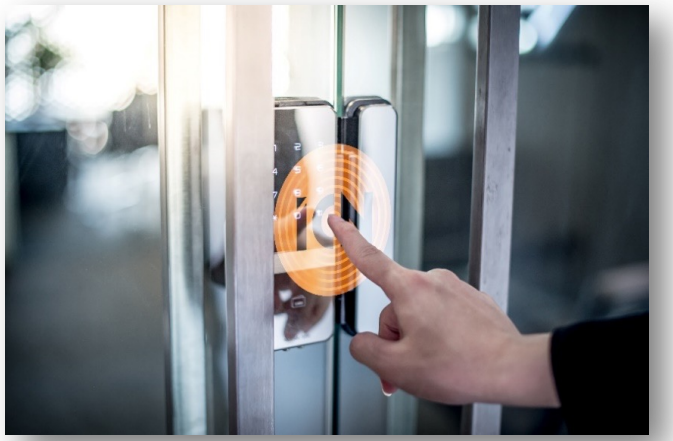
# Gencoa's iC-nano Protection

## Infection control via nanotechnology

- Gencoa has patented nano-structured coatings for antimicrobial and antiviral applications.
- The layers are opaque, transparent or semi-transparent with varying hardness levels and with killing efficiencies of 99.9999% under standard testing conditions. The coatings are effective in both dark and light environments.



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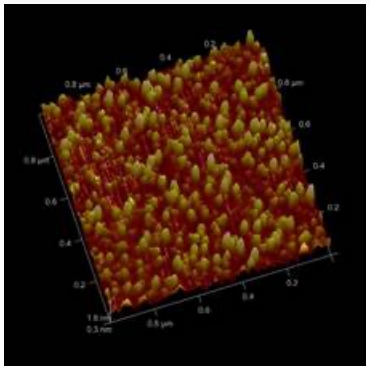
# Reactive Sputtering Deposition



**Sputtering can create very thin copper-based layers, but also can enhance the performance by using nano-morphology**

- Surface morphological features of the order of 10-40nm size have been shown to greatly enhance the antimicrobial performance.

**Copper and a wide range of its alloys are the only antimicrobial metal that the US Environmental Protection Agency has approved.**

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# Deposition Set-up

Step 1

**High Vacuum**

Background ~·$10^{-6}$ mbar


Step 2

**Substrate cleaning**

Ion Source **IM300**
Used for coating adhesion

Step 3

**Active Coating**

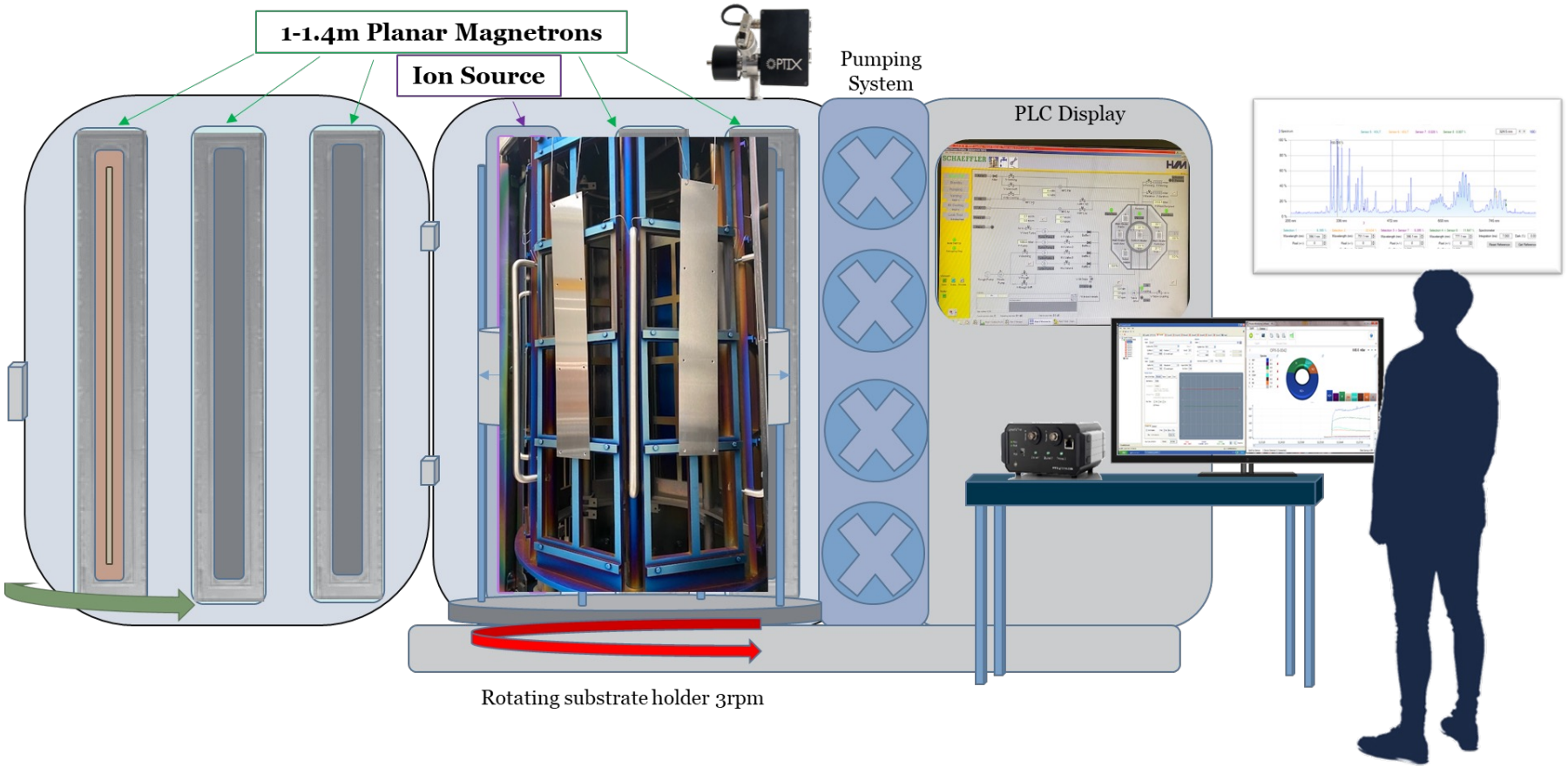
Gencoa Magnetron
Process Gas
Reactive Gas


