CHARACTERIZATION OF THE INDUCED CONTAMINATION AFTER ATOMIC OXYGEN EROSION OF SPACE MATERIALS

Riyo YAMANAKA, Yugo KIMOTO
Research Unit I, Research and Development Directorate, JAXA

Delphine FAYE, Guillaume RIOLAND, Jean-Michel DESMARRES
DSO/AQ/LE Laboratories & Expertise Department, CNES

The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France
Background

- Japan Aerospace Exploration Agency (JAXA) and the Centre National d'Etudes Spatiales (CNES) have been carrying on collaborative activities for years, which are based on

“Inter-Agency Agreement between JAXA and CNES concerning the cooperation in the field of space programs”.

- The agreement was concluded in 2010, and our collaborative activities were initiated in the contamination field.
Background

Our recent collaborative test campaign focuses on

“**Atomic Oxygen Induced Contamination**.”
Today’s Contents

- Introduction
  - About “ATOX induced contamination”.
  - Motivation
  - Objectives of our collaborative test

- Experiment
  - Concept
  - ATOX irradiation
  - Test samples
  - Analysis methods

- Results & discussion
  - Visual Inspection
  - Optical Microscopy
  - Mass Measurement
  - Profilometry
  - Qualitative Analysis on Particles with SEM/EDS
  - FT-IR spectroscopy
  - XPS

- Conclusion
Introduction
Introduction - Effect of “Atomic Oxygen (ATOX)”

- variation of material thickness
- variation of emissivity
- deterioration of protective layers
- deterioration of MLI
- erosion of composite materials
- erosion of contaminants
- recovery of surfaces

The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France
Introduction - Our motivation

Induced contamination: new deposits on adjacent sensitive surfaces on satellite
degradation of the performance of instruments

However...
- Poor literature
  up to now: almost all the studies focused on the determination of the erosion yield of materials

Nevertheless...
- More and more long duration missions in low orbit
  ➔ Materials exposed to high ATOX fluence
  ➔ More surfaces sensitive to contamination

Increasing demand to quantify the level of induced contaminants

*The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France*
Introduction - Objectives

- To characterize the molecular and particulate contamination induced by ATOX under vacuum
- To characterize ATOX induced contamination’s effects on the sensitive surfaces of optical instrument on spacecraft
- To improve the design of the instruments and the selection of exposed materials

The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France
Experiment
Experiment - Concept of our AIC test

If AIC were induced by ATOX…

AIC can be collected by collector plates!

The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France
Experiment - ATOX irradiation

- Conditions of ATOX irradiation

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ATOX average flux</td>
<td>4.7E15 atoms/cm(^2)/s (Test 1)</td>
</tr>
<tr>
<td></td>
<td>3.7E15 atoms/cm(^2)/s (Test 2)</td>
</tr>
<tr>
<td>ATOX beam average speed</td>
<td>8.1 km/s (Test 1 and Test 2)</td>
</tr>
<tr>
<td>ATOX fluence</td>
<td>1.0E21 atoms/cm(^2) (Test 1 and Test 2)</td>
</tr>
</tbody>
</table>

