SOCOMORE

DEVELOP
MANUFACTURE
COMMERCIALIZE

21 people in R&D
80% activity / aerospace
$46M sales

Main Development Areas for Paint Shop Processes
- Sol-gel technologies + Deoxidizers
- VOC Reduction in Surface Preparation (pre-saturated wipes)
- Paint Strippers according to EH&S regulation
- Non-VOC and Low-VOC cleaners for paint equipment

Located Worldwide
- Americas
- Europe
- Middle-East & Asia
Hexavalent chrome alternatives

Sol-gels for corrosion protection

SOCOGEL HCP

A heat-cured anticorrosion sol-gel

SOCOGEL UV Cured

Hybrid sol-gel coating system

Cr(III) and post treatment
Conversion
Sealing after anodizing
Sol-gels
Strong links with surface and with organic coat

**Adhesion promoter and functional coating**

Sol-gel is used as an interface

Schematic drawing of a sol-gel coating.
### Sol-gel for enhanced adhesion

<table>
<thead>
<tr>
<th>Colors</th>
<th>Approvals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Socogel B0202</strong></td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>✓ Boeing (BMS 10-128)</td>
</tr>
<tr>
<td>Clear</td>
<td>✓ Comac (CMS CT-401)</td>
</tr>
<tr>
<td><strong>Socogel A0203</strong></td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>✓ Airbus (AIP 05-02-018)</td>
</tr>
<tr>
<td></td>
<td>✓ Bombardier</td>
</tr>
<tr>
<td></td>
<td>✓ Dassault Aviation</td>
</tr>
<tr>
<td></td>
<td>✓ Target: Comac</td>
</tr>
</tbody>
</table>
Sol-gel for corrosion protection

SOCOGEEL HCP
A heat-cured anticorrosion sol-gel

SOCOGEEL UV Cured
Hybrid sol-gel coating system
• Heat cured anti-corrosion sol-gel
• 3 component formulation (3K)
• High corrosion protection performances (ISO 9227)
  • From 336 hrs (unclad Aluminium) to 1000 hrs (clad Aluminium)
  • > 3000 hrs with Airbus or Boeing paint systems
• Chrome-free
# SOC OGE L HCP Application

| Surface preparation | Alkaline cleaning  
|                     | Alkaline etching (optional)  
|                     | Acid Chemical DEOX  
| Socogel HCP preparation | **3-part kit**  
| Induction time | Mix part C and part F continuously for 1.5h at room temperature  
| Pot-life after induction | Add part CM and mix continuously for 30 minutes at room temperature  
|                     | 2h  
| Socogel HCP application | Spraying - Manually or by robot  
| Socogel HCP curing | **230°F (110°C) - 30 min**  

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## SOC OGEL HCP performance parameters

<table>
<thead>
<tr>
<th>With paint system</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adhesion promoter</strong></td>
</tr>
<tr>
<td><strong>Anti-corrosion protection with Airbus/Boeing paint system</strong></td>
</tr>
<tr>
<td>Protection against filiform corrosion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Without paint system</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active anti-corrosion protection (self healing)</strong></td>
</tr>
<tr>
<td><strong>Anti-corrosion protection</strong></td>
</tr>
<tr>
<td><strong>AI 2024-T3</strong></td>
</tr>
<tr>
<td><strong>AI 7075-T6</strong></td>
</tr>
<tr>
<td><strong>AI 5xxxx and 6xxxx series</strong></td>
</tr>
<tr>
<td>Chemical protection (Skydrol, solvents, acid, neutral)</td>
</tr>
<tr>
<td>Mechanical protection (impacts, scratches)</td>
</tr>
<tr>
<td>Adhesion on multi-substrates (metals, plastics, composites, glass)</td>
</tr>
</tbody>
</table>
UV-cured hybrid sol-gel

**Historical System**
- Aluminium
- Wash primer or Alodine 1200
- Chromated or Cr free primer
- Top Coat or BC/CC
- Cr pre-treatment + Chromated or Cr free paint system