Step 4

**Feedback Control**

OPTIX
Speedflo
Fibre Optic

# Deposition Chamber

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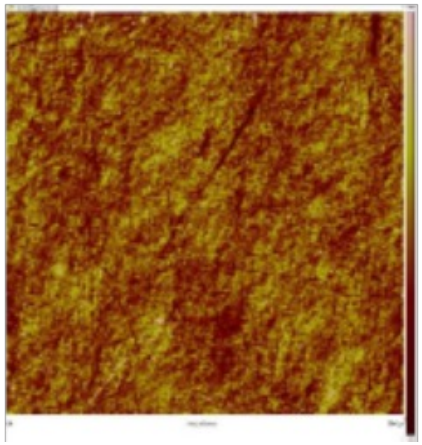
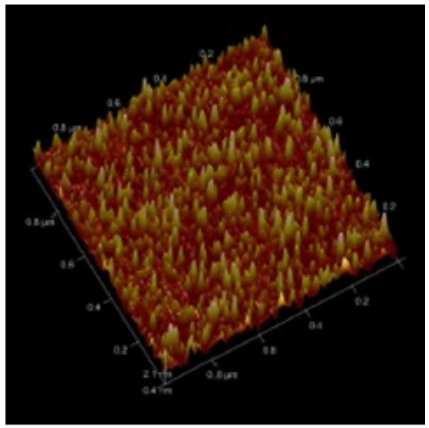
# Substrate Cleaning

- Improves adhesion of the antimicrobial coating
- Removes organics from substrate surface
- Has the means to liberate moisture and burn-off hydrocarbons before the sputtering process

## Importance of Pre-treatment and surface preparation



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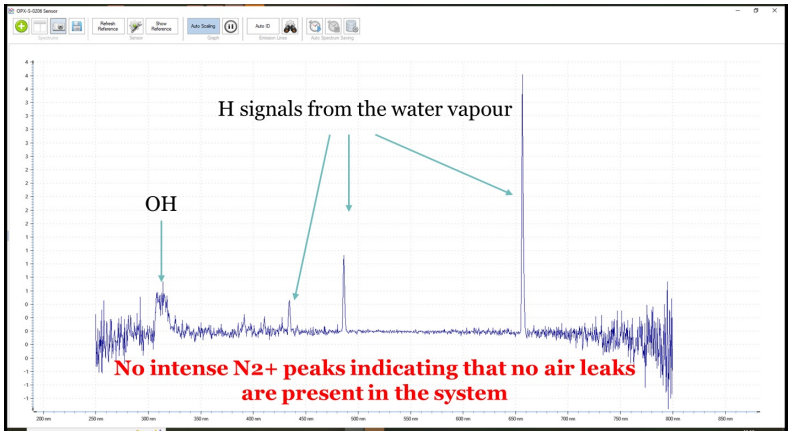
# Control Options by Gencoa

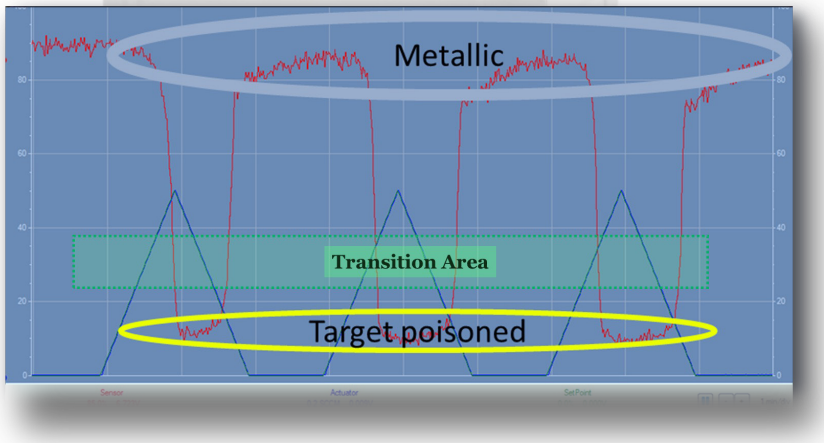
## Optix

The Optix can measure the real time partial pressures of the gas composition in the chamber.


## Speedflo mini


**2 sensor inputs**
– Target Voltage
- Partial pressure of $O_2$

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# Scale up for Production : Roll-to-Roll

The coating technology is currently being scaled up to Roll-to-Roll process to result in a larger volume throughput for commercial use.

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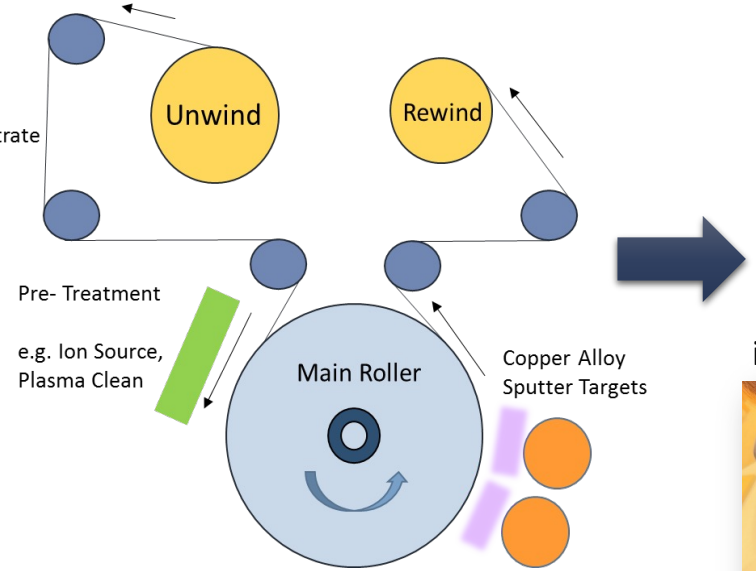


