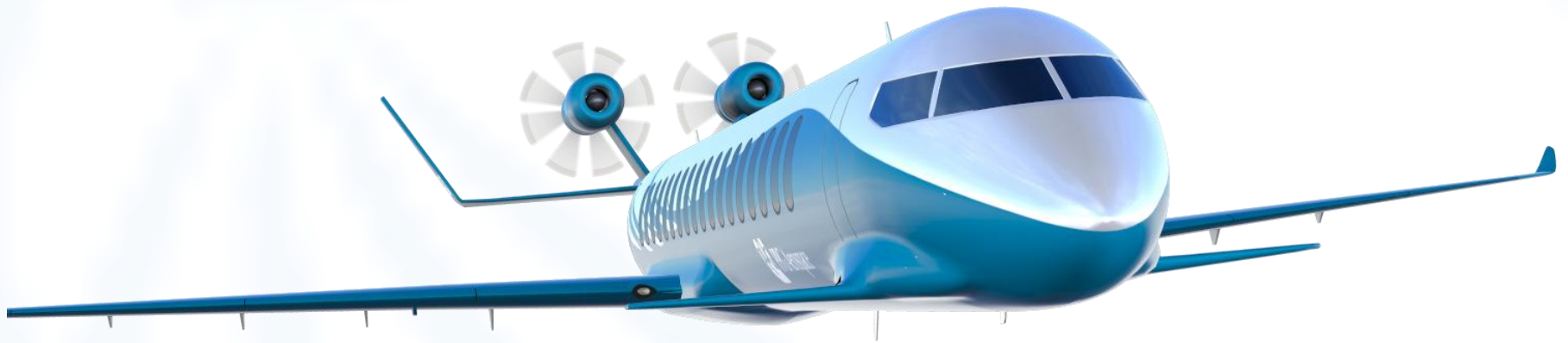


Electrodeposition paint –

A breakthrough chrome-free automatic tank process for the aviation industry



IMFair June 15th 2011

Enhanced Coating Systems for the Aerospace Industry

Today's environmental regulations combined with new substrates used for aircrafts present challenges to develop new materials and / or processes for painting.

As a coatings manufacturer PPG Aerospace provides Cr(VI)-free solutions via two pathways:

- Elimination of Cr(VI) in conventional coating systems
 - Cr(VI)-free conversion coating
 - Cr(VI)-free sol-gel surface treatment
 - Spray primer containing novel corrosion inhibitor pigments
- New Technology
 - Electrocoat primer - Aerocron™

Electrocoat Primers for the Aerospace Industry

Agenda

- Electrocoat Principles
- Advantages for the Aerospace Industry
- Test Results
- Conclusions

Technology Maturity

- Electrocoat has a long history of use for corrosion prevention in both the automotive and industrial industries.

Currently >95% of all automobiles produced worldwide use electrocoat

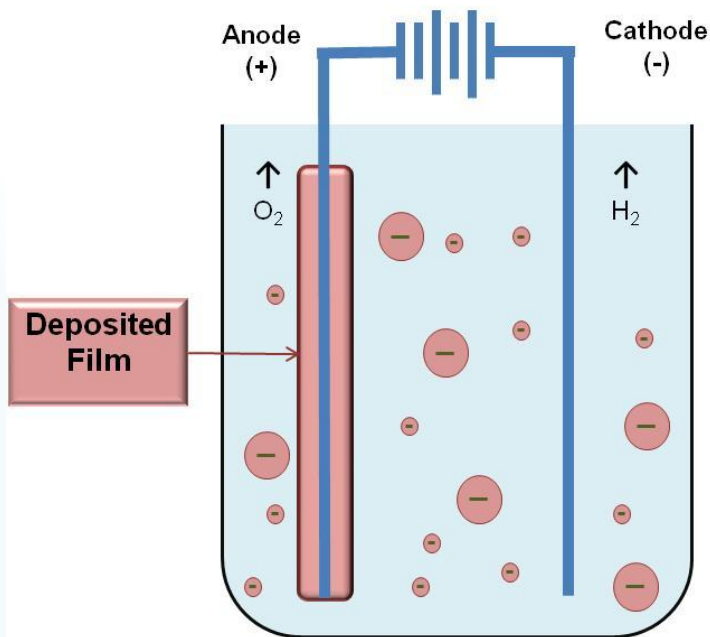
8 out of 10 electrocoat tanks worldwide use PPG technology