**New sol-gel UV cured**
- Aluminium
- UV cured hybrid sol-gel (20 um)
- Top Coat or BC/CC
- Cr free pre-treatment + Cr free paint system
UV-cured hybrid sol-gel

Developed to save cycle and production time/cost

Fully automated process: Application and curing

Spraying application: \( \sim 10 \text{ m}^2/\text{min} \)
UV-curing speed: \( \sim 4 \text{ m}^2/\text{min} \)

UV process

- Room temperature process
- Solvent free formulation
- Photolatency
- Less energy
- Less time
- Sprayable

ASETSDefense
UV-cured hybrid sol-gel: the technology

- Hybrid sol-gel + UV technology

- Inorganic components (organo-alkoxysilanes)
- Organic component
- Photoinitiators
- UV light

Formation of 2 networks in a single-step process
Simultaneous polymerization
Solvent-free system

3D-network with covalent bonds with aluminium substrate
# UV-cured hybrid sol-gel: industrial process

<table>
<thead>
<tr>
<th>Process</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formulation</strong></td>
<td><strong>1K-formulation</strong></td>
</tr>
<tr>
<td></td>
<td>No pot-life (until UV-exposure)</td>
</tr>
<tr>
<td><strong>Surface preparation</strong></td>
<td>SOCOCLEAN A3432</td>
</tr>
<tr>
<td></td>
<td>SOCOsurf A1858/A1806</td>
</tr>
<tr>
<td><strong>Sol-gel preparation</strong></td>
<td><strong>Formulation ready-to-use</strong></td>
</tr>
<tr>
<td><strong>Sol-gel application</strong></td>
<td>By spraying - <strong>By robot</strong></td>
</tr>
<tr>
<td><strong>Sol-gel curing</strong></td>
<td>Few seconds - <strong>By robot</strong></td>
</tr>
</tbody>
</table>

[Image of robotic arm spraying and curing]
UV-cured hybrid sol-gel: performances

- **Corrosion protection** Substrate: Al 2024-T3 / UV-cured hybrid sol-gel thickness: 22-26µm

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Time (h)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt Spray Test (NSST)</td>
<td>3000h</td>
<td>2 to 5 corrosion pits, 0 to 1mm corrosion extended on either side of the scratch depending on the formulations</td>
</tr>
<tr>
<td>Filiform corrosion</td>
<td>1000h</td>
<td>&lt;1mm on either side of the scratches</td>
</tr>
</tbody>
</table>

Depending on the paint system!

With corrosion inhibitors
UV-cured hybrid sol-gel: performances

**Fluid resistance**

Substrate: Al 2024-T3  
UV-cured hybrid sol-gel thickness: 22 - 26µm

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Grade 1 after 14 days immersion</td>
</tr>
<tr>
<td>Humidity</td>
<td>Grade 1 after 500h at 90%HR, 45°C</td>
</tr>
<tr>
<td>Skydrol</td>
<td>Grade 1 after immersion 1000h at 70°C</td>
</tr>
<tr>
<td>Organic solvent</td>
<td>Grade 1 after 2h immersion in toluene/trimethylpentane 25/75</td>
</tr>
<tr>
<td>Kerosene</td>
<td>Grade 1 after 168h immersion</td>
</tr>
<tr>
<td>De-icing fluid</td>
<td>No cracking after 168h immersion</td>
</tr>
<tr>
<td>Synthetic lubricant</td>
<td>No cracking after immersion 1000h at 70°C</td>
</tr>
</tbody>
</table>
Trivalent Chrome Conversion and Post Treatment

**SOCOSURF TCS/PACS**

Chemical Conversion and sealing after anodizing
Aluminium alloys surface treatment line

- Degreasing solution
- Deoxidizing or desmutter after alkaline etching
- Anodizing

Chromic conversion

NB: Rinse baths not shown

Cr⁶⁺ sunset date September 2017

Sealing with CrVI or H₂O
Integration of the new process in the aluminium alloys surface treatment line

