Effect of Disinfectants on Aircraft Seating Materials

Federal Aviation Administration

Presented by:

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JAMS

Joint Centers of Excellence for Advanced Materials

A Center of Excellence AMTAS Advanced Materials in Transport Aircraft Structures

CECAM center of excellence for composites and advanced materials

JAMS Technical Review

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Introduction

- Effects of the use of cleaning and disinfectants chemicals/processes in the mechanical and flammability characteristics of aircraft interior material
- Project Participants
    - PI: Gerardo Olivares Ph.D.
    - Researchers NIAR-WSU: Luis Gomez, Akhil Bhasin, Luis Castillo, Aswini Kona Ravi
    - Students: Tanat Maichan, Clayton Ehrstein, Javier Martinez, Carlos Gatti
- FAA Technical Monitor – Cindy Ashforth
- Other FAA Personnel – Jeff Gardlin, Ahmet Oztekin
- Industry Partnerships/Other Collaborations – Jamco America, Boeing, ACES, Collins Aerospace, AmSafe, SAE Seat Committee, AeroHygenx, SABIC, Lantal, Schroth, Schneller
- Matching contribution is a mix funding between Industry and NIAR/WSU

Background

- Motivation and Key Issues
    - Due to the coronavirus disease (COVID-19) public health emergency, the airline industry implemented meticulous and frequent disinfection of aircraft interior. However, the requirement for excessive use of disinfectants raised concerns on its potential negative impact on material performance. Thus it became a critical issue to determine what materials to test, what disinfectants to consider and which tests to perform.
- Objective and Scope
    - The objective of this research is to evaluate the effect of liquid disinfectants and UV-C light on physical, mechanical and flammability properties of materials used in aircraft seat and cabin interior
- Approach
    - Specimens were extracted from selected material systems and conditioned with liquid disinfectants using the submersion and/or wiping method. These conditioned specimens were tested for flammability and mechanical properties.

Project Status

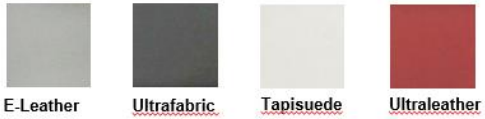
- **Phase I: Effect of liquid disinfectants on aircraft seating materials (Finished)**
  - Flammability performance of 17 different materials evaluated (Finished)
  - Mechanical properties of 5 different materials evaluated (Finished)
  - Write technical FAA Report: DOT/FAA/TC-21/18 (Published)
- **Phase II: Effect of UV-C on aircraft seating materials (Finished)**
  - Initial evaluation of materials used in cabin interior conditioned with liquid disinfectants – ULTEM 9085 and ULTEM 9075 (Finished)
  - Mechanical performance evaluated when exposed to UV-C wavelengths of 222 nm, 253.4 nm and 280 nm (Finished)
  - Write technical FAA Report (On going)
- **Phase III: Effect of liquid disinfectants and UV-C on cabin interior materials (Ongoing)**
  - Scope expanded to materials used in cabin – Honeycomb sandwich panels, Decorative laminates, Flooring Carpets
    - Testing of Decorative Laminates (Finished)
    - Testing of Floor Carpets (Finished)
    - Testing of Honeycomb Sandwich Panels (Ongoing)

Materials selected for Seat

Material Type: Plastic (Strength and Flammability)

Kydex 6565 | Boltaron 9815E | Lexan XHR | Boltaron 9815N

Material Type: Synthetic Leather (Flammability)



E-Leather | Ultrafabric | Tapisuede | Ultraleather

Material Type: Wool/ Nylon Blend (Flammability)