- First automotive electrocoat tank in 1971 at Ford Wixom
- First low-cure / high-gloss, exterior durable electrocoat in 1980
- First ultra-white, non-yellowing epoxy electrocoat for appliances in 1989
- Introduced ENVIOPRIME[®] lead-free electrocoat

– ***Winner of Presidential Green Chemistry Award in 2001***

Electrodeposition Process

- Method of applying a coating which uses electrical current to deposit aqueous dispersed resins and pigments onto a conductive substrate
- Coatings can be applied via anodic or cathodic deposition
- Several screening studies proved **Anodic Electrocoat** to be best choice for Aluminum and their alloys in terms of paint adhesion and corrosion protection



Coated part is the anode

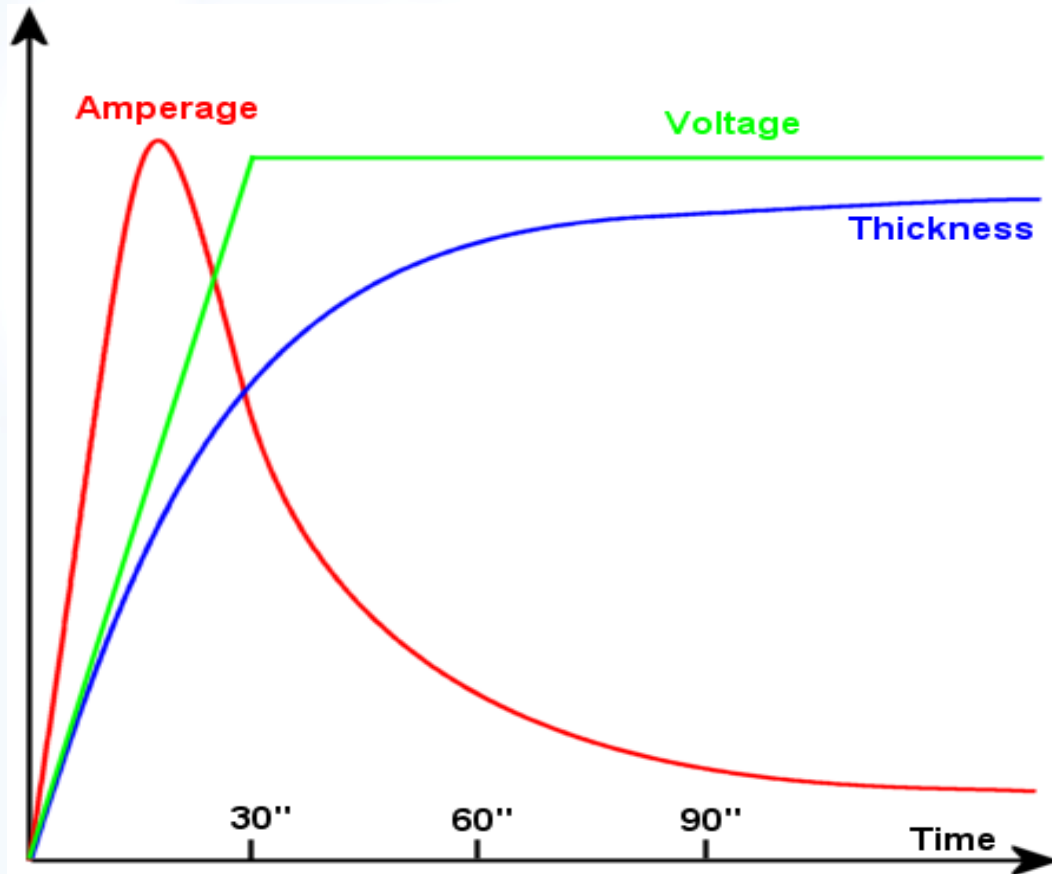
⇒ Surface oxidation, Deposition of paint film