Degreasing solution

Deoxidizing or desmutter after alkaline etching

Conversion

SOCOSURF TCS

Sealing

SOCOSURF PACS

Anodizing

NB: Rinse baths not shown
SOCOSURF TCS / SOCOSURF PACS process

- SOCOSURF TCS - Trivalent Conversion and Sealing
- SOCOSURF PACS - Passivation After Conversion and Sealing

SOCOMORE manufactures and sales under Mécaprotec licence
**Socosurf TCS/PACS** - Chemical conversion

**SEM microscopy**

Measure of thickness obtained with SEM, TOF-SIMS

200 - 250 nm

Socosurf TCS/PACS
Chemical conversion characteristics

Salt spray testing

The most sensitive test

SO CO SURF TCS + PACS

Electrical conductivity

Coating weight

Paint adhesion

SO CO SURF TCS / PACS
**Corrosion resistance** 2024 alloy

- Trivalent conversion bath
- Trivalent conversion + post treatment baths

Testing Hours

- 336H
### Electrical Conductivity

**According to MIL DTL 81706**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Requirement MIL DTL 81706</th>
<th>Trivalent conversion + post treatment processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical conductivity before SST</td>
<td>&lt; 5000 µΩ/inch²</td>
<td>2040 µΩ/inch²</td>
</tr>
<tr>
<td>Electrical conductivity after 168h SST</td>
<td>&lt; 10000 µΩ/inch²</td>
<td>5220 µΩ/inch²</td>
</tr>
</tbody>
</table>

6061 alloy

10 measurement points on 5 panels
### Coating weight

**According to MIL DTL 81706**

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<tr>
<th>Parameter</th>
<th>Requirement MIL DTL 81706</th>
<th>Trivalent conversion + post treatment processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coating weight (Class 1A Type II)</td>
<td>&gt; 10 mg/ft²</td>
<td>30 mg/ft²</td>
</tr>
<tr>
<td>DRY</td>
<td>WET</td>
<td>Chromated paints</td>
</tr>
<tr>
<td>------</td>
<td>------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td>MAPAERO P60-A</td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td>ANAC ALUMIGRIP 10P8-11</td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td>ANAC 10P4-2NF</td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td>DEFT 44G N060** Reproducibility issue for wet adhesion</td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
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<td>✔</td>
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<td></td>
</tr>
<tr>
<td>✔</td>
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<td></td>
</tr>
</tbody>
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**Paint Adhesion**

Dry / Wet Adhesion Cross-cut Test

**Chemical conversion**
Socosurf TCS/ PACS - Chemical conversion

Impact of Post Treatment

2024 alloy

Trivalent conversion layer

2024 alloy

Trivalent conversion + post treatment layer
**Socosurf TCS/ PACS - Chemical conversion**

**Impact of Post Treatment**

TCP without post treatment

SST

TCP

Socosurf TCS/ PACS

TCP and post-treatment
Sealing of anodizing - Characteristics

Compatible with all types of anodizing:
- TSA
- BSA
- SAA
- TFSAA
Corrosion resistance 2024 and 7075 alloys

- **TFSAA + SOCOSURF TCS/PACS seal**
  - 336H
  - 550H
  - 750H

- **TFSAA + CrIII + Water seal**
  - 750H

- **TFSAA + Water seal**
  - 360H

TFSAA: Thin Film Sulfuric Anodizing
<table>
<thead>
<tr>
<th>DRY</th>
<th>WET</th>
<th>Chromated paints</th>
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<tr>
<td>✓</td>
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OEM evaluation and Users evaluation

OEM Evaluation
Qualification in progress

- AIRBUS
- AVIO AERO
- BELL
- BOEING
- BOMBARDIER
- CESSNA
- DAASSULT
- GE
- LOCKHEED MARTIN
- MTU
- NORTHROP GRUMMAN
- PRATT & WITHNEY
- SAAB
- SIKORSKY
- UTC US

Evaluations at Manufacturing Plants

- MECAPROTEC Toulouse
- GIT Toulouse
- UTC Ratier Figeac
- UTC Goodrich Vernon
- DAASSULT Argonay
- POETON Gloucester
Thank you!

Questions?

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