The Combined Space Effects Test Facility
## Experiment - Test samples

<table>
<thead>
<tr>
<th>Materials</th>
<th>Sample ID</th>
<th>Collector plate</th>
<th>Collector plate ID</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Betacloth</strong></td>
<td>B-1</td>
<td>PFO</td>
<td>P-1</td>
</tr>
<tr>
<td></td>
<td>B-2</td>
<td>ZnSe</td>
<td>Z-1</td>
</tr>
<tr>
<td></td>
<td>B-3 (Reference sample)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Kapton (110 µm)</strong></td>
<td>K-1</td>
<td>PFO</td>
<td>P-2</td>
</tr>
<tr>
<td></td>
<td>K-2</td>
<td>ZnSe</td>
<td>Z-2</td>
</tr>
<tr>
<td></td>
<td>K-3 (Reference sample)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>UPILEX-S (125 µm)</strong></td>
<td>U-1</td>
<td>Al mirror</td>
<td>A-1</td>
</tr>
<tr>
<td></td>
<td>U-2 (Reference sample)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Kapton 200 HN</strong></td>
<td>H-1</td>
<td>PFO</td>
<td>P-3</td>
</tr>
<tr>
<td><strong>Alum. on 1 side (50 µm)</strong></td>
<td>H-2</td>
<td>ZnSe</td>
<td>Z-3</td>
</tr>
<tr>
<td></td>
<td>H-3 (Reference sample)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>CFRP</strong></td>
<td>C-1</td>
<td>PFO</td>
<td>P-4</td>
</tr>
<tr>
<td></td>
<td>C-2</td>
<td>ZnSe</td>
<td>Z-4</td>
</tr>
<tr>
<td></td>
<td>C-3 (Reference sample)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>UPILEX-S (125 µm)</strong> with UV irradiated silicone contaminants</td>
<td>U-3</td>
<td>Al mirror</td>
<td>A-2</td>
</tr>
<tr>
<td></td>
<td>U-4 (Reference sample)</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**CNES samples**  **JAXA samples**

*The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France*
Experiment - Analysis methods

- **Visual inspection** by using the digital camera (EOS kiss X70; Canon Co.)
  ➡ All materials and collector plates

- **Optical microscopy** by using the optical microscopy (VHX-900; KEYENCE Co.)
  ➡ All collector plates

- **Mass measurement** by using the microbalance (MX6; Mettler Toledo International, Inc.)
  ➡ All materials and ZnSe

- **Profilometry** by using Sensofar optical profilometer
  ➡ Betaclloth (B-2), Kapton (110 µm) (K-2), Kapton 200HN (H-2), CFRP (C-2)

- **Qualitative analysis on particles with SEM/EDS** by using Hitachi SEM and Oxford EDS spectrometer
  ➡ PFO and Al mirrors

- **FT-IR Spectroscopy** by using the FT-IR spectrometer (Spectrum One; PerkinElmer Co.)
  ➡ ZnSe

- **XPS analysis** by using the THERMO K-alpha X-ray photoelectron spectrometer
  ➡ Betaclloth (B-1, B-3), Kapton (110 µm) (K-1, K-3) and CFRP (C-1, C-3)
Results
Results - Visual Inspection of materials

- Betacloth
  - Before
  - After
  - B-1
  - B-2
  - B-3

- Kapton (110μm)
  - Before
  - After
  - K-1
  - K-2
  - K-3

- UPILEX-S (125μm)
  - Before
  - After
  - U-1
  - U-2

AO irradiated samples
Reference sample

The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France
Results - Visual Inspection of materials

- Kapton 200 HN Alum. on 1 side (50 µm)
  - Before
  - After
  - H-1
- CFRP
  - Before
  - After
  - C-1
  - Before
  - After
  - C-2
- UPILEX-S (125µm) with UV irradiated silicone contaminants
  - Before
  - After
  - U-3

The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France
Visual change was observed on all surfaces of ATOX irradiated materials, except the area with silicone layer.

Visual change was not observed at all surfaces of non ATOX irradiated materials.
Results - Visual Inspection

- different morphologies of particles: blanket of many very thin particles and some bigger ones above plus fibres on every PFO plates and mirrors
- on P-4: some whitish traces
- Size range: 1-1000 μm
- Surface obscuration on PFO > 2450 ppm

The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France
Results - Optical Microscopy

- P-1 (close to Betacloth)
- P-2 (close to Kapton 110 μm)
- P-3 close to Kapton 200 HN
Results - Optical Microscopy

- P-4 close to CFRP
- A-1 close to UPILEX-S
- A-2 close to UPILEX-S with UV irradiated silicone contaminants
Results
-Visual Inspection and optical microscopy of collector plates-

The exposed surfaces dedicated to collect contaminants are remarkably visible.