Self-adhere thin film

iPad/mobile screens protectors

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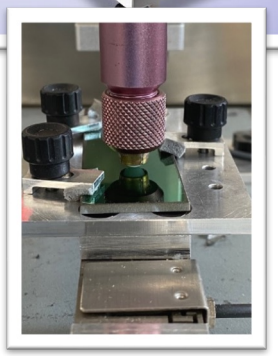
# Surface Characterisation

- Copper has **extremely good antimicrobial** properties but can sometimes fail when it comes to **mechanical properties such as wear and scratch resistance**.
- ***AIM –*** To produce a film that maintains the LOG5 antimicrobial efficacy as well as increasing the mechanical properties.

- A  Delrin ball was used to simulate the wear on the handle by skin/touch.
- A tungsten carbide ball was used to simulate the wear on the handle by jewellery / metal contact.

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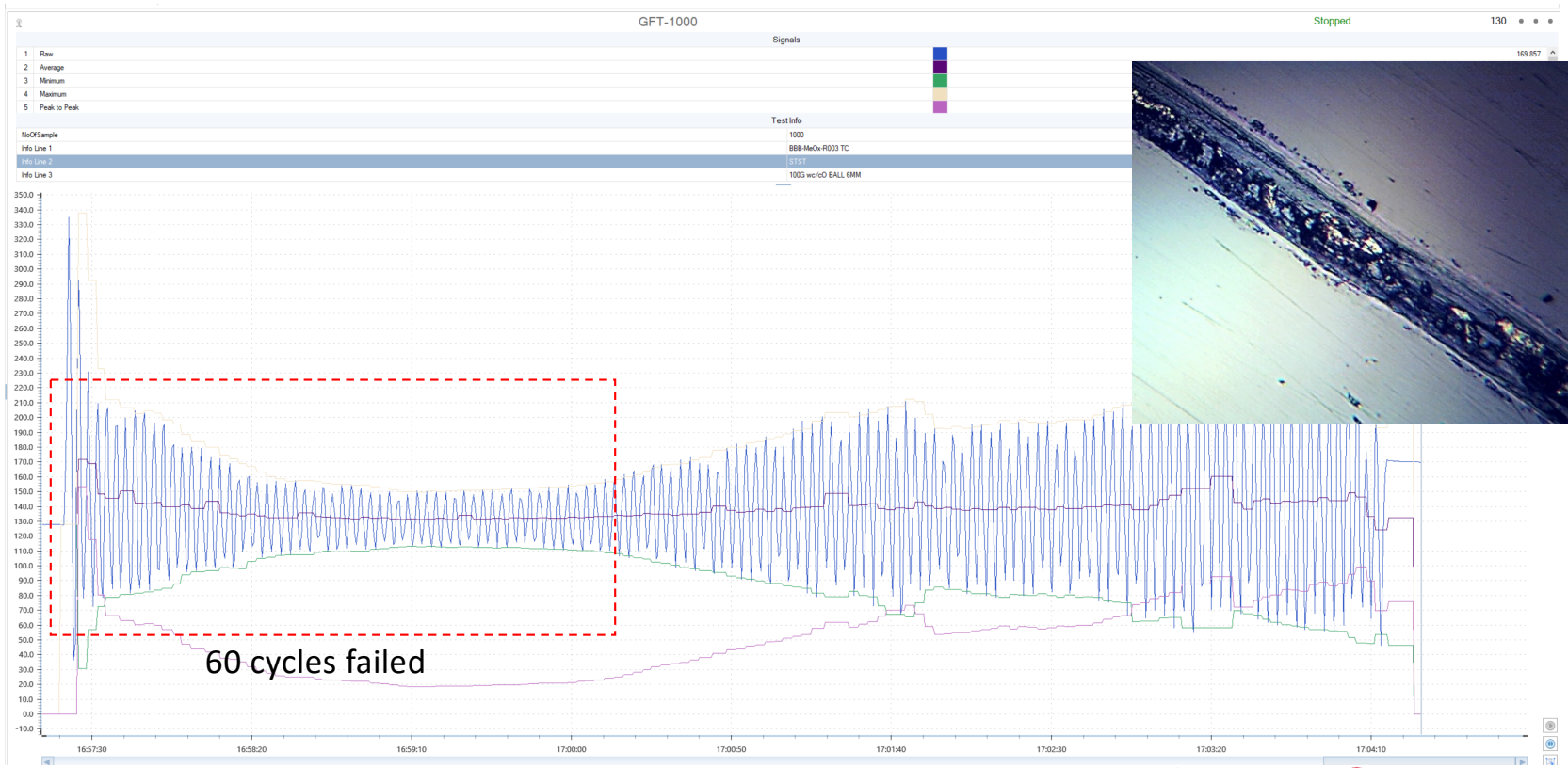
# Wear Resistive Properties

