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Antimicrobial solutions in aviation

Implementation of antimicrobial solutions as alternative disinfection method

Triennal Fire and cabin safety research conference-October 2022

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Wanted: common alternative disinfection method

- All investigated disinfection methods have certain drawbacks.
- Evaluation results for methods varied between aircraft manufacturers and no common statement was agreed in Aircraft Disinfection Working Groups.
  - Boeing found more positive results for most methods and defined procedures for thermal disinfection and UV disinfection
  - Airbus found many disinfection methods overall to be less efficient & identified significant drawbacks regarding material compatibility, operating time and effort
  - At that time, antimicrobial surfaces were shortly discussed during working group meetings.
- Current recommendation remains to stick with Aircraft Maintenance Manual recommendation: Disinfectant with Apply & Wipe-off for hard surface.

	Efficacy Target : 99.9%	Operation Time	Visual Material impact	Flammability protection impact	Tensile strength impact	Conclusion
Thermal dry air (humid air)	90% (up to 99.9%)	~4h (~3h)	no	no	no	Low efficiency in dry air, efficiency improved with higher humidity; rather long process
UV-C	Up to 99.9%	~45min	Yellowing effect Above 500kJ/m2	no	yes	Efficient but impact on some material aspect after repetitive use
Spraying & Fogging	Between 90%-99.9%	~30min	minor	impact on soft materials	minor	Efficient depending on disinfectant used but impact on flammability properties for soft material
Gaseous H2O2 (below <0.1 ppm)	> 99.99%	~2h (optimized process)	minor (nylon)	minor	not tested	Very efficient but long process for full cabin disinfection

Status

All investigated disinfection methods have certain drawbacks.

A common alternative disinfection method could be the coating of surfaces.

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Potential alternative solution

Antimicrobial surfaces

Antimicrobial surfaces solutions are promising

➔ to mitigate drawbacks from other disinfection methods

➔ they providing comparable efficacy benefits against communicable pathogens as currently used disinfection methods.

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Route to antimicrobial surfaces in aviation

Detailed evaluation of antimicrobial solutions in key areas of concern

Airworthiness

Prove robustness & material compatibility with fire / smoke / toxicity / heat release requirements

Sustainability & operational efficiency

Show that antimicrobial cabin solutions significantly reduce waste & their handling is user-friendly and efficient

Antimicrobial efficacy

Prove efficacy of antimicrobial coatings on bacteria & enveloped viruses (according to ISO 22196 & after wear load) under laboratory conditions

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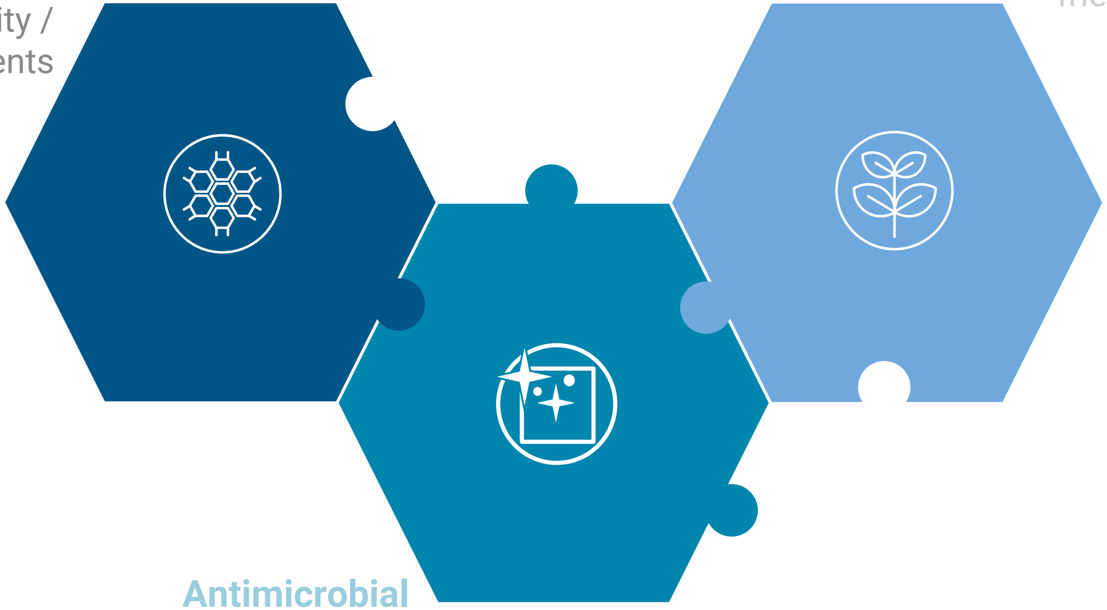