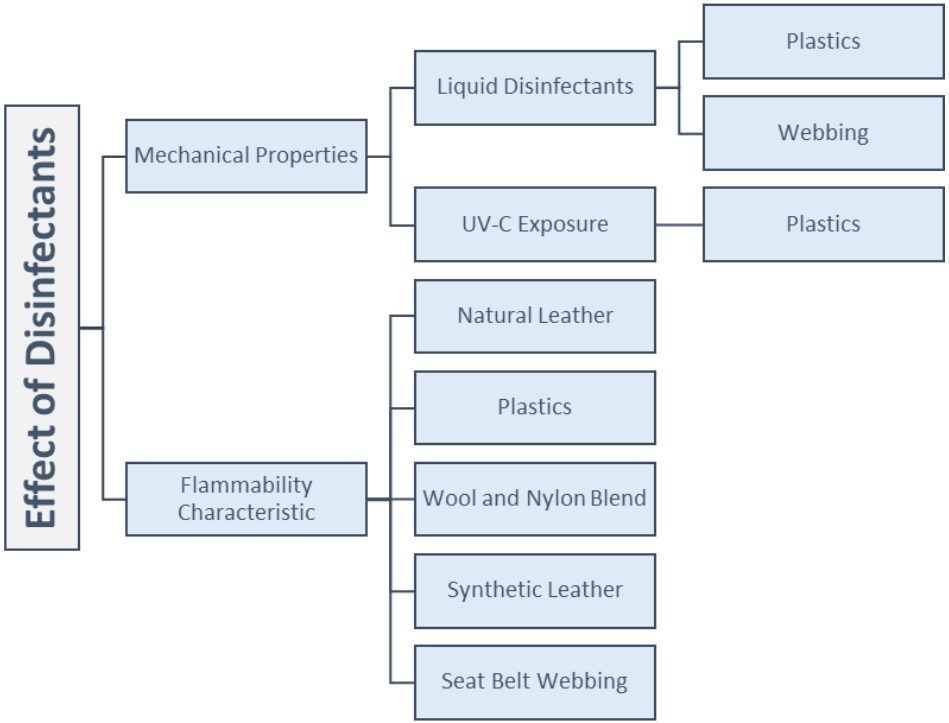
Lantal | Rohi Beach | Sheepskin | Botany Fabric

Material Type: Leather (Flammability)

Muirhead | Perrone Pewter | Perrone Feather Weight

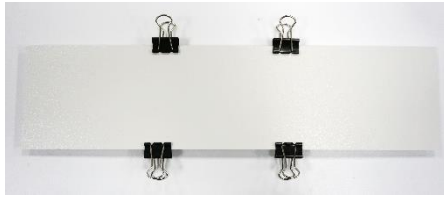
Material Type: Seatbelt Webbing (Flammability)