**NHS005**

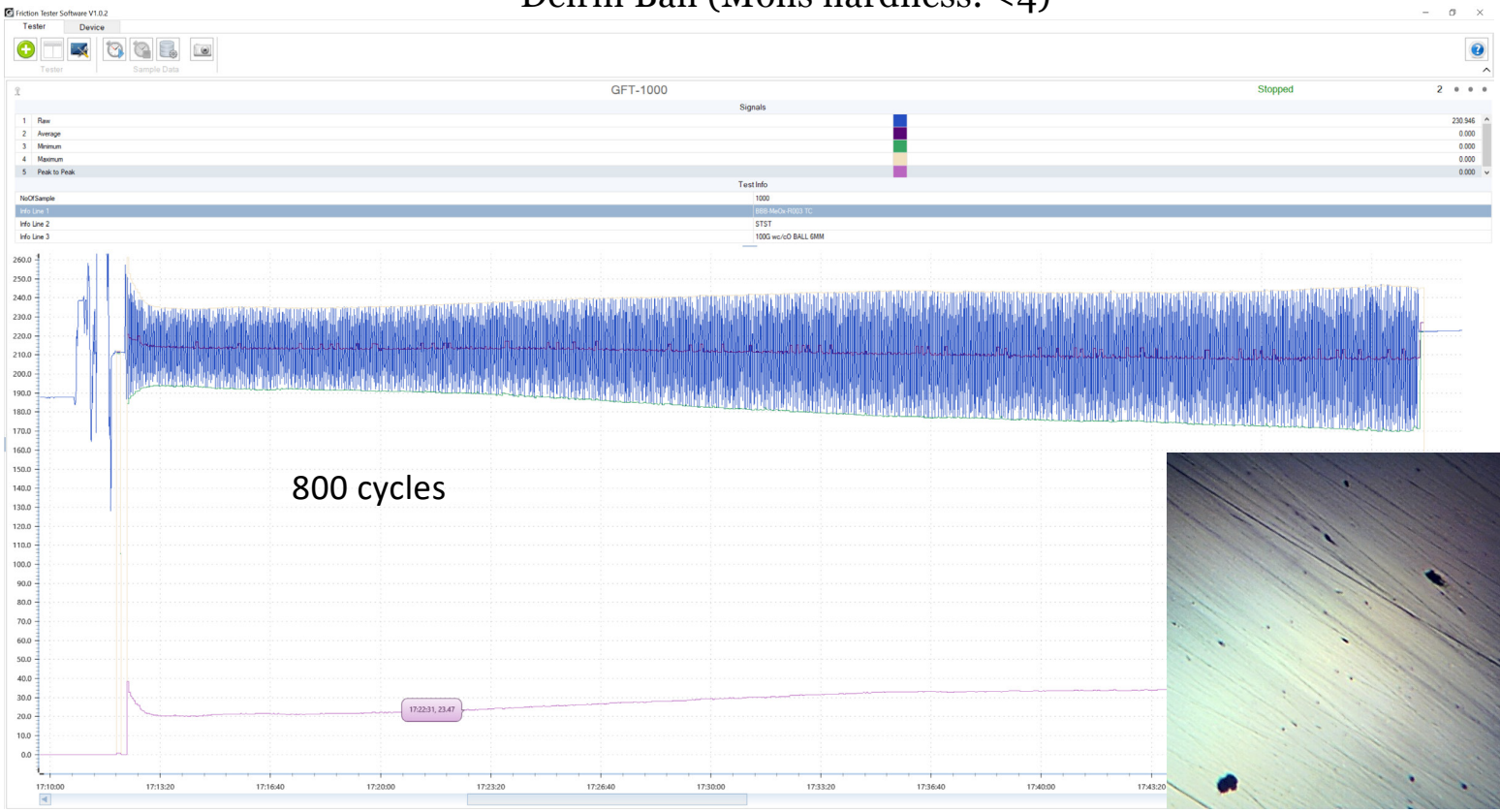
WC/Co – Ball (Mohs Hardness: 9, Vickers Hardness: 2600)

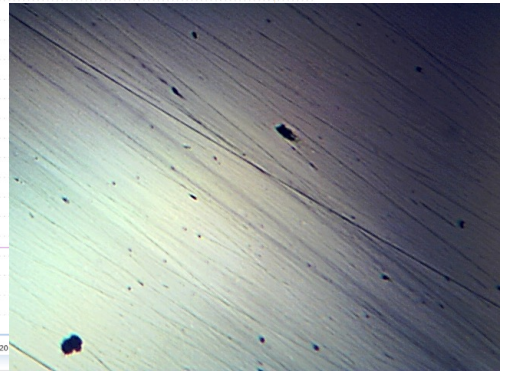


# Wear Resistive Properties

**NHS005**

Delrin Ball (Mohs hardness: <4)



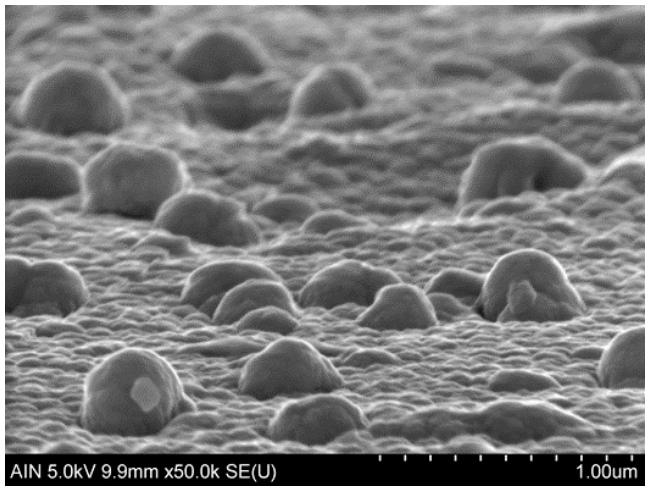



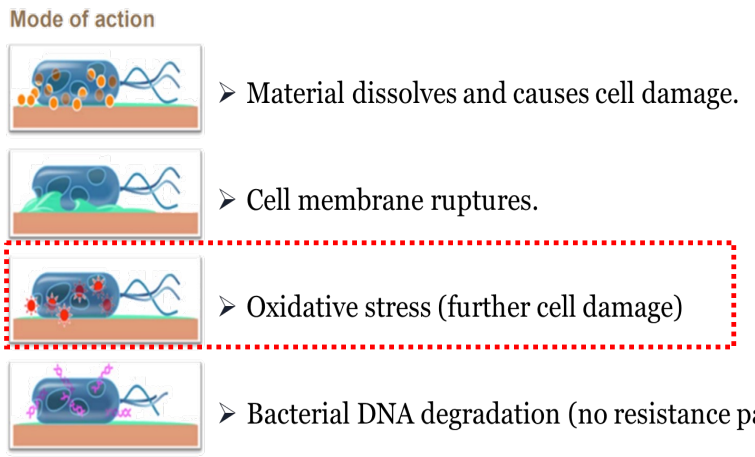
# What makes a surface antimicrobial / antiviral?