Different morphologies of particles, blanket of many very thin particles and some bigger ones above plus fibres on every PFO plates and Al mirrors were observed.
# Results - Mass Measurement

- **Betacloth**

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Mass (mg)</th>
<th>Mass loss (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>B-1</td>
<td>154.313</td>
<td>150.373</td>
</tr>
<tr>
<td>B-2</td>
<td>153.255</td>
<td>149.115</td>
</tr>
<tr>
<td>B-3</td>
<td>153.449</td>
<td>153.444</td>
</tr>
</tbody>
</table>

- **Kapton (110µm)**

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Mass (mg)</th>
<th>Mass loss (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>K-1</td>
<td>112.003</td>
<td>97.690</td>
</tr>
<tr>
<td>K-2</td>
<td>114.548</td>
<td>100.593</td>
</tr>
<tr>
<td>K-3</td>
<td>111.837</td>
<td>111.814</td>
</tr>
</tbody>
</table>

- **UPILEX-S (125µm)**

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Mass (mg)</th>
<th>Mass loss (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>U-1</td>
<td>136.019</td>
<td>124.765</td>
</tr>
<tr>
<td>U-2</td>
<td>132.376</td>
<td>132.367</td>
</tr>
</tbody>
</table>

- **Kapton 200 HN Alum. on 1 side (50 µm)**

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Mass (mg)</th>
<th>Mass loss (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>H-1</td>
<td>44.017</td>
<td>30.093</td>
</tr>
<tr>
<td>H-2</td>
<td>44.294</td>
<td>31.080</td>
</tr>
<tr>
<td>H-3</td>
<td>44.466</td>
<td>44.496</td>
</tr>
</tbody>
</table>

- **CFRP**

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Mass (mg)</th>
<th>Mass loss (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>C-1</td>
<td>1809.454</td>
<td>1797.087</td>
</tr>
<tr>
<td>C-2</td>
<td>1818.056</td>
<td>1805.960</td>
</tr>
<tr>
<td>C-3</td>
<td>1749.466</td>
<td>1747.941</td>
</tr>
</tbody>
</table>

- **UPILEX-S (125µm) with UV irradiated silicone contaminants**

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Mass (mg)</th>
<th>Mass loss (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>U-3</td>
<td>134.552</td>
<td>134.296</td>
</tr>
<tr>
<td>U-4</td>
<td>131.139</td>
<td>130.987</td>
</tr>
</tbody>
</table>
All ATOX irradiated materials lost mass whereas the FTIR witnesses masses increased.

There is a possibility that UV irradiated silicone contaminants prevent mass loss.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Mass (mg)</th>
<th>Mass loss (mg)</th>
<th>After-Before</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>Z-1</td>
<td>5329.915</td>
<td>5329.549</td>
<td>0.034</td>
</tr>
<tr>
<td>Z-2</td>
<td>5493.096</td>
<td>5493.110</td>
<td>0.014</td>
</tr>
<tr>
<td>Z-3</td>
<td>5351.251</td>
<td>5351.262</td>
<td>0.011</td>
</tr>
<tr>
<td>Z-4</td>
<td>5332.206</td>
<td>5332.222</td>
<td>0.016</td>
</tr>
</tbody>
</table>
Results - SEM/EDS analysis

On P-1 (close to Betacloth)
particles mostly composed of C and F
longer straight fibres composed of Si and O

origin may be due to the erosion of the
fluoropolymer coating resulting in C/F residues and naked weakened fiberglass

On all the other substrates
particles characterized by a complex morphology
no straight fibres like those found particularly on P-1
C, O detected
F surprisingly detected

another source of fluorine investigated:
Teflon poppet located in the path of AO flux inside the facility
Results - SEM/EDS analysis

- elements detected corresponding to AIC particles: C, O, F, Si
- metallic elements: mainly Al and sometimes Fe, Cr, Ni...
- elements from minerals like salts
- F detected even if it does not come from the polymer
  considered as foreign matter
Results - topography measurements

first direct measurements: unsatisfactory
• very poor resolution for the Betacloth and CFRP
• samples problem of reflectivity for the Kapton samples

use of replicas

replica principle: to apply a fast curing silicon rubber on the surface to be analyzed
flexible high resolution replica

Betacloth specimen and replica
CFRP specimen and replica
Kapton 200HN specimen and replica
Kapton specimen and replica

The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France
Results - topography measurements

- **Betaclth replica**

- **CFRP replica**

Top resin layer eroded. Height differences depend on the fibre position. Carbon fibres stable under ATOX flux.