SCHROTH | AmSafe



Liquid Disinfectants Conditioning

Submersion Method

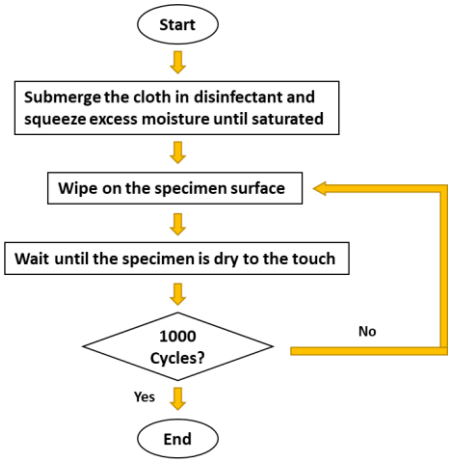


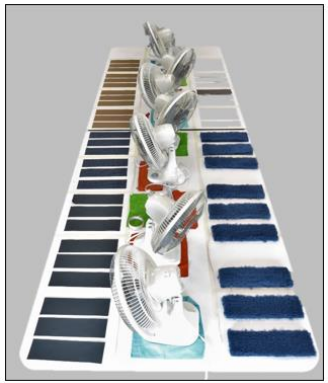
Clamp each specimen with paper clip

Place them in a tray filled with disinfectant

Cover the tray with vacuum bag

Wiping Method



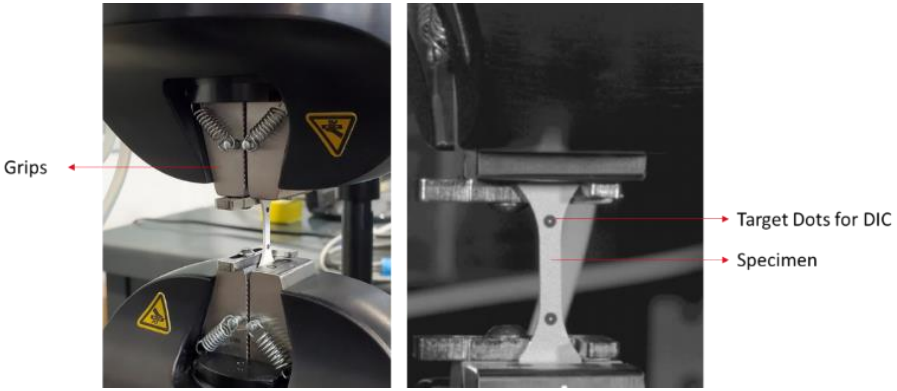


1,000 Cycles

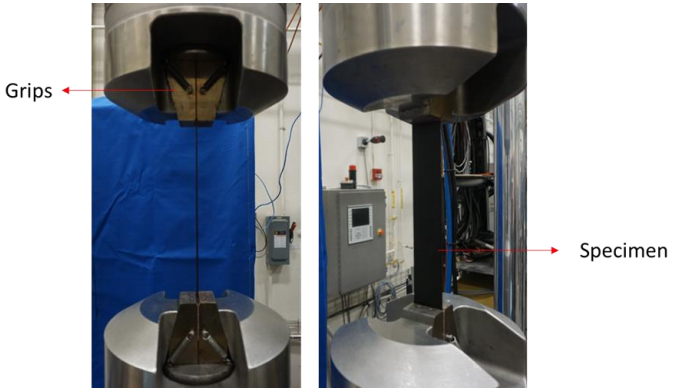
Qualitative Color Change

Materials	Pristine	70% IPA	Calla 1452	Sani-Cide EX3	BactroKill+	PREempt RTU
Kydex 6565						
Boltaron 9815E						
Lexan XHR						
Boltaron 9815N						
Perrone Pewter BC						
Perrone Feather Weight						
E-Leather CL820						

Strength Characterization Tests



Plastics Tensile Test Setup



Seat Belt Webbing Tensile Test Setup

Kydex 6565

Boltaron 9815E

Lexan XHR

Boltaron 9815N

SCHROTH Webbing

Strength Characterization Results

Material Type	Material Name	Disinfectant Type				
		70% IPA*	Calla 1452	Sani-Cide EX3	BactroKill+	PREempt RTU
Plastics	Kydex 6565					
	Boltaron 9815E					
	Lexan XHR					
	Boltaron 9815N					
Webbing	SCHROTH					
	AmSafe Polyester					

*AmSafe Polyester webbing specimens were conditioned with 99% IPA

Material properties “equivalent” to unconditioned specimens

Material properties not “equivalent” to unconditioned specimens

Material properties “equivalent” to unconditioned specimens based on limited data