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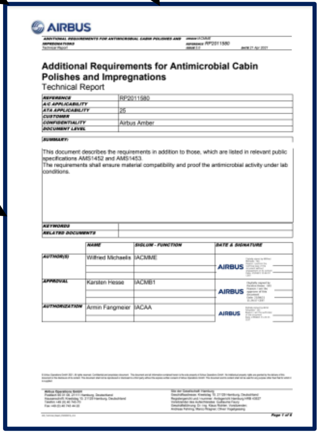
Typical Product under investigation
General material data and airworthiness

Test	Status or due date	Remark
Medical Safety Data Sheet	Available	Includes information about potential risks and hazards to workers handling toxic substances.
AMS 1452 AMS 1453	Passed, except for corrosion on unprotected Aluminium	Corrosion risk assessment (see ME2025100) -> low risk Boeing D6 spec. comparable with Airbus spec. (AMS 1452/1453 + add. Req.)
Material compatibility Chemical resistance Aging	Passed	Applicable for all plastic surfaces (with and without decor) incl. metal parts
Burning behaviour	Passed	Tested on standard material samples for interior
Application areas	Applicable for all plastic surfaces (with and without decor) incl. metal parts and artificial leather	Not applicable for textiles and leather

AMS 1453
Disinfectant Cleaner for Aircraft Interior General Purpose Liquid

AMS 1452
Disinfectant, Aircraft, General Purpose

Airbus tests
Material compatibility, burning behaviour, antimicrobial performance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Additional Requirements for Antimicrobial Cabin Polishes and Impregnations
Technical Report

Additional Requirements for Antimicrobial Cabin Polishes and Impregnations

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[Airbus Amber]

Airbus Test Results

Test	Result	Additional Information
Flammability Test Vertical Bunsen Burner Test, 12 s Ignition Time	Passed	**Test substrate:** Ultem 9075 (2 mm) **Test Standard:** Fire Testing Handbook, DOT/FAA/AR-00/12, Chapter 1 & AITM2-0002B, Issue 3 **Requirement:** No change in FST/HR properties
Heat Release Test Determination of Heat Release Rate and Heat Release	Passed	**Test substrate:** Ultem 9075 (2 mm) **Test standard:**Fire Testing Handbook, DOT/FAA/AR-00/12, Chapter 5 & AITM2-0006, Issue 3 **Requirement:** No change in FST/HR properties
Smoke Density Test Determination of the Specific Optical Density of Smoke	Passed	**Test substrate:** Ultem 9075 (2 mm) **Test standard:** Fire Testing Handbook, DOT/FAA/AR-00/12, Chapter 6 & AITM2-0007, Issue 3 **Requirement:** No change in FST/HR properties
Toxicity Test Determination of the Toxic Components on Combustion Products	Passed	**Test substrate:** Ultem 9075 (2mm) **Test standard:** AITM3-0005, Issue 2 **Requirement:** No change in FST/HR properties
Tensile Test/ Ageing in Cleaner	Passed	**Test substrate**: Lexan CFR5630, Ultem 9075 **Test standard**: DIN EN ISO 527-2 Visually, no major changes, besides smear marks, were observed after ageing the specimen for 8h in Cleaner at 23±2°C **Requirement:** E-Modul less than 10% reduction
Tensile Test/ Ageing in Coating	Passed	**Test substrate**: Lexan CFR5630, Ultem 9075 **Test standard**: DIN EN ISO 527-2 Visually, no major changes were observed, besides smear marks, after ageing the specimen for 8h in Coating at 23±2°C **Requirement:** E-Modul less than 10% reduction

