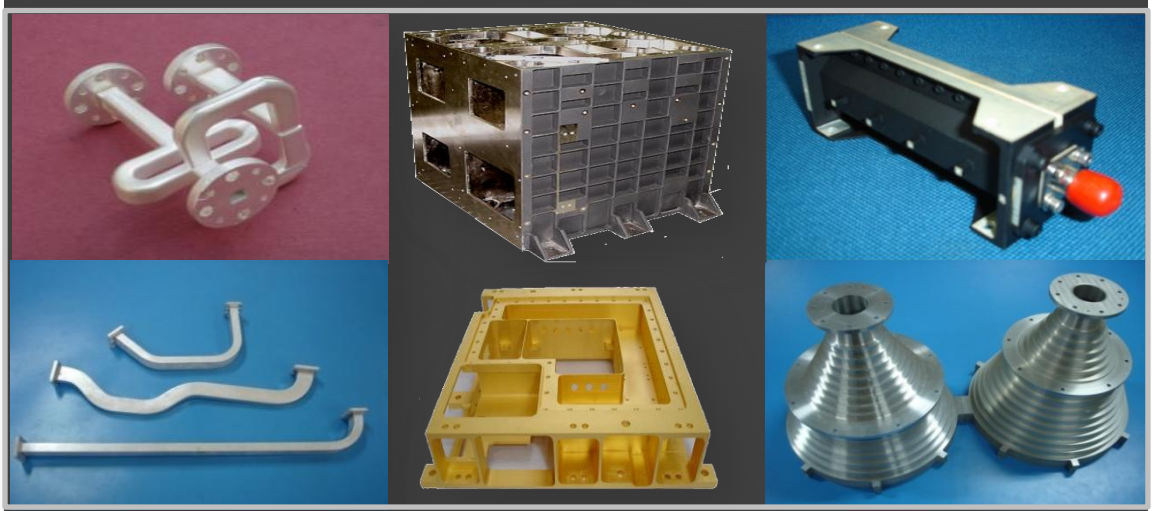
Surface Treatment & Thermal Control Coating

for know-how transfer



Space Applications Centre
Indian Space Research Organization
Ahmedabad

INTRODUCTION

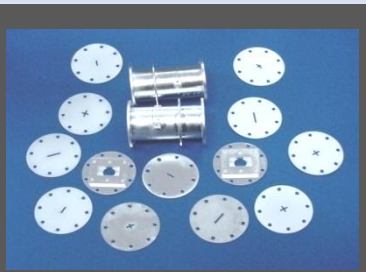
Space Applications Centre (SAC) of ISRO has developed electroplating and electroless plating processes for space hardware to achieve required surface engineering properties like Electrical conductivity, Non-conductivity, Corrosion protection, Solderability, EMI/EMC, Emissivity etc. and making them a good base for Thermal Control Coatings. These processes are qualified for space use with very tight tolerances after subjecting to various tests like visual inspection, adhesion test, environmental tests, and engineering property specific tests confirming to ASTM and MIL standards. SAC invites industry to come forward and take up the technology for know – how or technical consultancy.

SILVER PLATING

Silver Plating on Aluminum 6061T6

- ✓ Developed and qualified the process of Silver Plating on Aluminum 6061-T6 Alloy for best electrical conductivity & solderability, corrosion protection and good base for thermal control coatings.
- ✓ Silver plating reduces insertion losses and improves return losses.
- ✓ Silver plating on Aluminum is used for components like waveguides, adaptors, HRFs, Filters for many ISRO projects.

Silver Plating on Invar



- ✓ Silver Plating on Invar is developed & qualified for good electrical conductivity & solderability and good base for thermal control coatings.
- ✓ Silver plating reduces insertion losses and improves return losses.
- ✓ Silver Plating on Invar is used for manifolds, cavities, iris, adaptors.

Silver Plating on Copper

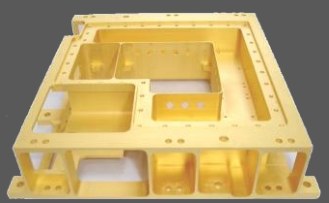
- ✓ SAC has developed and qualified the process of Silver Plating on Copper helix conductors for solderability to helix antenna and feed network.
- ✓ Silver plating improves conductivity and prevents copper from oxidizing.

Silver Plating on DMLS Aluminum

- ✓ Components are fabricated using Direct Metal Laser Sintered technique for fast throughput & difficult geometries.
- ✓ Silver plating is carried out for achieving RF performance.

GOLD PLATING

Gold Plating on Aluminum 6061 T6



- ✓ Gold plating on Aluminum 6061T6 is developed and qualified with electroless nickel undercoat.
- ✓ Gold plating is required on aluminum boxes for avoiding EMI and improving EMC properties and protects them from corrosion.
- ✓ Gold plating is one of the widely used surface treatment processes at SAC for many ISRO projects.

Gold Plating on Kovar

- ✓ Kovar is used for fabrication of carrier plates.
- ✓ Gold plating on Kovar is used for attachment of gold plated alumina substrates onto carrier plates.
- ✓ Gold plating on Kovar is optimized to achieve required solderability and corrosion protection with less gold plating thickness.

Other Gold Plating Processes

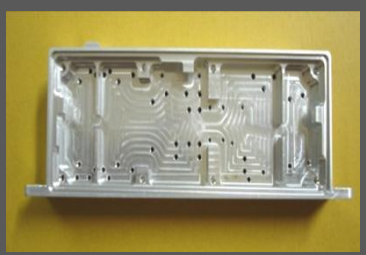
- ✓ ***Gold plating SS-304*** :- used for electrical conductivity and corrosion protection on SS screws, washers.
- ✓ ***Gold plating on Invar*** :- used for solderability and corrosion protection on pedestals, induction posts etc.
- ✓ ***Gold plating on Phosphorous Bronze*** :- used for corrosion protection on reeds, shims etc.