No reduction in failure load

Reduction in failure load less than 5%

Vertical Flammability Tests


Kydex 6565


E-Leather CL820


Lantal


Boltaron 9815E


Ultrafabric 492-6579FR12


Rohi Beach


Lexan XHR


TapiSuede TSFRC0961


Sheepskin


Boltaron 9815N

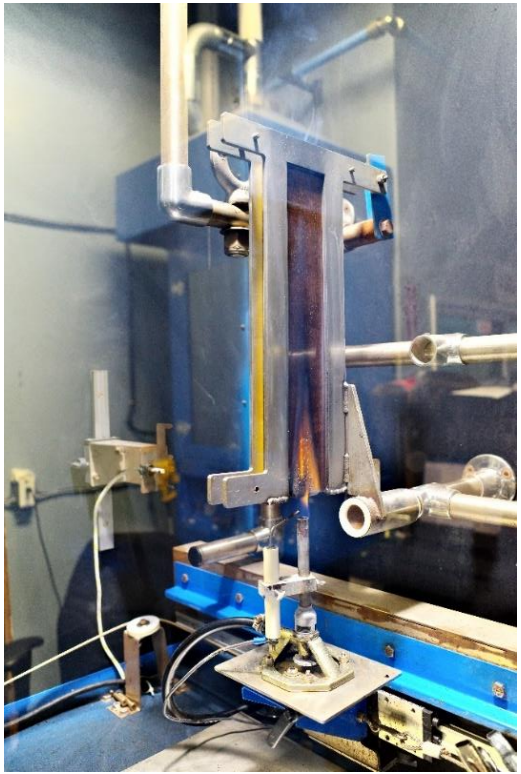

Ultraleather ULFRB971-1363


Botany Fabric


Perrone Pewter BC


Perrone Feather Weight


SCHROTH



Flammability Results– Submersion Method

Material Type	Material Name	Disinfectant Type				
		70% IPA	Calla 1452	Sani-Cide EX3	BactroKill+	PREempt RTU
Plastics	Kydex 6565					
	Boltaron 9815E					
	Lexan XHR					
	Boltaron 9815N					
Synthetic Leather	E-Leather CL820					
	Ultrafabric 492-6579FR12					
	TapiSuede TSFRC0961					
	Ultraleather ULFRB971-1363					
Wool/Nylon Blend	Lantal					
	Rohi Beach					
	Sheepskin					
	Botany Fabric					
Leather	Perrone Pewter BC					
	Perrone Feather Weight					
Webbing	SCHROTH					
	AmSafe Polyester					

Increase in average burn length is less than or equal to approximately 50 % of the average burn length obtained from the unconditioned specimens

Increase in average burn length is greater than approximately 50% of the average burn length obtained from the unconditioned specimens

Increase in average burn length is less than 6” when compared against unconditioned specimens and self-extinguishing

Flammability Results – Wiping Method

Material Type	Material Name	Disinfectant Type				
		70% IPA	Calla 1452	Sani-Cide EX3	BactroKill+	PREempt RTU
Synthetic Leather	E-Leather CL820					
	Ultrafabric 492-6579FR12					
	Ultraleather ULFRB971-1363					
Wool/Nylon Blend	Lantal					
	Rohi Beach					
	Sheepskin					
	Botany Fabric					
Leather	Muirhead DF602					
	Perrone Pewter BC					
	Perrone Feather Weight					

Increase in average burn length is less than or equal to approximately 50 % of the average burn length obtained from the unconditioned specimens test data.

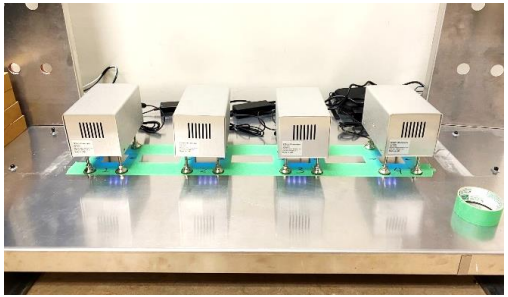
Increase in average burn length is greater than approximately 50% of the average burn length obtained from the unconditioned specimens test data.

Normally equivalent results obtained when conditioned using submersion method

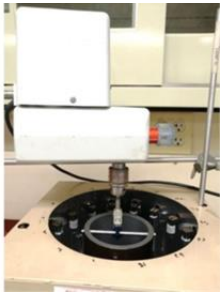
Liquid Disinfectants - Conclusions

- **17 different materials were tested (Plastics, Natural and Synthetic leathers, Wool/Nylon fabrics, Webbing)**
- **5 different chemical disinfectants were evaluated**
- **Mechanical Properties**
  - Tension tests were conducted for four different type of plastics. Statistical evaluation showed equivalency between conditioned & unconditioned specimens for Kydex 6565, Boltaron 9815N and Lexan XHR. For Boltaron 9815 E, material properties of conditioned specimens were not equivalent to unconditioned specimens.
  - Tension test were conducted on SCHROTH and Amsafe seatbelt webbings. Reduction in failure load, if any, was less than 5%.
- **Flammability Properties – Submersion Method**
  - All materials were first conditioned using submersion method. This approach represented worst-case scenario
  - Plastics and seatbelt webbings were normally equivalent when conditioned with all liquid disinfectants
  - For other material types, combination of both normally equivalent and significantly different flammability results existed
- **Flammability Wiping**
  - Material and disinfectant combinations for which flammability properties were significantly different using submersion method were revaluated by wiping method
  - Synthetic leather was normally equivalent when conditioned with all liquid disinfectants
  - For other material types (Wood/nylon Fabric and Natural Leather), combination of both normally equivalent and significantly different flammability results existed.