The antimicrobial polishes did not significantly change the properties of the cabin surface materials (incl. Flammability). The risk of corrosion of metal parts (e.g. behind the lining) is "Low"

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[Airbus Amber]

Airbus Test Results

Test	Result	Additional Information
Exposure to LED and Temperature	Passed	**Test substrate:** Lexan CFR5630, Ultem 9075 Visually, no major changes, besides smear marks, were observed after ageing the specimen for 1008h at 50±3°C and LED light after applying cleaning with Isopropanol, applying the Cleaner and Coating
Robustness Test Tensile test strips mounted in test fixture with stress applied, 14 cycles of: • Applying Product Cleaner+ Product Coating, • Drying for 3 h at 55+/-3°C, • inspect for visual damage, After these cycles - reconditioning, test of tensile properties (ISO527-2)	Passed	**Test substrate:** Ultem 1000 Visually, no major changes, besides smear marks, were observed after ageing the specimen according to the customer specified robustness test procedure **Requirement:** no visual damage, E-Modul less than 10 % reduction
Cross- cut - After aging (1008h, 50 °C, LED light)	Passed	**Test standard:** ISO2409 **Requirements:** GT0, no change in visual appearance
X-Cut - After aging (1008h, 50°C, LED light)	Passed	**Test standard:** AIMS04-09-000 **Requirements:** GT0, no change in visual appearance
Chemical Resistance Test - Cross- cut Product Cleaner	Passed	**Test standard:** ISO2409 Soaked cotton on coated specimes for 8h (23°C) **Requirements:** GT0, no change in visual appearance
Chemical Resistance Test - Cross- cut Product Coating	Passed	**Test standard:** ISO2409 Soaked cotton on coated specimes for 8h (23°C) **Requirements:** GT0, no change in visual appearance
Chemical Resistance Test - X-Cut	Passed	**Test standard:** AIMS04-09-000 Soaked cotton on laminated specimes for 8h (23°C) **Requirements:** GT0, no change in visual appearance
Chemical Resistance Test - X-Cut	Passed	**Test standard:** AIMS04-09-000 Soaked cotton on laminated specimes for 8h (23°C) **Requirements:** GT0, no change in visual appearance

The antimicrobial polishes did not significantly change the properties of the cabin surface materials (incl. Flammability). The risk of corrosion of metal parts (e.g. behind the lining) is "Low"

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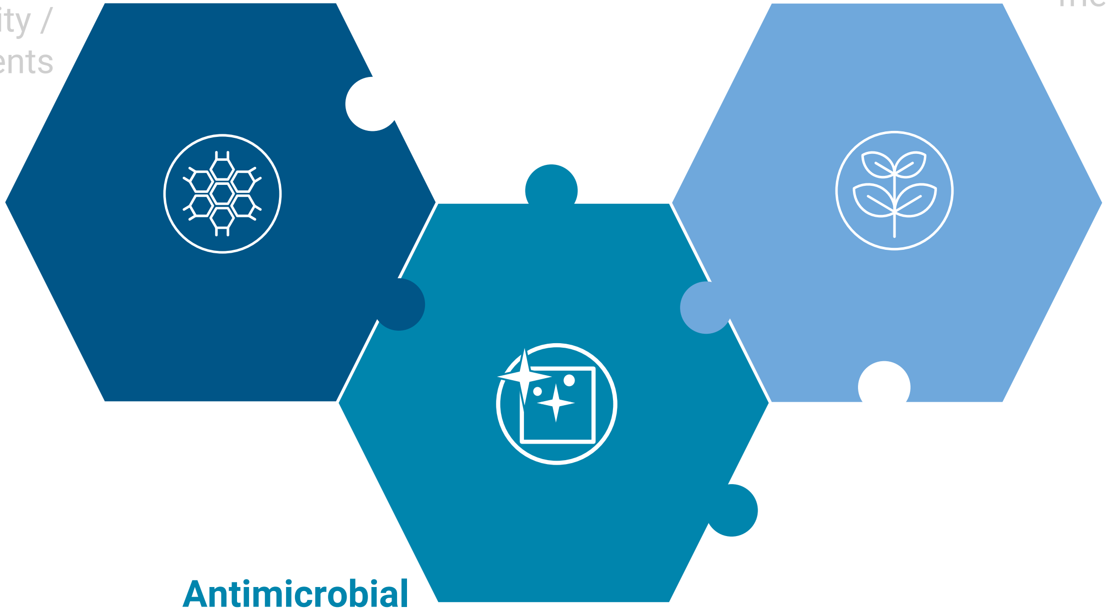

