Executive Summary COIN COAT Project

Project leader: CeraNovis GmbH; GERMANY

Thermo-optical coatings are used to control and to protect sensitive surfaces of satellites and spacecrafts. The paints are mostly either black (high α) and conducting or they are white (low α) and non-conducting. Most paint also do not originate from Europe.

COIN COAT is an acronym for COnducting Inert Non-hazardous COATings and wants to overcome the statement that a conducting paint needs to be black.

The project was funded under the OSIP-platform and dealt with the development of a white thermo-optical coating with the goal to achieve a coating with an α<0.3 with electrically conducting properties and additional advantages.

A first development goal shall establish ESD properties (surface resistivity in the low $M\Omega_{\square}$ range), in the second step a conductivity in the $k\Omega_{\square}$ range shall be achieved. The coating shall be designed to be non-hazardous and REACH compliant; it shall be ambient curing and it shall be applicable to aluminium and CFRP surfaces. The application is foreseen to be performed by spraying with a layer thickness < 100 µm. Technically two routes shall be pursued:

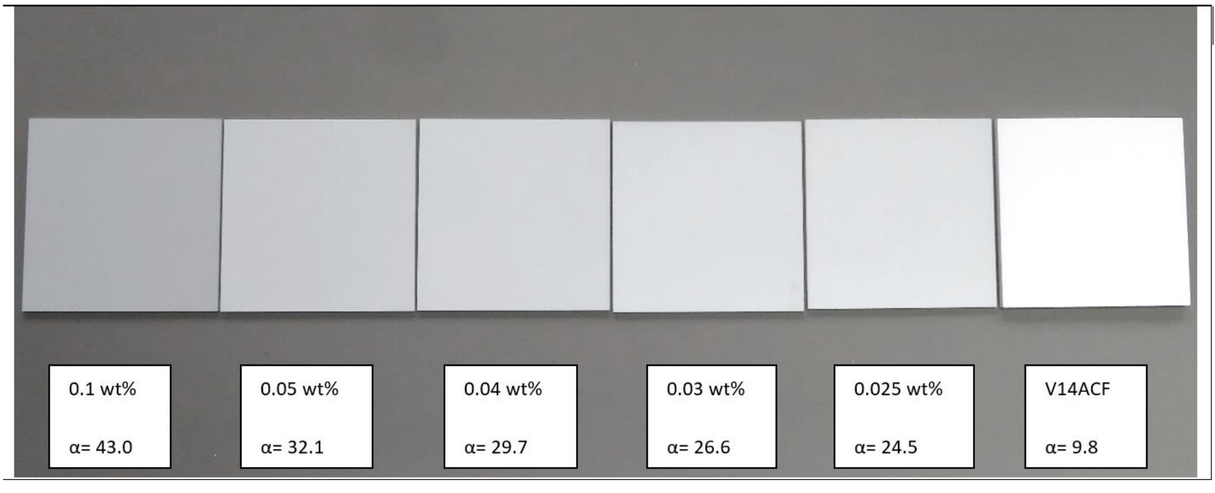
Route 1 starts with an aqueous system consisting of inert lithium or potassium water glass binder, white inert fillers (e.g. Al_2O_3, Y_2O_3, BN) and conducting materials with relatively low alpha e.g. ITO, AZO or ATO coated silica spheres, steel flakes, metal coated fibres or other. These fillers are expected to be conductive at low percolation threshold values. Their influence on alpha shall thus be low.

The second route deals with a commercial low VOC or VOC-free methylsiloxane binder in combination with similar white inert fillers (Al_2O_3, Y_2O_3, BN) and similar conducting materials. Additionally, aluminium flakes are compatible with these non-aqueous systems.

The final system shall have a TRL of 4 with conducting properties, low α (< 0.3), high epsilon (> 0.8) and ECSS conformal adhesion to various substrates. It shall also be curable at low temperatures (ideally room temperature), be inert to contamination and stable under space conditions (high vacuum, UV irradiation, T_{max} = 120°C) with no significant deterioration of mechanical and optical properties.