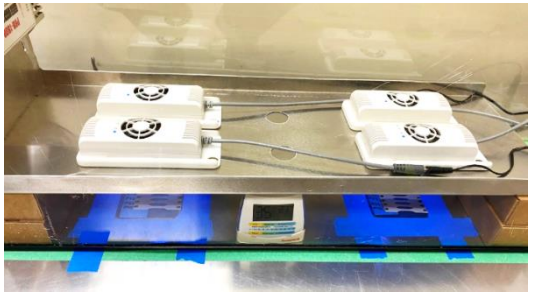
UV-C Light Conditioning



UV-C Wavelength: 222 nm Setup



UV-C Wavelength: 253.4 nm Setup

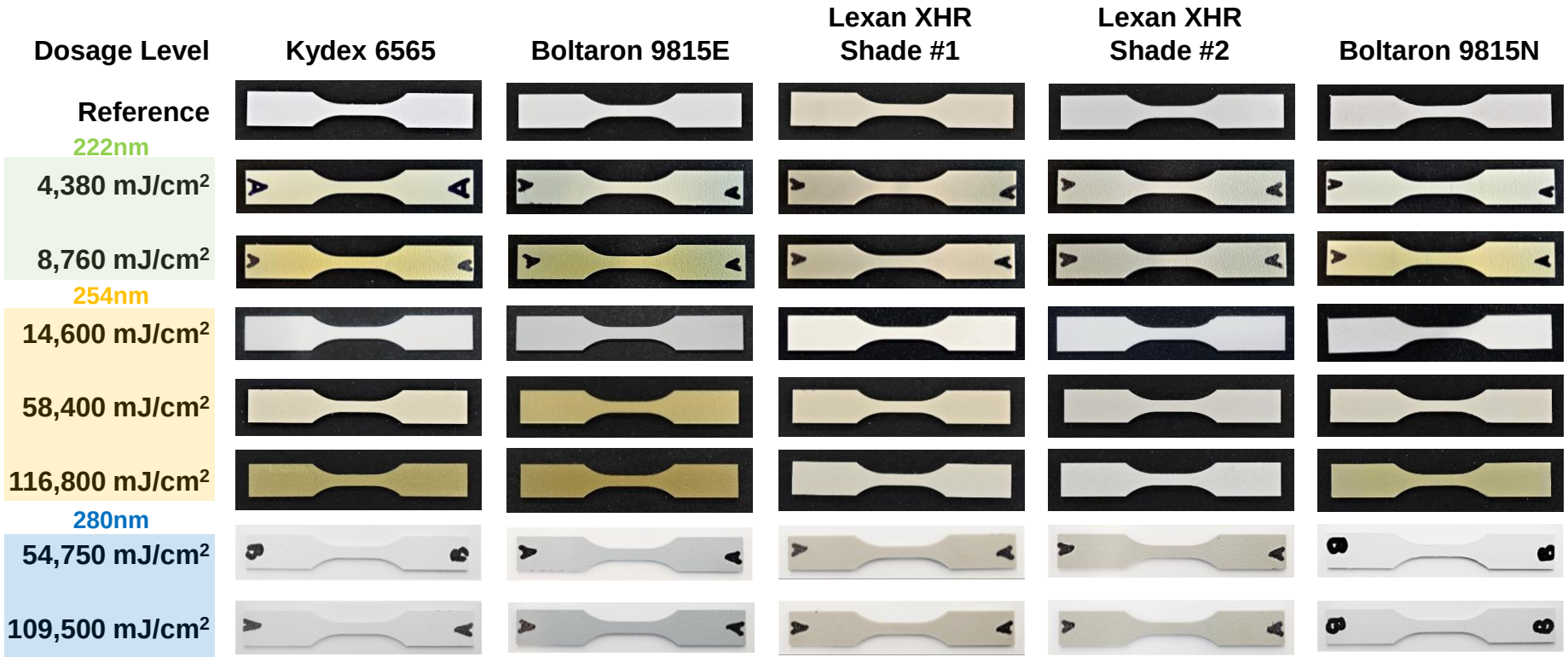


UV-C Wavelength: 280 nm Setup

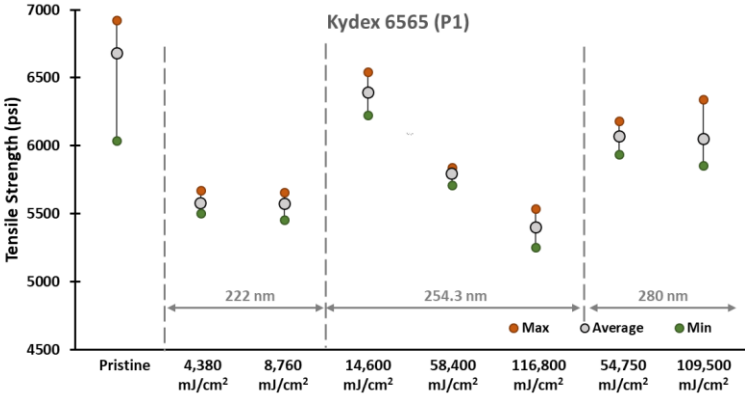
UV-C Wavelength (nm)	Treatment Dose (mJ/cm^2)	Cumulative Time (Years)	Cumulative Dosage* (mJ/cm^2)