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External lab results on antibacterial and antiviral efficacy

4.1 Antiviral Effectivity

ISO 21702 "Measurement of antiviral activity on plastics and other non-porous surfaces" (for textiles: ISO18184 - Textiles — Determination of antiviral activity of textile products")

- Virus to be tested: as of "DVV/RKI-Leitlinie Suspensionsversuch" level to be defined ("begrenzt viruzid wirksam" - "viruzid wirksam")
- To be adapted e.g. by lightning requirements for photoactive technologies

Requirement: Tested to be after 0,5h, 1h, 3h, 8h and 24h

Internal target: **lg 3 after 24h**

Product tested: Log 2,7 (99,8%) after 8h

Product E (ref): Log 3,5 (> 99,9%) after 1h

4.2 Antibacterial Effectivity

ISO22196 - "Measurement of antibacterial activity on plastics and other non-porous surfaces" or JIS Z 2801 "Antibacterial products - Test for antibacterial activity and efficacy" (for textiles: ISO20743 "Textiles – Determination of antibacterial activity of textile products")

- Bacteria to be tested: Staphylococcus epidermidis, Staphylococcus aureus or Escherichia coli
- To be adapted e.g. by lightning requirements for photoactive technologies

Requirement: Tested to be after 0,5h, 1h, 3h, 8h and 24h

Internal target: **lg 3 after 24h**

Product tested: Log 3,2 (> 99,9%) after 1h

Product E (ref): Log 4 (> 99,9%) after 24h

Product

Under investigation

Higher efficacy is observed against bacteria.

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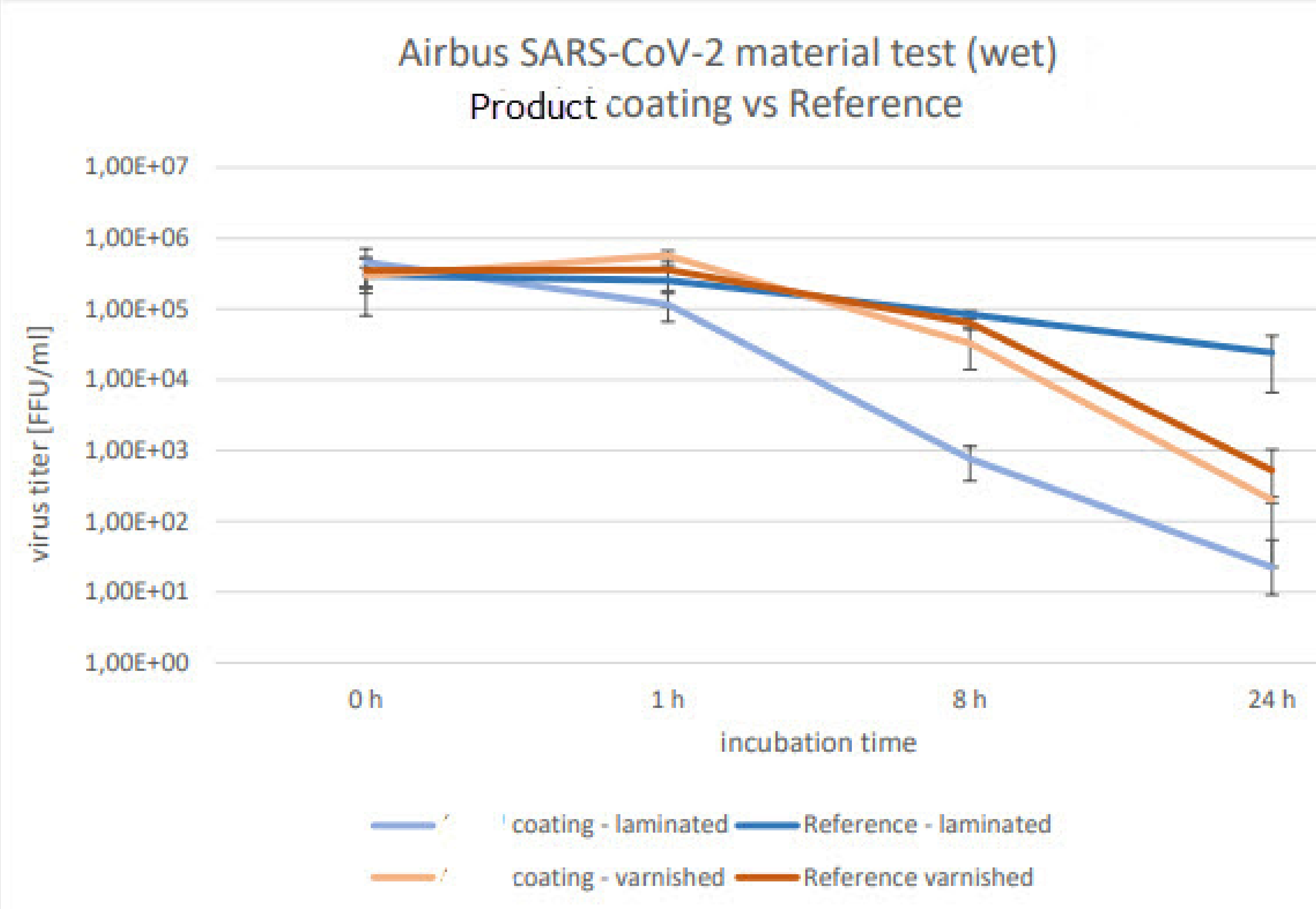
Airbus-Fraunhofer lab results on antibacterial and antiviral coatings efficacy