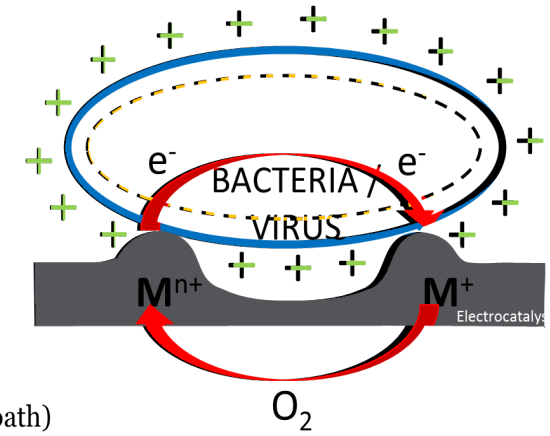
Electrochemical reaction

$$BACTERIA + O_2 \xrightarrow{M^{n+}} CO_2$$

The electrocatalyst helps to “oxidize” the microbe or viral material.

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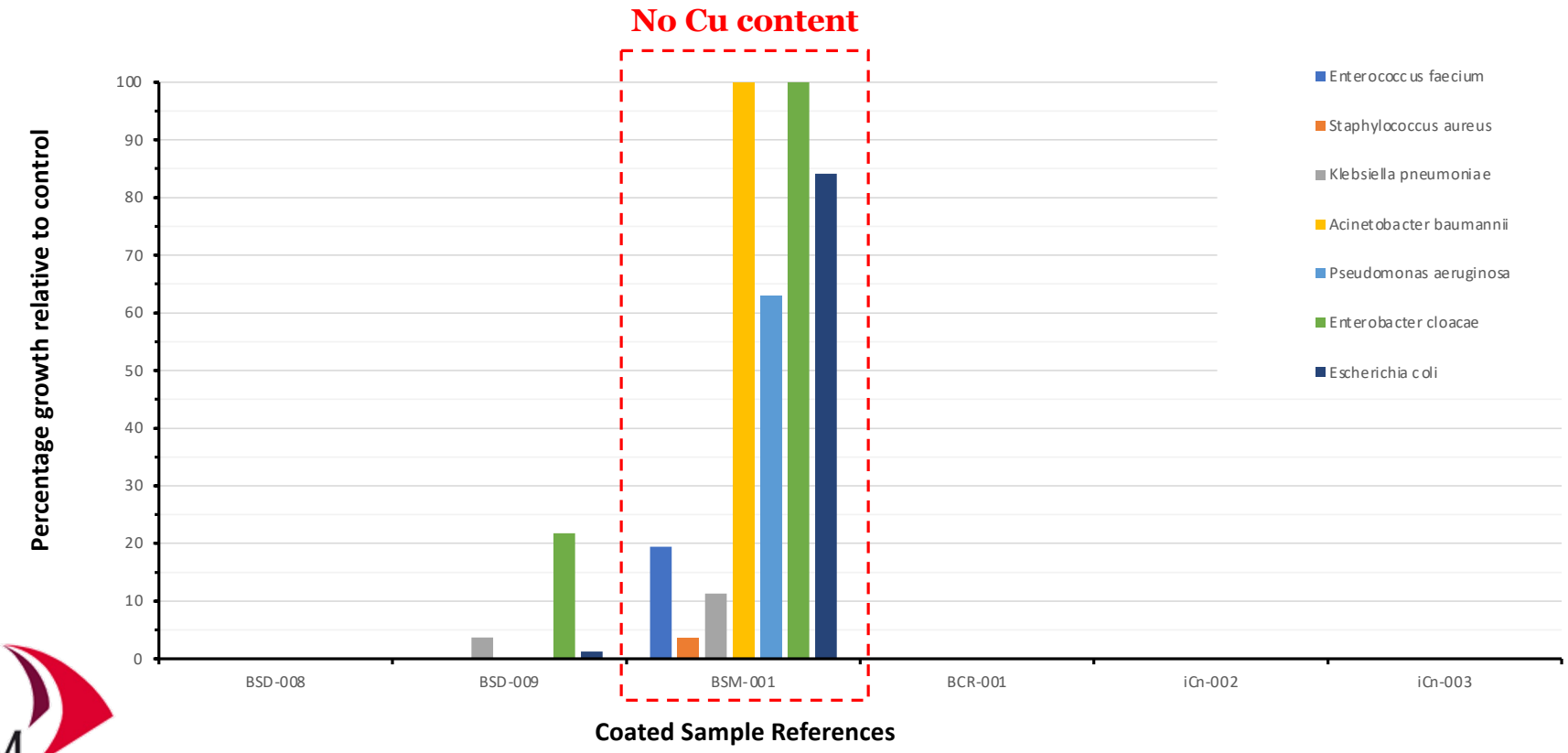
# ESKAPE(e) Testing