222 nm	3	4 years	4,380
		8 years	8,760
253.4 nm	40	1 year	14,600
		4 years	58,400
		8 years	116,800
280 nm	37.5	4 years	54,750
		8 years	109,500

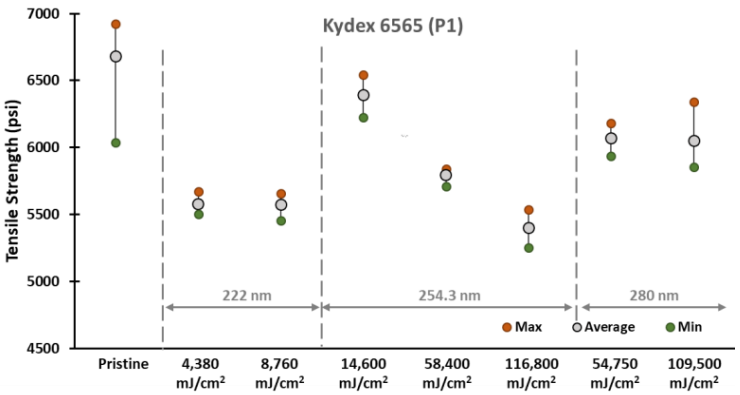
*Cumulative dosages represent one, four and eight years worth of doses calculated at one treatment per day.