Polymerization of paint film through oven curing

⇒ Actual development allows temperature cure 100 - 120 °C

Electrodeposition Process

- Covering of part surface with small paint film in first seconds \Rightarrow high electricity transfer on surface
- Uniform paint film build over part during application time \Rightarrow part becomes more and more insulated



Film thickness can be controlled by Voltage and/or application time

A new direction for Aerospace

Use of Electrocoat as Corrosion Resistant Primer

Technology Shift

- Immersion vs. Spray Process
 - Reduction in overall process cycle time
- Thermal vs. Air Cure
 - Low Cure Technology

Performance

- Performance Equivalent to Conventional Spray Primer
- Weight savings

Environmental

- Elimination of Chrome
- Reduced worker exposure

Advantages for the Aerospace Industry

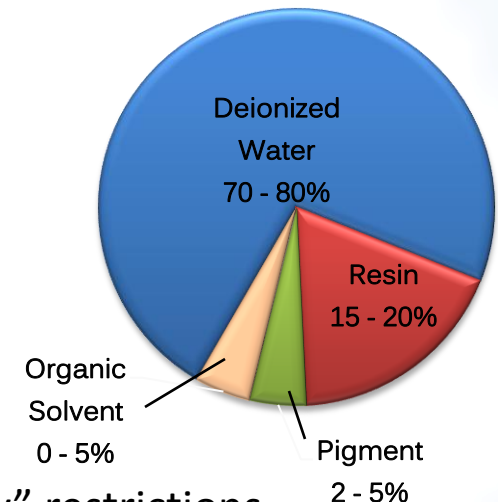
➤ Environmental, Health and Safety Considerations

- Aqueous based – low solvent emission
- Minimal waste discharge – closed loop process
- Minimal exposure of workers to hazardous materials

➤ Productivity / Efficiency

- Automated process – increased productivity
- 90-95% material utilization / no overspray
- Immediate part handling after thermal cure
 - Do not have “dry to touch”, “dry to tape”, “dry to fly” restrictions