Product under test

The laminated coating is efficient against virus.

The varnish coating could be used for targeted touch points.

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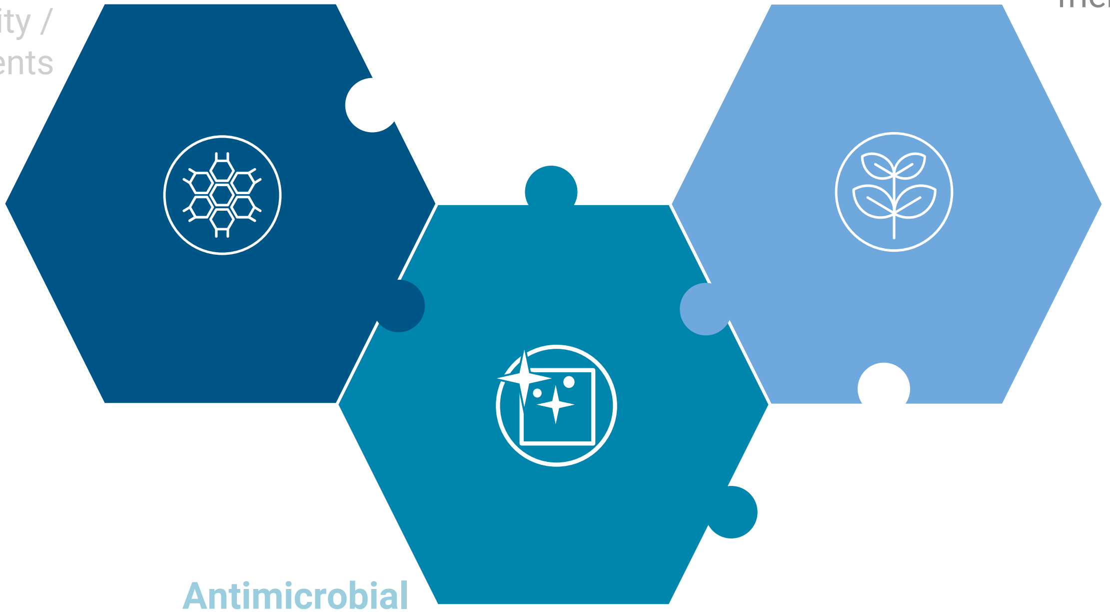

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Frequent surface disinfection comes at high cost for the sustainability goals of our industry

Disinfectants require energy and water during production and cause enormous amounts of waste during application, mostly due to empty bottles and frequent disposal of cleaning cloths.
In addition, application of disinfectant agents implies health hazards, if personal protective procedures are not followed thoroughly*.