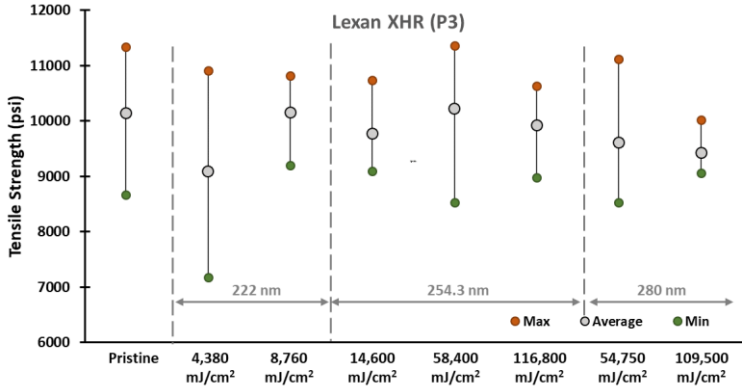
Color Change UV-C Light Conditioning

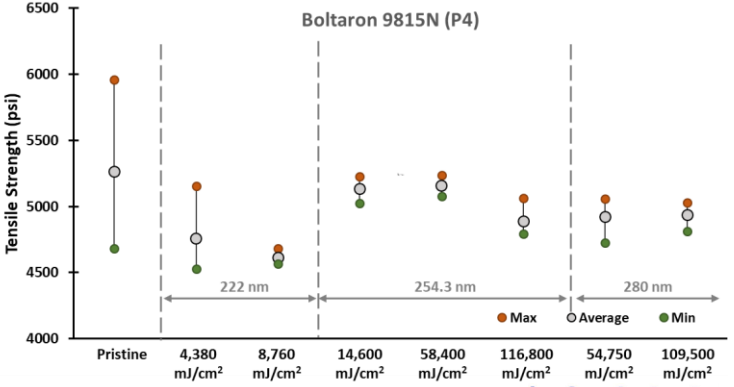


UV-C Strength Characterization Results





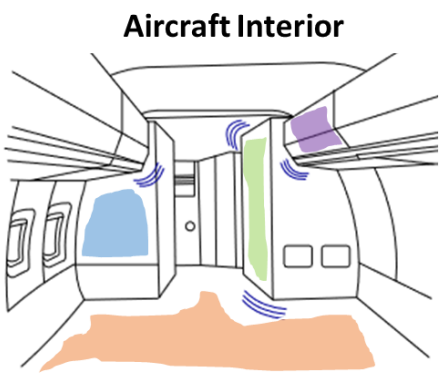


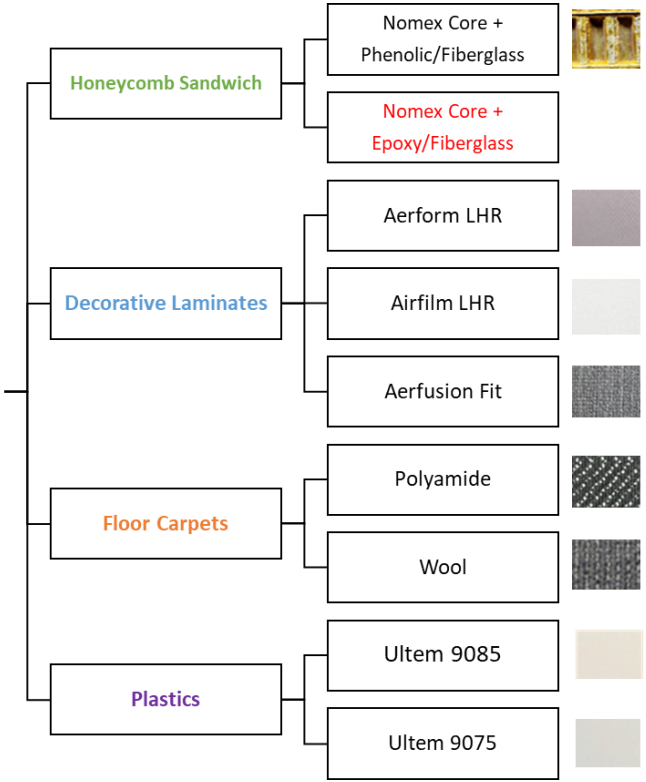


UV-C Strength Characterization Results

- **Four different type of plastics were exposed to three different wavelength configurations of UV-C light**
- **Qualitative color changes were observed only when exposed to wavelength of 253.4 nm and 222 nm.**
- **No significant change was observed in the weight of the specimens**
- **Tensile properties were evaluated for all plastics by limited coupon level experiments (x3 specimens per dosage level):**
  - For Kydex 6565 –
    - No significant reduction in yield stress observed. Although smaller values were observed across all the wavelengths.
    - Reduction in tensile strength and failure strain observed for all wavelengths
  - For Boltaron 9815 E –
    - No reduction in yield stress observed
    - Reduction in tensile strength and failure strain observed for 253.4 nm and 222 nm
  - For Lexan XHR –
    - No reduction in yield stress observed. Only 253.4 nm lower dosage results in smaller yield value when compared to pristine samples.
    - Reduction in tensile strength observed for 222 nm and 280 nm. 253.4 nm results seem to be within the scatter of the pristine data.
  - For Boltaron 9815 N –
    - Reduction in yield stress for only 222 nm
    - Reduction in tensile strength and failure strain observed for all wavelengths. With larger effects on 222 nm and 280 nm.
- **Due to the limited amount of samples tested (x3 specimens per dosage level), this data cannot be considered statistically significant and all these are qualitative observations.**

Materials for Cabin Interior





- Honeycomb Sandwich Panel –
  - Flammability Test
  - Flatwise Compression Test
  - Drum Peel Test
  - Flexure Test
- Decorative Laminates –
  - Flammability Tests
  - Tension Tests
- Floor Carpets –
  - Flammability Tests
- Plastics –
  - Flammability Tests
  - Tension Tests

Questions?