Electrocoat bath
Breakdown

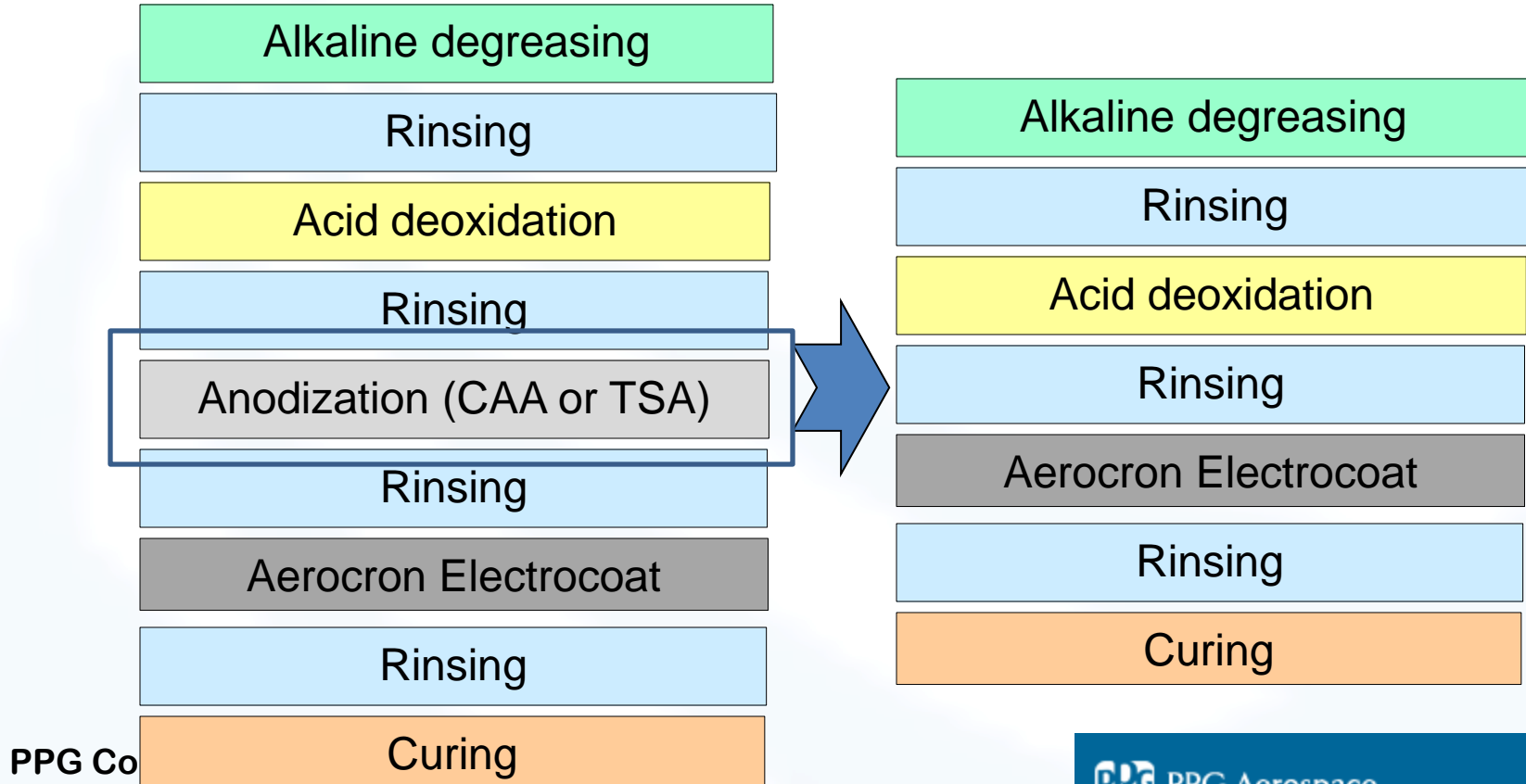


➤ Application / Performance

- Uniform film across entire surface including recessed areas
- Throwpower capability (holes/gaps) due to dip process
- Excellent barrier / corrosion resistance properties

Substrate Preparation

- Initial electrocoat application tested on fresh anodized pretreatment (CAA and TSA)
- Mechanical and Corrosion Performance equal to Cr6 spray primer
- New approach : **no anodization treatment** – clean and deoxidize only
- Anodic process leads to thin compact oxide layer on surface when paint is applied



Aerocron™ Chrome Free – Test Data

Application parameters

- **Bath parameter:** **pH : 9 - 9,5 / Temperature : 24 – 26 °C**
- **Application:** **Time : 2min (incl. Ramp-up phase) / Voltage: 180 V**
- **Curing:** **30 min @ 110 °C (object temperature)**
- **Paint film thickness:** **18 to 22µm**

Aerocron™ Chrome Free – Test Data

Performance over alkaline degreased and deoxidized Al 2024 bare / clad (no anodization)

- **Mechanical performance**

- Cross hatch Adhesion : **PASS** (G=0)
- Fatigue tests
 - equal to or better than Alodine 1200 + sprayable primer