- Antimicrobial efficiency of different coated samples with iCnano

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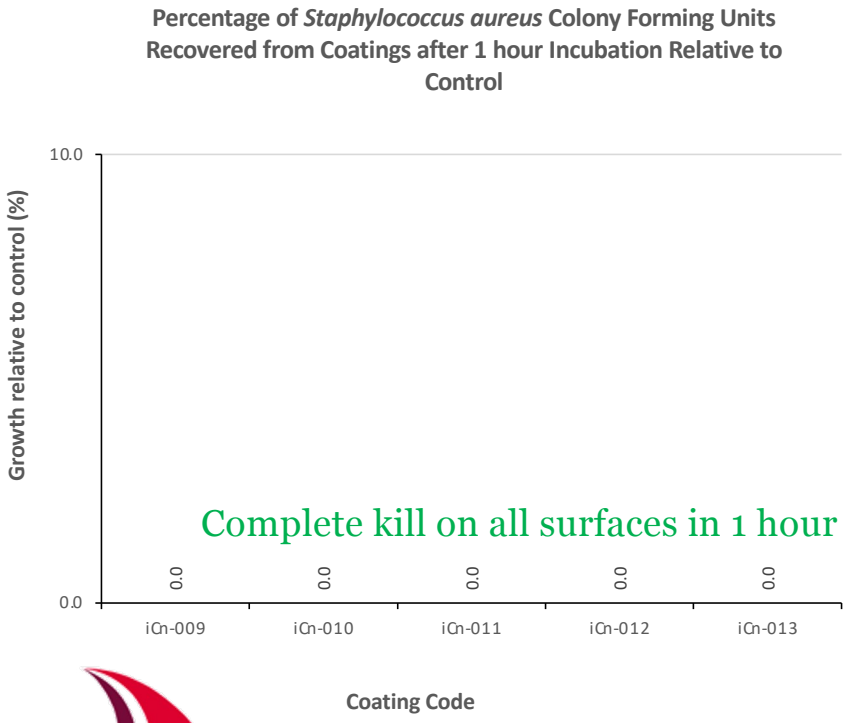
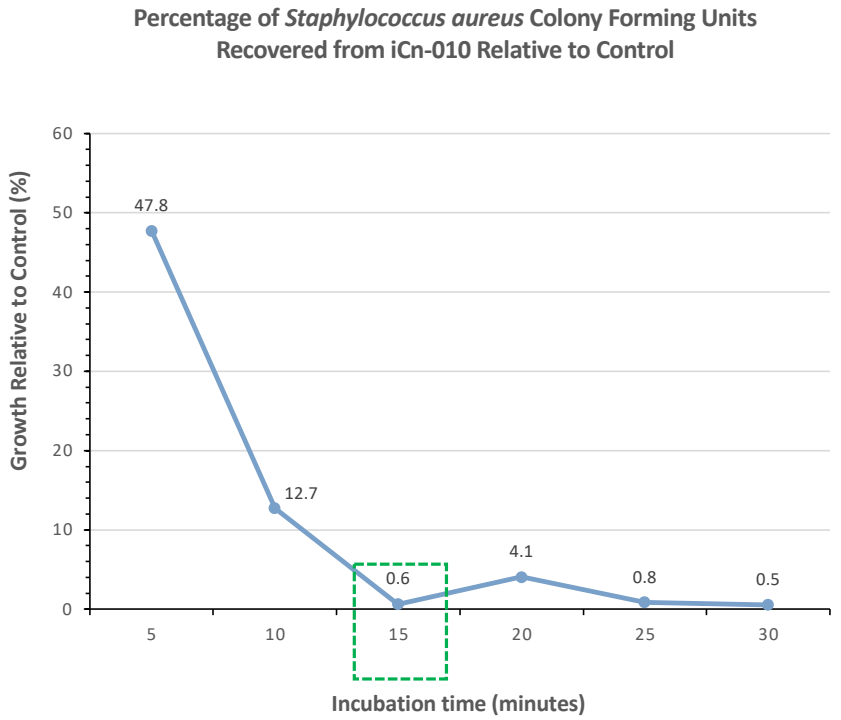
# iC-nano vs S.aureus