Negative sustainability side effects of a hygienic cabin can be significantly reduced when using antimicrobial polishes instead of performing manual disinfection of the aircraft cabin.

- ➔ Reducing waste of single-use cleaning cloths, empty bottles, spraying devices etc.
- ➔ Additionally, reducing waste of personal protective equipment and reducing water & energy consumption for production & application of disinfectants

Sustainability benefits of antimicrobial polishes

Maintaining hygiene could be more sustainable than manual disinfection with aggressive agents

*according to CDC, https://www.cdc.gov/niosh/topics/disinfectant/default.html on 11.11.2021

Sustainability benefits of antimicrobial polishes

Significant waste reduction can be achieved from using Antimicrobial Polishes as alternative to manual disinfection

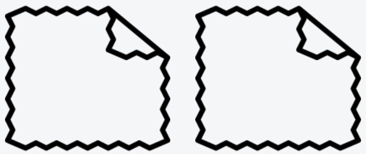
Potential waste reduction & CO_2 Savings* per A350-900 per year

Plastic bottle waste reduction for use of Antimicrobial Polishes in A350-900

Equals savings of app. 753 kg plastic per year

+

Cloth waste reduction for use of Antimicrobial Polishes in A350-900



Equals savings of app. 237 kg cloths per year

Equals carbon savings of up to 3,5 spruce trees per year**

+

Equals carbon savings of up to 1,5 spruce trees per year**

*CO2 savings based on LCA-Data from GaBi: Hazardous waste incineration with energy recovery in Germany
**Based on carbon storage of a single spruce tree in a German forest with a height of 15m and a chest height diameter of 20cm, which provides a potential for saving 200-400kg CO2-Units per year.

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Conclusion

The aviation industry needs guidance on how to ensure high hygienic standards while mitigating the risk of aircraft material degradation.

Antimicrobial polishes have benefits over other alternative disinfection methods in three key aspects:

- ➔ Safety - *improved material compatibility*
- ➔ Health - *comparable or improved protection from communicable pathogens*
- ➔ *Environmental/Technical - Product has to be efficient in aircraft specific environment (temperature, humidity, hydrophobic surfaces)*
- ➔ Operations - *improved sustainability and reduced Operator burden (costs, time, impact on operations)*

Proposed Way Forward

➔ Airbus to keep testing of antimicrobial solutions.

➔ Aircraft manufacturers and Health organisations with support of EASA/FAA to work on commonly agreed disinfection levels and disinfection procedures which fulfill 3 key criteria:

1. Airworthiness (safety)
2. Antimicrobial/Antiviral Efficiency (Health)
3. Sustainability and operational efficiency

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Thank you

Backup Slide: Airbus-Fraunhofer **2022** lab results on **thermal disinfection**

Fraunhofer IZI

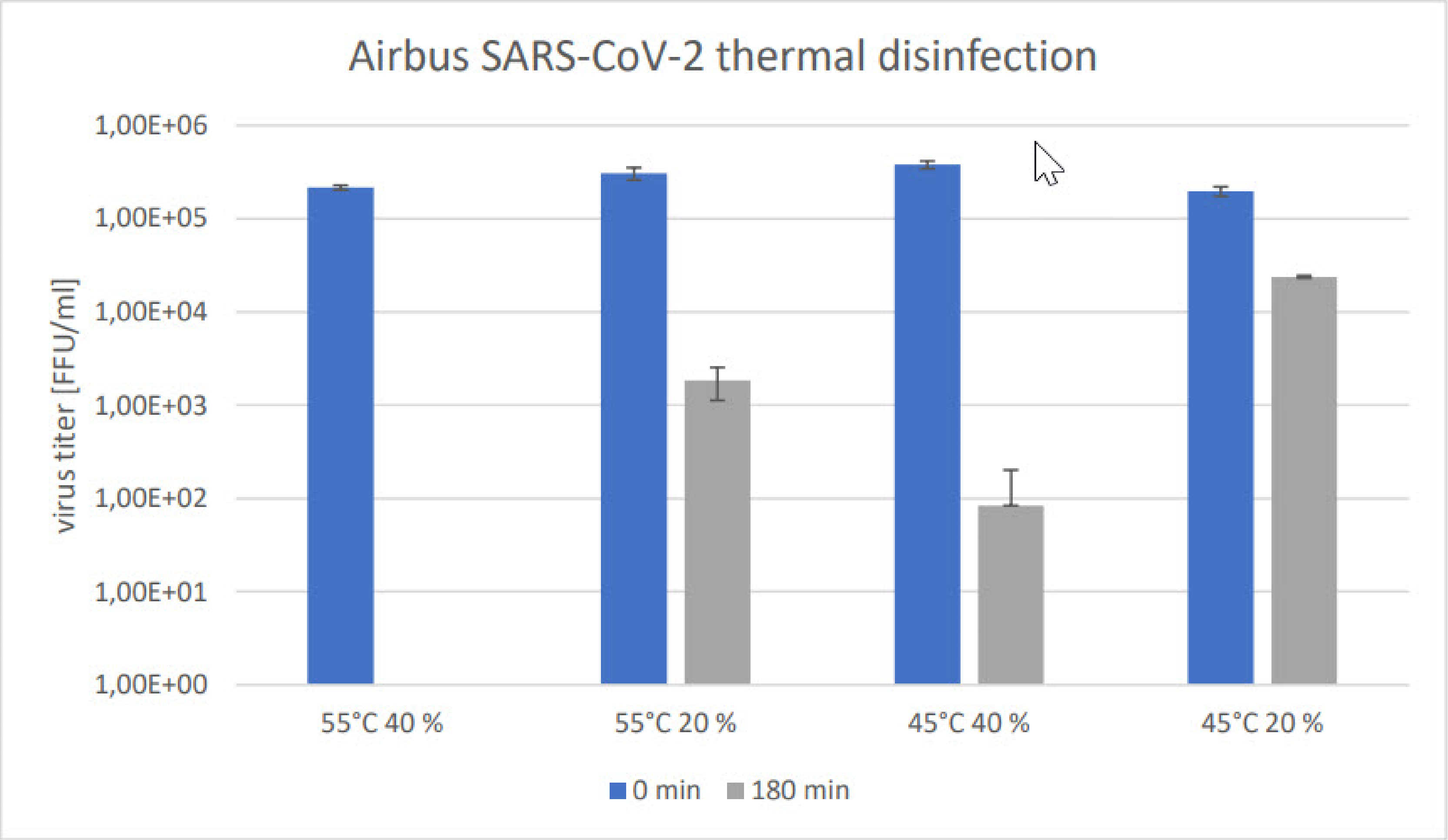

Figure 2: Mean FFU per well of two replicates for time points 0 min and 180 min. Mean values and standard deviation (SD) were calculated (Table 2). No column means the titer is below the detection limit.

Product under test

Thermal disinfection has antiviral efficacy if temperature is combined with higher humidity levels. These results are similar to those published by Boeing.

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Backup Slide: Liquid Product applied to public busses in France

Objective

Compare the effectiveness of an antimicrobial polish coupled with regular cleaning versus regular disinfection procedure.

Method

Surfaces in public buses treated with Liquid Product.
Contamination levels of frequently touched surfaces evaluated by impression tests over 30 days and compared to untreated buses.
Treated buses were only cleaned with non-disinfectants, while untreated buses were disinfected regularly.

Results

Untreated bus surfaces presented contamination fluctuating around 50 colony forming units (CFU)/25 cm^2 with contamination peaks at 150 CFU/25 cm^2 over the entire test period.
Treated bus surfaces showed a significant reduction in contamination levels throughout the test period: the levels of contamination were more controlled with significantly lower contamination peaks and average contamination levels (< 25 CFU/25 cm^2 after 14 days, < 50 CFU/25 cm^2 after 30 days).

Conclusion

Results show the ability of Liquid Product to control the overall level of contamination over a month with regular cleaning only.

Results of real-life studies

Antimicrobial polishes show the ability to control the overall microbial contamination level without additional disinfection

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