INFLUENCE OF TEST CONDITIONS AND VARIABILITY OF END-OF-LIFE SOLAR ABSORPTANCE OF THERMAL CONTROL MATERIALS

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ABSTRACT

This paper reports on 20-year ground ageing test data on thermo-optical performance of SG121FD/122FD and PSB/N paintings. It shows the influence of test parameters on results and provides estimate of experimental solar absorptance variability for these coatings.

End-Of-Life (EOL) solar absorptance \( \alpha_s \) is of concern for thermal control system designer. This parameter is known to be radiation-sensitive and has to be estimated from ground testing with representative test conditions. Combined particles/UV testing associated to in situ measurement is generally carried out for surface materials in order to approach realistic and valid degradation mechanisms. The SEMIRAMIS facility at ONERA DPHY allows for simulating GEO dose profile with electrons, protons and UV and in situ reflectance measurement. Reference paintings SG121FD, SG122FD, PSB and PSBN are used at each CNES test campaign to check reproducibility of test conditions and thus ensure the ageing data on new painting developments can be compared to previous formulation. This paper takes advantage of 20-year test data to investigate the relative influence of test parameters and variability of EOL \( \alpha_s \).

To discard dispersion of Beginning-Of-Life (BOL) \( \alpha_s \), the analysis focused on \( \Delta \alpha_s \), i.e. degradation related to a single step or full test flow (for similar or different experimental conditions).

Standard test sequence here always includes first UV, electron (bulk) then proton (surface) doses for increasing dose levels (1-, 3- ... 8-years in GEO). As an illustration below the mean degradation and dispersion after

- 1-year GEO UV dose (Table 1),
- 1-year GEO electron dose (Figure 1).

Table 1 - \( \Delta \alpha_s \) after 1000ESH UV dose for 13 test campaigns. The figures accounts for all data whatever the UV acceleration (in the 3-7 suns range) or spectrum.

<table>
<thead>
<tr>
<th>sample</th>
<th>Mean ( \Delta \alpha_s ) and std-deviation</th>
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<tbody>
<tr>
<td>PSB</td>
<td>0.032 ± 0.008 (25%)</td>
</tr>
<tr>
<td>PSBN</td>
<td>0.016 ± 0.004 (25%)</td>
</tr>
<tr>
<td>SG121FD</td>
<td>0.011 ± 0.004 (36%)</td>
</tr>
<tr>
<td>SG122FD</td>
<td>0.010 ± 0.003 (31%)</td>
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</tbody>
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Figure 1 – \( \Delta \alpha_s \) induced by 1-year electron GEO dose on PSB painting at 8 different test campaigns. Beam current is indicated (i.e. flux or dose rate).

In Figure 1, the worst cases degradation observed in 2007 and 2014 is not due to larger flux (dose rate effect) but to a tight timing (time effect) (no waiting time between irradiation and measurement).

In the end, the dispersion on EOL \( \Delta \alpha_s \) is in the 10-20% (for 1 to 3-year GEO experiments), same order of magnitude as for \( \Delta \alpha_s \) due to protons (surface dose). More data and complete analysis will be provided in the final paper: impact of beam flux (electron and UV), UV spectrum (standard or enhanced), photo-annealing and test sequence and timing.


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