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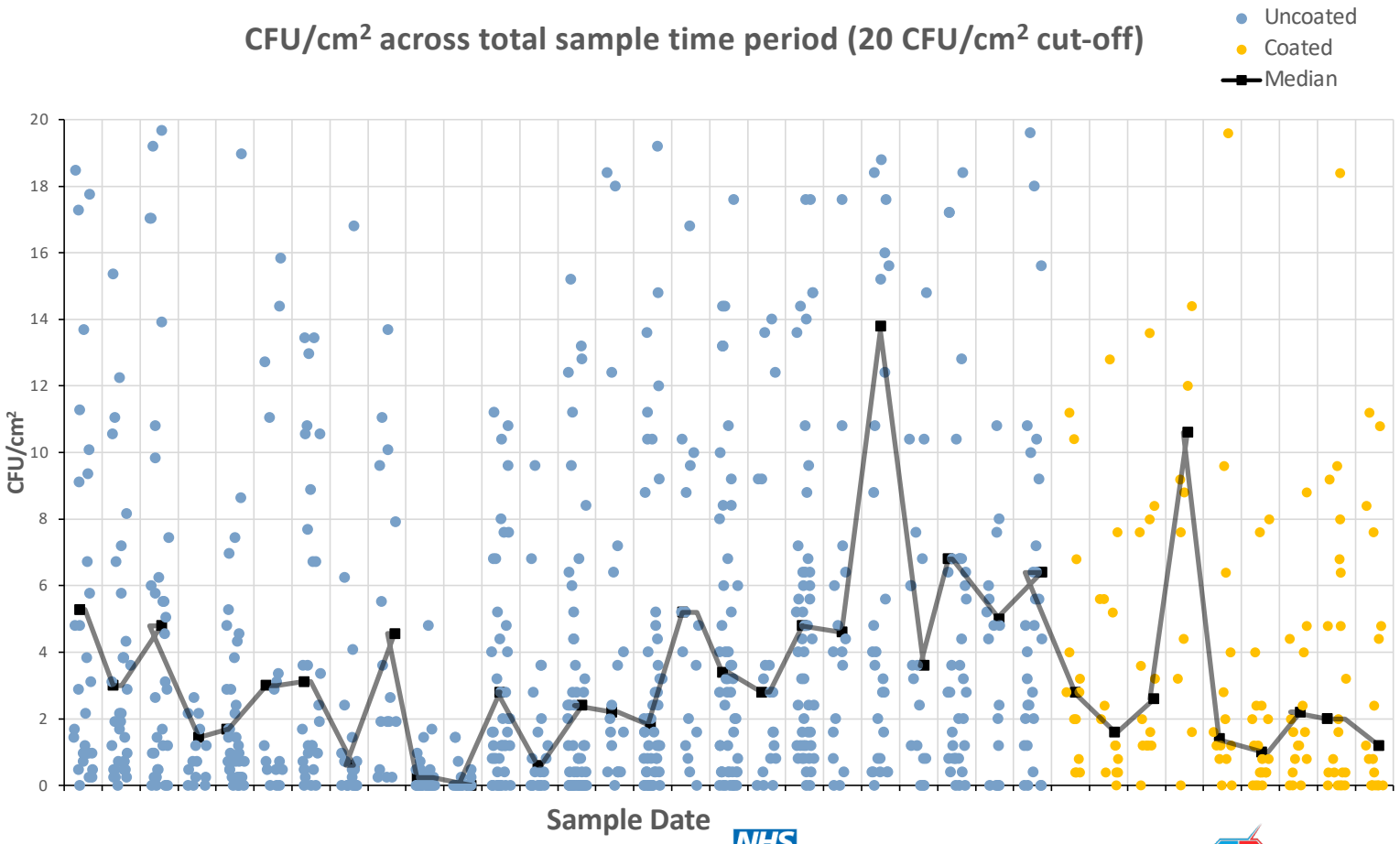
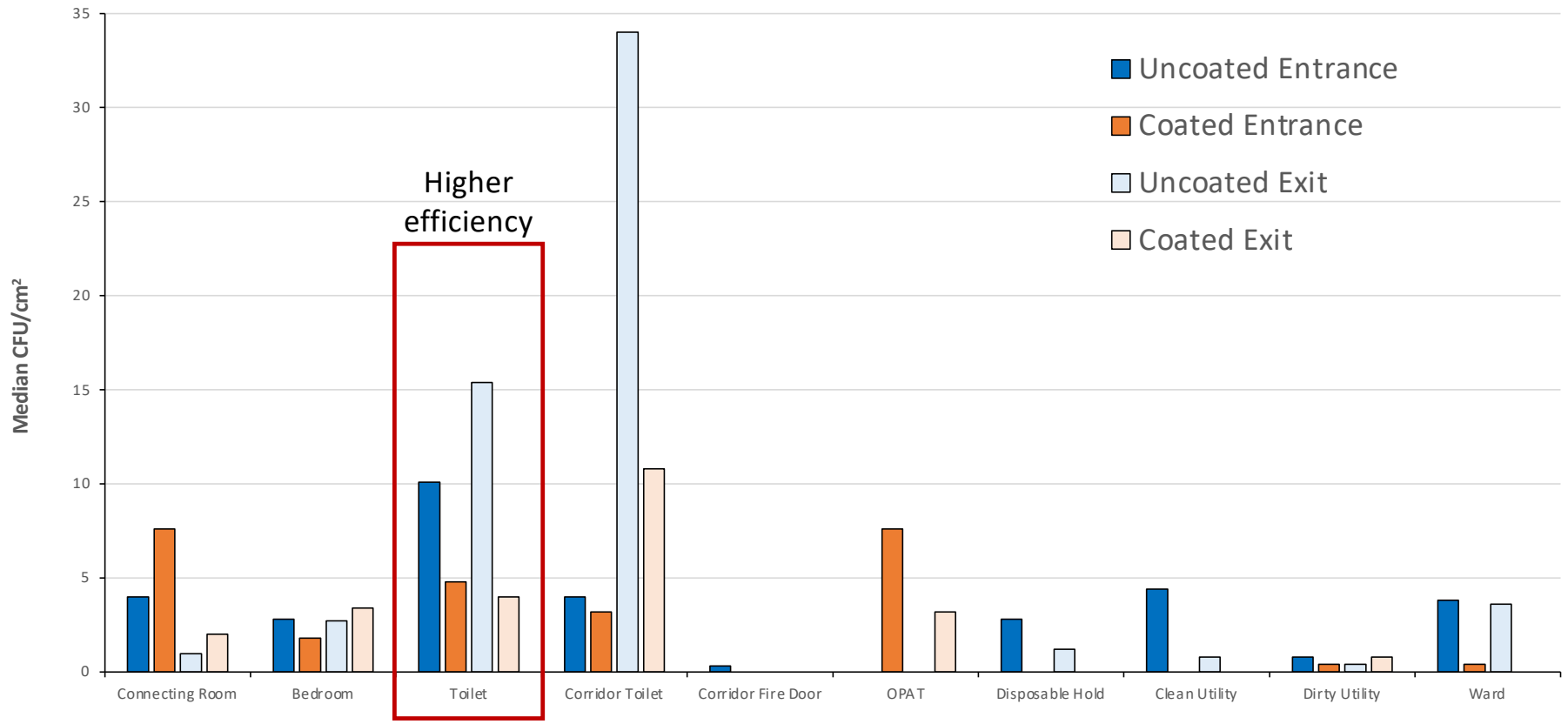
# LSTM: *In situ* analysis of coatings over time