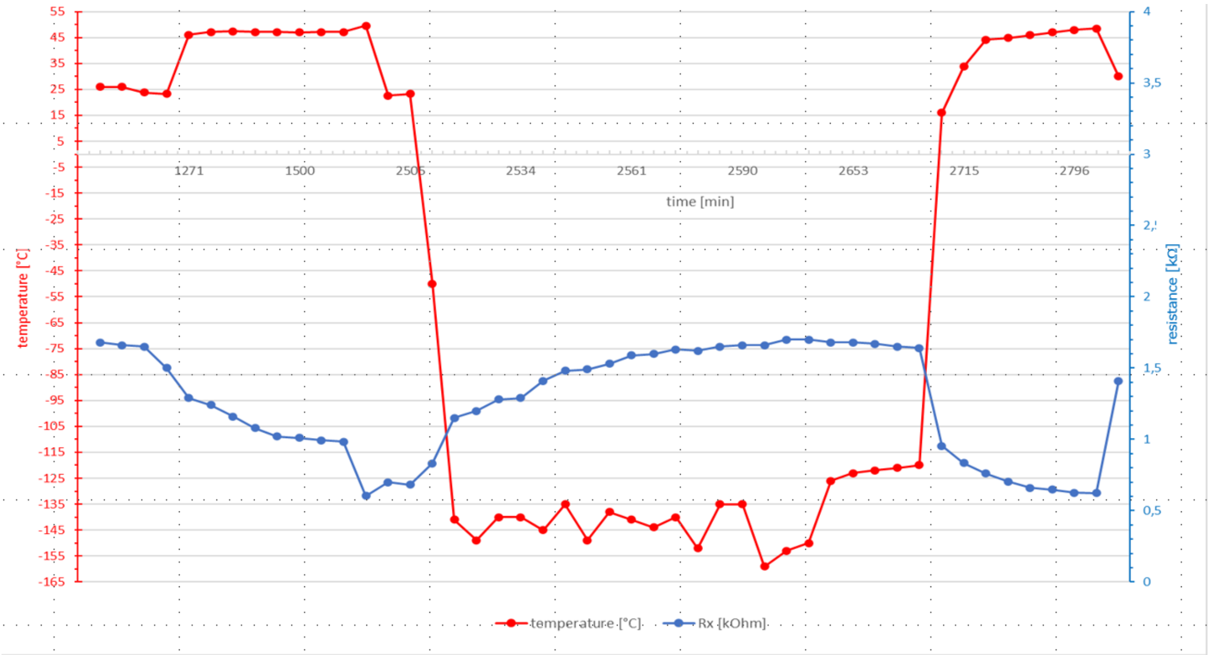
RESULTS

Route 1 proved to be the most promising route and identified a filler which only needed to be incorporated in very low amounts to achieve an α <0.3. The percolation threshold could be found at below 0.05%. Picture 1 shows the α in dependence of filling .



Picture 1

This system called LF13 with 0.04% of conducting filler showed excellent conductivity, even under vacuum and varying temperatures as shown in picture 2 below. For this purpose, a set-up was developed that permitted resistivity measurements in dry condition in the first stage and even thermo-controlled resistivity measurement in vacuum better than 10^{-6} mbar in the final stage.



Picture 2

The LF13 system also successfully passed Estec ESD´s requirements and achieved all other requirements such as adhesion, ε, outgassing or thermocyling.

Route 2 called SiloxaneV14 proved a bit more challenging and especially the combination of low α and low resistivity proved to be more complicated. At the final stage state an α of 0.4 is needed to achieve sufficiently low resistivity. All other requirements were though the filling degree was significantly higher to achieve percolation threshold and the absorption in the IR was also higher.

Table 1 shows the summarised results of both routes in terms of pass/fail

criterium	LF13	Siloxane V14
optical appearance	✓ pass	✓ pass
solar absorptance α < 0.3	✓ pass	✓ pass
emissivity ε > 0.8	✓ pass	✓ pass
adhesion (X-cut, tape-test)	✓ pass	✓ pass
thermoshock, thermocycling	✓ pass	✓ pass
outgassing	✓ pass	✓ pass
ESD properties in vacuum	✓ pass	✗ fail

Table 1

It is foreseen to further develop the projects results and mainly to investigate the topics: stability under V/UV, long-term stability, optimisation of route 2, optimisation of dispersion process to reduce percolation threshold, esp. for route 2 and behaviour under contamination.

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