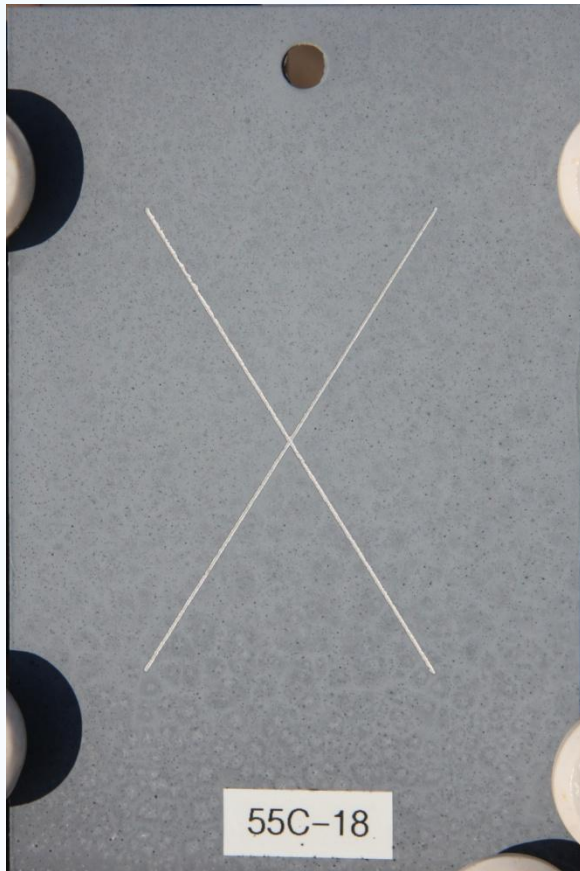
- **Chemical resistance**

- Water immersion (2 weeks @ 23°C): **PASS** (G=0), no blistering
- Resistance to phosphate ester hydraulic fluids (Skydrol LD4)
 - 1000 h @ 23°C : **PASS**
 - 1000 h @ 70°C : **PASS**

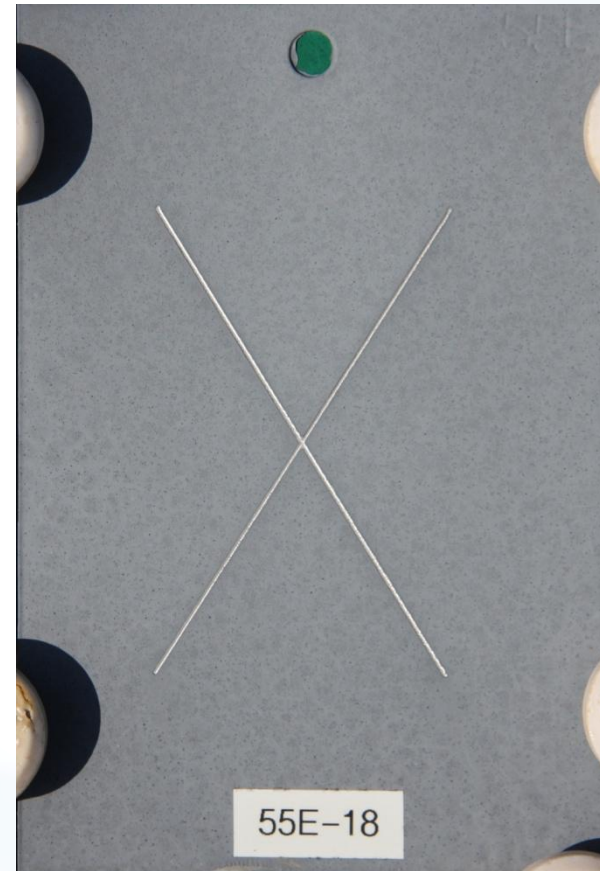
- **Corrosion resistance**

- Filiform (960h): **<2mm on either side of the scratches**
- Salt Spray (3000h): **average creep <1 mm on either side of the scratches, no face blistering**

Long term testing – 2 years Beach exposure



Aerocron™ Electrocoat
over clean & DeOx
10 Rating



Spray Chrome primer
over clean & DeOx
10 Rating

AEROCRON™ Application trials

- Successfully application of multiple test series for Aerospace customers between 2009 – 2010
- No anodization used (clean and deoxidize only)
- Over 1500 parts/panels already coated and tested
 - Test panels and parts (up to 3 m long)
 - tested Al-alloys 2024 / 2214 / 5xxx-6xxx-7xxx Series
- Intense discussions with several OEM's for industrialization
- First electrocoat tank at a customer site scheduled for 2011

Conclusions

Electrocoat Primers for the Aerospace Industry

- Aerocron™ CF is the first breakthrough in the Aerospace paint activity as it combines:
 - Outstanding corrosion protection properties
 - Increased material utilization / No overspray
 - Uniform coating of complex parts / Throwpower capability
 - Overall weight reduction
 - Fully automated process