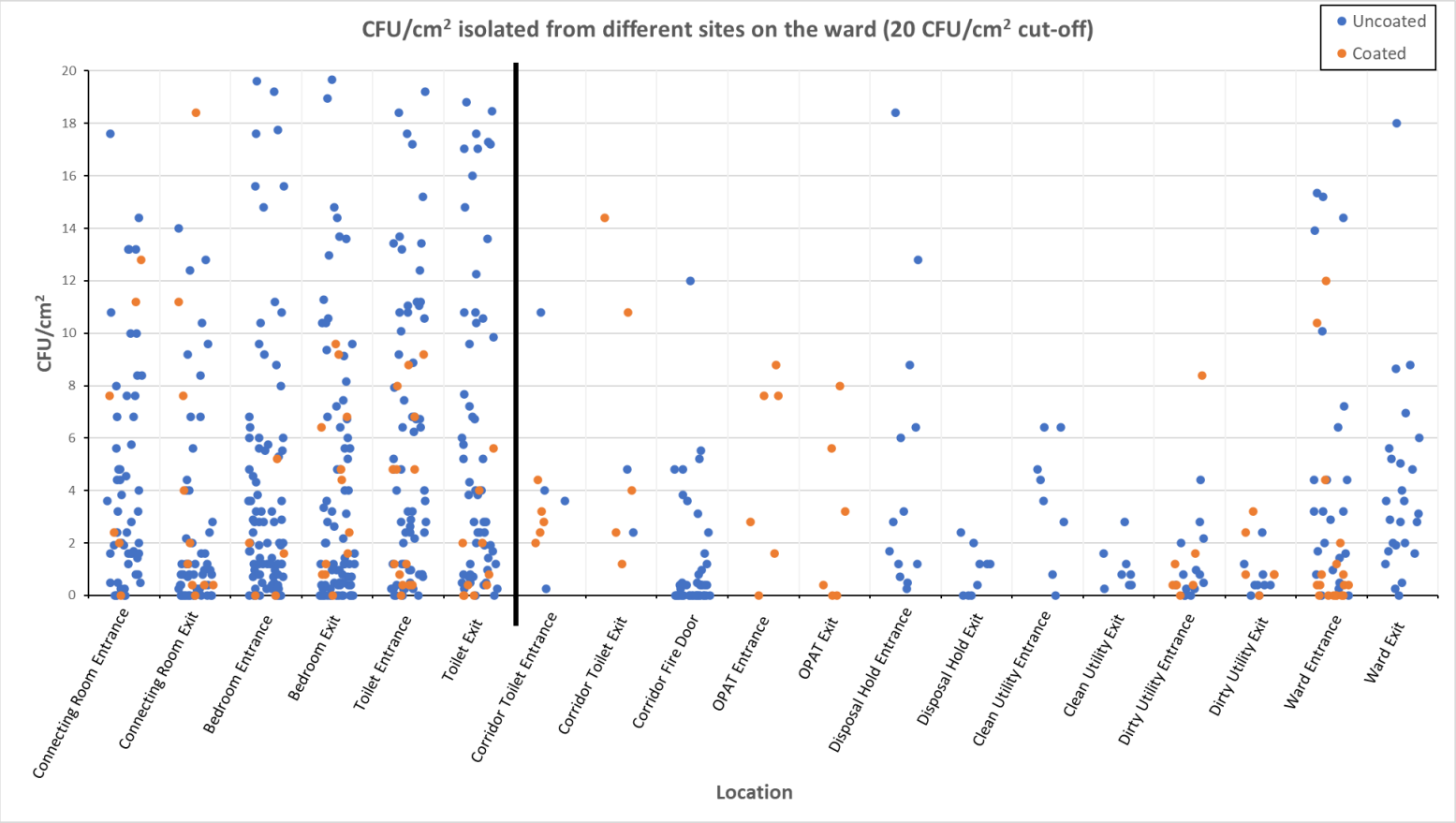



- 1057 total samples processed
- 899 uncoated
- 158 coated

# *In situ* analysis of coatings **by location in the hospital**



# *In situ* analysis of coatings by location



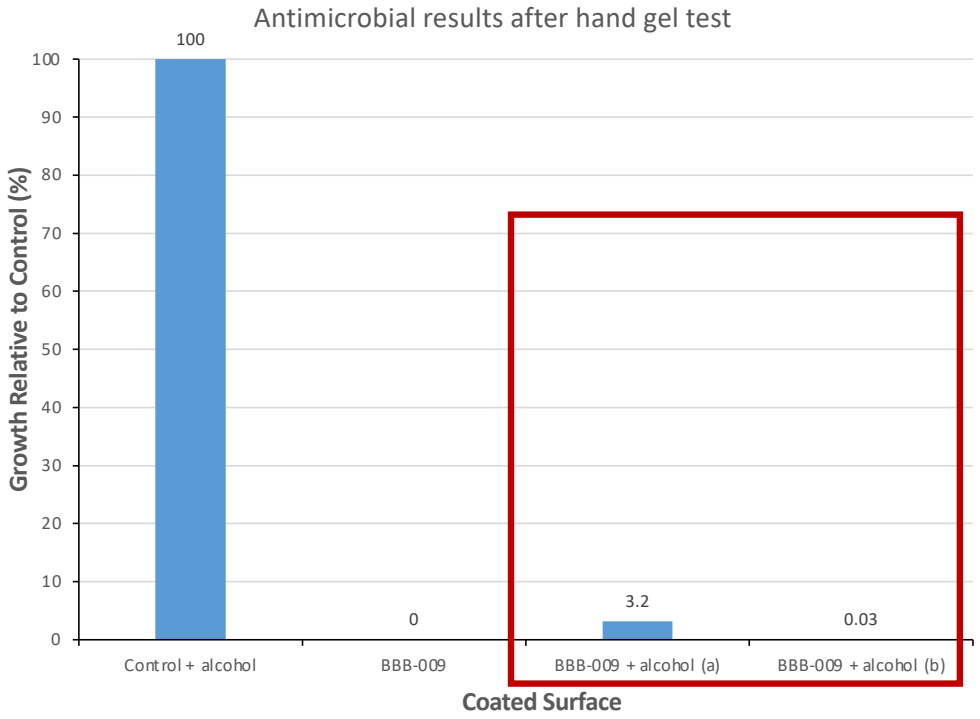

Data in more detail

# Summary

- HAI's are a leading cause of death worldwide and PVD coatings with antimicrobial properties can be produced on surfaces and disposable films to combat the spread of ESKAPE(e) pathogens throughout healthcare settings.
- Gencoa have developed very thin, mechanically enhanced, antimicrobial surface coatings which can be applied to 3D parts or flexible adhesive films.
- These copper based thin film coatings have been proven to kill 99.9999% (log 6) of the ESKAPE(e) pathogens in both light and dark environments as quickly as 15 minutes.
- The layers are solid state and hard wearing that could last over 10 years based on abrasions tests and simulation.

# The effect of alcohol hand gel on coated surfaces

- Marking and alcohol gel → Not decreasing antimicrobial efficiency
- Environmental effect to be aware of

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# Collaborators




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