

# IUVA Task Force: **Understanding the Impacts of UV-C Exposure on Polymer Degradation**

## Phase 3 2023-2024





# IUVA Task Force – UVC Impact on Materials

## PURPOSE

Provide a shared understanding for the impacts of various UV-C disinfection technologies on polymeric materials through the development of meaningful scientific data.

Develop testing protocols to establish a framework for standardizing UV-C exposure testing of polymeric materials.

## SCOPE

**Polymeric materials which commonly encounter UV-C disinfection.**

**UV-C disinfection technologies broadly used for surface disinfection.**

**Analytical techniques which capture relevant changes to the materials.**

**Round robin testing to evaluate consistency of results between different technologies.**



# Systematic Approach

## Phase 1

- Focus on the unformulated resins to understand their behavior when exposed to the UVC technologies most commonly used for disinfection purposes
- Monitor the most important physical properties to capture the severity of the degradation
- Based on survey the most commonly used polymers were selected and the critical properties

## Phase 2

- Focus on a selection of fully formulated polymeric systems that are used in real life for applications that are commonly exposed to the same UVC technologies for disinfection purposes
- Monitor the most important physical properties to capture the severity of the degradation
- Based on survey the most commonly used polymers were selected and the critical properties

## Phase 3

- What is the dose reciprocity for UVC exposure (time vs dosage)
- How can we extrapolate our findings to determine the lifetime of the material up to 10 years (request from ANSI)
- What is the degradation mechanism



# Member Participation

*Members contributed in a variety of ways, during phase I and II, for example*

- Sample UV exposure (LP-Hg, UV-LED, Excimer)
- Sample generation (coupons, tensile bars)
- Sample testing (tensile, colorimetry, reflectance, transmission)
- Subtask force management and logistics
- Data Analysis
- Report/Paper writing and review



# Timeline

Tasks	Responsibility	23-Jan	23-Feb	23-Mar	23-Apr	23-May	23-Jun	23-Jul	23-Aug	23-Sep	23-Oct	23-Nov	23-Dec
Peer Review article													
UV Solutions article	TBC												
Selection of Phase 3 topic	All												
Preparation of Phase 3 approach	TBC												

## Peer Review Article

- The executive committee has now approved sending the material degradation manuscript to the Board for review with a one-week review period.
- The target publication of either “Polymer” or “Journal of Polymer Science” needs justification for open access
- Other free open access journals such as IWA may be considered
  - Note these are water specific while the Phase I and 2 work is relevant to surface irradiation as well

UV Solutions Article pending acceptance of peer review article


NOTE: Unpublished results should not be shared outside of the task force



# Phase 3 Actions

## Phase 3 Aim

- What is the dose reciprocity for UVC exposure (time vs dosage)
- How can we extrapolate our findings to determine the lifetime of the material up to 10 years (request from ANSI)
- What is the degradation mechanism

1. Determine materials 
2. Determine metrics
3. Determine test parameters
  1. Wavelengths for testing
  2. Dose range
  3. Irradiance Range (Note: Time dose reciprocity for UV disinfection, 3 orders of magnitude<sup>1</sup>)
  4. Dose points
  5. No. of sample replicates

1. R. Sommer, T. Haider, A. Cabaj, W. Pribil, M. Lhotsky, Time dose reciprocity in UV disinfection of water, Water Science and Technology, Volume 38, Issue 12, 1998, Pages 145-150, ISSN 0273-1223

# Phase3 Material Selection

AquiSense Technologies



1. Polycarbonate (PC)
2. Acrylonitrile-Butadiene-Styrene (ABS)
3. Polypropylene (PP)
4. Poly(methyl methacrylate) (PMMA)
5. Nylon 6
6. Polysiloxane
7. Polyvinyl Chloride (PVC)
8. Polycarbonate (PC) Copolymer

# Phase3 Metrics



## Screening Test

1. Gloss
2. Color

## Full Test

1. Tensile/Elongation
2. SEM
3. Gloss
4. Color
5. Other?



# Screening Test



## UVC Technologies:

1. Low Pressure Mercury – 254 nm
1. KrCl Excimer Far UVC – 222 nm
1. UVC LED – 280 nm  $\pm$  5 nm

## Action Choose

1. Material(s)
2. Wavelength(s)
3. Exposure Range

## Phase 2 parameters

**Average Irradiance:**  
**0.5–8.0 mW/cm<sup>2</sup>**

**Maximum Energy Dosage: 500,000 mJ/cm<sup>2</sup>**

**Estimated Time to Reach Final Dosage**  
**(assuming 1.0 mW/cm<sup>2</sup>):**  
**~139 hours (69–277 hours)**

**Number of Intervals (color chips):**  
**4 (including time zero)**  
**0 mJ/cm<sup>2</sup> | 30K mJ/cm<sup>2</sup> | 150K mJ/cm<sup>2</sup> | 500K mJ/cm<sup>2</sup>**

**Number of Intervals (tensile bars):**  
**2 (including time zero)**  
**0 mJ/cm<sup>2</sup> | 500K mJ/cm<sup>2</sup>**

**Temperature: ~Ambient**  
**Humidity: Noted but not controlled**

# Member Participation-Screening Test

AquiSense Technologies



- Sample UV exposure (LP-Hg, UV-LED, Excimer)
- Sample generation (coupons, tensile bars)
- Sample testing (tensile, colorimetry, reflectance, transmission)