Slightly erosion roughness locally increased on eroded side. PTFE resin eroded on ATOX exposed side.
Results - topography measurements

- Kapton 200 HN replica
- Kapton (110µm) replica

- Red line profile
  - Height difference = 25.15 µm

- Blue line profile
  - Height difference = 22.80 µm

very similar erosion depths of more than twenty microns
similar roughness evolution with the eroded area rougher than the reference
Results - FT-IR spectroscopy

- Z-1 close to Betacloth
- Z-2 set up with Kapton (110μm)
- Z-3 close to Kapton 200 HN Alum. on 1 side (50 μm)
- Z-4 set up with CFRP (C-2)
Results - FT-IR spectroscopy

All FT-IR spectra were almost unchanged before and after ATOX irradiation.

There is a possibility that not enough AIC was deposited on ZnSe to be detected by FT-IR spectroscopy.
Results - XPS analysis

on samples as received, on two areas with and without ATOX irradiation
✓ elemental quantitative analysis
✓ study of chemical states
✓ quantitative profile with ions Ar+ clusters at 6 kV from the surface to the core

<table>
<thead>
<tr>
<th>area</th>
<th>C</th>
<th>O</th>
<th>N</th>
<th>Na</th>
<th>Ca</th>
<th>K</th>
<th>Mg</th>
<th>F</th>
<th>Si</th>
<th>S</th>
<th>Al</th>
<th>Ni</th>
<th>Cu</th>
<th>Cr</th>
<th>O/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kapton</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>110 µm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K-1</td>
<td>61.7</td>
<td>27.7</td>
<td>7.6</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&lt;0.1</td>
<td>0.2</td>
<td>&lt;0.1</td>
<td>-</td>
<td>0.4</td>
<td>0.3</td>
<td>0.8</td>
<td>0.45</td>
</tr>
<tr>
<td>K-3</td>
<td>64.0</td>
<td>28.1</td>
<td>6.2</td>
<td>0.7</td>
<td>&lt;0.1</td>
<td>0.1</td>
<td>-</td>
<td>0.8</td>
<td>0.1</td>
<td>T’?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.44</td>
</tr>
<tr>
<td>Betacloth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-1</td>
<td>15.1</td>
<td>35.5</td>
<td>0.5</td>
<td>0.9</td>
<td>8.5</td>
<td>2.3</td>
<td>23.5</td>
<td>8.0</td>
<td>-</td>
<td>5.3</td>
<td>-</td>
<td>0.4</td>
<td>-</td>
<td>-</td>
<td>2.35</td>
</tr>
<tr>
<td>B-3</td>
<td>28.6</td>
<td>0.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>70.4</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.03</td>
</tr>
<tr>
<td>CFRP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-1</td>
<td>46.0</td>
<td>38.3</td>
<td>1.2</td>
<td>0.1</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>0.9</td>
<td>12.4</td>
<td>-</td>
<td>0.5</td>
<td>0.1</td>
<td>0.1</td>
<td>-</td>
<td>0.83</td>
</tr>
<tr>
<td>C-3</td>
<td>62.3</td>
<td>29.1</td>
<td>3.5</td>
<td>0.2</td>
<td>1.1</td>
<td>-</td>
<td>-</td>
<td>0.2</td>
<td>3.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.1</td>
<td>-</td>
<td>0.47</td>
</tr>
<tr>
<td>UPLEX-S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U-1</td>
<td>49.5</td>
<td>35.4</td>
<td>4.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.4</td>
<td>10.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&lt;0.1</td>
<td>-</td>
<td>0.72</td>
</tr>
<tr>
<td>U-2</td>
<td>66.5</td>
<td>24.2</td>
<td>7.4</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.2</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.36</td>
</tr>
</tbody>
</table>

