Antimicrobial Transparent Protection for Touch Screen Application

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Outline of Presentation

- Introduction to Gencoa
- The need for Antimicrobial Protection and Self-Sanitising Screens
- Gencoa’s iCnano Technology
- Development of Material and Deposition
- Real World Application
- Gencoa Miller Antimicrobial Results
- Standard Antibacterial Results from University of Liverpool
- Summary and Conclusions
The Need For Antimicrobial Protection

Need for protection on 3D & 2D objects
The Need For Antimicrobial Protection

The CDC estimates that 80% of infectious diseases are transferred by touch.

In the US ~100,000 people die annually due to Hospital Associated Infections, many of which are contracted through touch.

**HAIs kill more people each year than Breast Cancer and Heart Failure combined**
HAIs Infections: in US

CDC reported the most common germs causing HAIs were:

- C. difficile (12%);
- Staphylococcus aureus, including MRSA (11%);
- Klebsiella (10%);
- E. coli (9%);
- Enterococcus (9%);
- Pseudomonas (7%).
The Need for Self-Sanitising Screens

- Touch screen devices are common place among a vast number of sectors

- Upwards of 10,000 people can use a single ticketing kiosk everyday in a busy station in the UK alone

- There is an urgent need to implement smart self-sanitising technology
The Need for Self-Sanitising Screens

- Retail
- Food Industry
- Entertainment
- Hospitality
- Transport
Environmental Effect

• **Water Pollution** – Thousands of chemicals from cleaning products are washed into streams and rivers

• **Air Pollution** – Volatile organic compounds (VOC) in cleaning products can affect indoor air quality and add to outdoor smog

• **Waste** – Many containers are not made from recyclable materials. Packaging and empty plastic bottles often end up in landfills
Gencoas’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.
Why Sputtering is an ideal choice

- Controlled features – Smooth/Rough
- Coating chemistry variations
- Added functionality
- Cheaper alternative to monolithic materials when it comes to combating bacteria and viruses on touch surfaces.

Biocidal material is in full concentration on the surface
For the antimicrobial layers, less energy and less smooth layers are desired – rougher top surface.
Developing the Material

- Different levels of transparency depending on thickness < 40nm
- Ability to maintain transparency and high level biocidal activity
Electrochemical reaction

\[ \text{BACTERIA} + \text{O}_2 + M^{n+} \rightarrow \text{CO}_2 \]

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

- Material dissolves and causes cell damage.
- Cell membrane ruptures.
- Oxidative stress (further cell damage)
- Bacterial DNA degradation (no resistance path)
Coating Principle

Original Substrate

Add microbe

Alive microbe  Dead microbe

Coated substrate

Add microbe

Doping material  Base material  Reactive gas
Deposition Set-up

Step 1
High Vacuum
Background \(\sim 10^{-6}\) 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
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
Control Options by Gencoa

Feedback control units were used on the system to ensure good control and reproducibility.

Gas sensing device used for monitoring vacuum quality and fast process feedback and flow control.

The controller has 3 fully featured and independent control channels allowing for simultaneous feedback control of up to 3 MFCs.
Deposition Process

- Speedflo
- Process chamber
- OPTIX
- Atmosphere
- Load lock
- Substrate Linear Movement
- Reactive gases
- Ion source
- BioAlloy target
- Fibre Optic cable
- Deposition Process
Deposition Process

The coating technology has the capability to be scaled up to Roll-to-Roll process resulting in a larger volume throughput for commercial use.
Real World Application

Large polymer films with Gencoa’s iC-nano antimicrobial coating were installed on train ticketing kiosks around the North West of England.

The protective films were tested in-situ over a period of 3 months.
Bio-fouling Assessment

Sampled by swabbing, grown in media and bacteria counted
CFU Assessment

NR Stations 24hrs Test

CFU

UNCOATED

0 20000 40000 60000 80000 100000 120000 140000

ICN ICN ICN ICN ICN ICN ICN ICN

20210816 NLW AV 2 24hrs 20210816 Roby AV 24hrs 20210816 St Helens AV 'BUY' 24hrs 20210816 St Helens AV 'COLLECT' 24hrs 20210816 St Helens AV 'RAILCARD' 24hrs 20210816 Warrington AV 1 24hrs 20210816 Warrington AV 2 24hrs

20210816 Huyton AV 24hrs 20210816 Huyton Uncoated 1 24hrs 20210816 Huyton Uncoated 2 24hrs

20210816 St Helens AV

STATION SCREEN
CFU Assessment

UNCOATED

NR Stations 7hrs

UNCOATED

NR Stations 24 hrs

UNCOATED
Removed Screens and Testing

Newton-le-Willows  Warrington West  St Helens  Huyton  Roby
Miller Redox Principle


Fructose

Oxidation
(a)

Gluconic acid

Reduction
(b)

3,5-dinitrosalicylic acid (yellow)

3 amino, 5-nitro salicylic acid (orange-red)
Antimicrobial Level Assessment
Gencoa-Miller

NO ANTIMICROBIAL
More microorganisms – Less Fructose
R-$\text{NO}_2$

ANTIMICROBIAL
Less microorganisms – More Fructose
R-$\text{NH}_2$
Antimicrobial Performance Testing

CCD Spectrophotometry (Absorbance)

The spectroscopic methods would allow a higher precision on the concentration of fructose.

\[ A = \log \left( \frac{l_o}{l} \right) \]

\( l_o = \) intensity of the light entering the sample

\( l = \) intensity of the light leaving the sample

The absorbance measured using a UV-Vis spectrophotometer is directly proportional to the amount of reducing sugar. (Adney and Baker, 1996)
Antimicrobial Performance Testing

Coating Development Phase

0%  22%  41%  60%  97%  100%

100% represents greater than LOG5 reduction
Gencoa Miller Test Results

3 months in the Field

LOG5 BIOCIDAL EFFECT
Antibacterial surface assessment conducted using ISO 22196:2011 (optimised).

Relative to the control (uncoated PET) over 24 h, all coated surfaces displayed a >6 log reduction for *E. coli* (Gram-negative) and *S. aureus* (Gram-positive).
**Results:** All surfaces recovered from the trains stations showed comparable antibacterial activity to the unused iCn-CuONx Std surface, indicating antibacterial activity remained.
VIRAL STUDIES
PET coated with ICN Half Life of Sars-CoV-2

- 50uL of SARS-CoV-2 placed onto surface and left to incubate for the indicated time.
- Starting SARS-CoV-2 titre: 7.14log10 PFU/mL. Represented by red line on graph
- Half life between 80 mins and 100 mins
- Problems: Large SD at 100mins
  - Replicate 1: 0.0log10 PFU/mL
  - Replicate 2: 5.23log10 PFU/mL
- Conflicts with data gained previously which saw a complete reduction of SARS-CoV-2 within 1 hour
Gencoa and production partner Diamond Coatings have developed visors with sputtered coatings with antireflective and biocidal properties (AR & AM/V)
All forms of infection are best avoided in order to preserve the health of the individual and the impact on the wider society and healthcare.

PVD coatings with antimicrobial / antiviral properties can be produced.

Gencoa have developed very thin, solid state, antiviral / antimicrobial surface coatings which can be applied to 3D parts or flexible adhesive film.

These new copper based transparent coatings have been proven to kill 99.9999% (log 6) of microbes in light or dark environments.

The layers are solid state and hard wearing > 12 months effective based upon touch screen trials.
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Thank you!

Please visit us at Booth 413