OTHER PLATING

Electroless Nickel plating on Invar

- ✓ Electroless nickel plating is carried out to protect ferrous Invar alloy from corrosion.
- ✓ Electroless plating has the advantage of even plating all over the surface with no edge buildups as in electroplating.
- ✓ It is a good base for thermal painting of optical components.

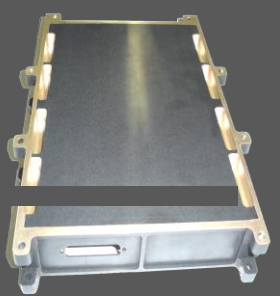
Electroless Nickel plating on Aluminum 6061T6



- ✓ Electroless nickel plating offers good corrosion protection to aluminum alloy components.
- ✓ EMI/EMC gaskets are compatible with electroless nickel and not with aluminum base.

Black Anodizing & Chromating on Aluminum 6061T6

- ✓ Black anodizing is carried out on aluminum to offer a dual use of protection from corrosion and also provide high emissivity with non conductive surface.
- ✓ Chromating provides for good corrosion protection and keeps the surface electrically conductive.



Anodizing on Aluminum 6061T6

- ✓ Anodizing process is used for corrosion protection of aluminum components. 8 – 10 microns of anodizing is space qualified.
- ✓ Anodized surface is a good base for thermal painting and aids in adhesion of paints.

THERMAL COATING

INTRODUCTION

Electronics components can work as per specifications only in a limited temperature range (0 to 40 ^{o}C). Satellites orbiting the earth are subjected to extreme temperature variation similar to lunar daytime temperature approaching +130 ^{o}C and night time temperature falling to -110 ^{o}C. In space, the operating temperature of a satellite is determined by the heat from the sun, the reflected solar energy from the earth, the deep space temperature, the internal heat generated by the spacecraft and by the emittance and absorptance of spacecraft coatings.

So, to keep the thermal balance of the satellite, thermal control coatings are used which have very good emissivity, absorptivity and negligible Total Mass Loss and Collected Volatile Condensable Material. Space Applications Centre has qualified black and white thermal control coatings on different substrates for thermal balance of the satellites.

Black Thermal Control Coating

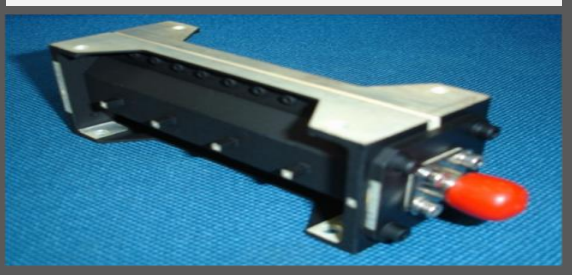
✓ SAC has developed and qualified the process of Black Thermal Control coating with high emissivity and solar absorptivity to facilitate radiant heat transfer among internal components of satellites. This process is qualified for following substrates:

- Anodized Aluminum 6061T6 alloy
- Chromated Aluminum 6061T6 alloy
- Aluminum 6061T6 alloy
- Aluminum 2024 alloy
- Silver plated Aluminum 6061T6 alloy
- Silver plated Aluminum 2024 alloy
- Gold plated Aluminum 6061T6 alloy

- Invar
- Silver plated Invar
- Electroless Nickel plated Invar
- Chromated Magnesium AZ31B alloy
- Magnesium AZ31B alloy
- Black Anodized Magnesium AZ31B alloy

Specifications

- Emissivity (ε) : >0.89
- Solar Absorptivity (α) : > 0.95
- Total Mass Loss (TML) : ≤ 1.00%
- Collected Volatile Condensable Material (CVCM) : ≤ 0.10%



Optical Diffuse Coating for Integrating Sphere

- ✓ Developed and qualified the process of Optical Diffuse coating.
- ✓ Highly reflective diffuse coating for optical radiation within the 300 to 2400 nm wavelength range

Specifications

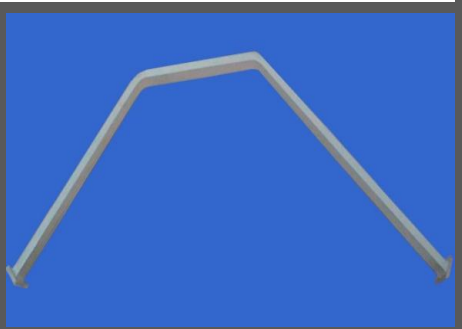
- Thickness: 0.4 to 0.5 mm
- Reflectance: 97% within the visible spectrum from 380 to 780 nm

White Thermal Control Coating

- ✓ Developed and qualified the process of White Thermal Control coating for high temperature applications with high emissivity and high reflectivity for components exposed to direct solar radiation. This process is qualified for different base substrates such as
  - Bare Aluminium Alloy 6061 T6
  - Anodized Aluminum Alloy 6061T6
  - Silver plated Aluminum Alloy 6061T6

Specifications

- Emissivity (ε) : > 0.89
- Solar Absorptivity (α) : 0.2 to 0.25
- Total Mass Loss (TML) : ≤ 1.00%
- Operating Temperature Range : -80^{O}C to +180^{O}C
- Collected Volatile Condensable Material (CVCM) : ≤ 0.10%



Technology Transfer and Industry Interface Division
Planning and Projects Group
Space Applications Centre, ISRO
Ambawadi Vistar,
Ahmedabad – 380 015

Web: www.sac.gov.in/SAC_Industry_Portal
Email: ttid@sac.isro.gov.in
Fax: +91-79-26915817