The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France
### Results – XPS chemical states

#### C1s photopeak synthesis

- **Kapton (110 µm)**

<table>
<thead>
<tr>
<th>area</th>
<th>C-C/C-H</th>
<th>C-N</th>
<th>C-O</th>
<th>N-C=O</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-1</td>
<td>39</td>
<td>22</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>K-3</td>
<td>40</td>
<td>23</td>
<td>16</td>
<td>20</td>
</tr>
</tbody>
</table>

- **UPILEX-S**

<table>
<thead>
<tr>
<th>area</th>
<th>C-C/C-H</th>
<th>C-N/C-O</th>
<th>C-O</th>
<th>C=O</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-1</td>
<td>33</td>
<td>38</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>U-2</td>
<td>67</td>
<td>13</td>
<td>-</td>
<td>20</td>
</tr>
</tbody>
</table>

- **Betaclth**

<table>
<thead>
<tr>
<th>area</th>
<th>C-C/C-H</th>
<th>C-O</th>
<th>O-C/O=C=O</th>
<th>O-C=O</th>
<th>-CF2</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>54</td>
<td>8</td>
<td>9</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>B-3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
</tbody>
</table>

- **CFRP**

<table>
<thead>
<tr>
<th>area</th>
<th>graphitic</th>
<th>C-C/C-H</th>
<th>C-O/C-N</th>
<th>C=O/O-C-O</th>
<th>O-C=O/ N-C=O</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1</td>
<td>main</td>
<td>-</td>
<td>traces</td>
<td>traces</td>
<td>traces</td>
</tr>
<tr>
<td>C-3</td>
<td>60</td>
<td>60</td>
<td>25</td>
<td>9</td>
<td>6</td>
</tr>
</tbody>
</table>

#### Si2p photopeak synthesis

<table>
<thead>
<tr>
<th>area</th>
<th>silicate</th>
<th>silica</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>C-3</td>
<td>82</td>
<td>18</td>
</tr>
</tbody>
</table>
Results - XPS profiles

- Kapton (110 µm)

- CFRP
Results - XPS analysis

- Kapton
  - low degradation under irradiation with presence of calcium in the core of the sample
  - weak oxygen enrichment

- Betacloth
  - strong degradation of the organic matrix with higher detection of the glass fibres

- CFRP
  - strong degradation of the organic matrix with higher detection of silica, possibly due to an oxidation of a cross-contamination of silicone from the neighbouring contaminated UPILEX-S sample
  - graphitization of carbon from the matrix (graphitized depth around 100 s etched)
  - Note: oxygen enrichment and calcium and nitrogen depletion were also observed in the film after irradiation

- presence of fluorine on most samples, more detected on CFRP ones, considered as foreign matter coming from the poppet material outgassing (Teflon)
  - Note: elemental composition of the poppet piece in at. %: C: 31.6 – O: 0.2 – F: 68.2
- presence of metallic traces (e.g. Ni, Cu, Cr) on the substrates after irradiation, considered as foreign matter
Conclusion
Conclusion

new approach to consider all types of contaminants and especially particles generated during ATOX irradiations of polymers

twofold aim:
I. to identify the nature of the contaminants (particulate and/or molecular)
II. To characterize their effects on the sensitive surfaces of optical instrument on spacecraft

focused on the generation of contaminants by ATOX erosion of polymers:

mass loss measurements of the samples, mass increase of the molecular witnesses visual inspection of the collector plates

evidence of deposits and particles in the vicinity of the irradiated materials

Both, irradiated samples and contaminants analysed by different techniques (EDS, XPS, FTIR, UV-vis, profilometry) consistent results demonstrated the origin of the contaminants.

next step: new tests campaign to characterize the performance loss of contaminated optical components before and after ATOX irradiation

*The 14th International Symposium on Materials in the Space Environment – 3rd of October, 2018, Biarritz, France*
Thank you for your attention