

# Practical issues in pre-treatment and coating of Aluminum



## Surface treatment of aluminum

- Anodizing



- The most effective and popular surface treatment on aluminum

## Surface treatment of aluminum

### Properties of anodizing layers

- ✓ Corrosion resistant
- ✓ Wear resistant
- ✓ Good adhesion
- ✓ Electrical isolation
- ✓ Thermal isolation
  
- ✗ No electrocal conductivity
- ✗ Limited chemical resistance
- ✗ No thermal conductivity
- ✗ No ductility
- ✗ No solderability



## *Surface treatment of aluminum*

# Alternative metal coatings

- Chemical Nickel
- Nickel
- Silver
- Gold
- Copper
- Tin
- Chromium

*The big advantage*

*Electrical conductivity and chemical resistance of the metal coatings*

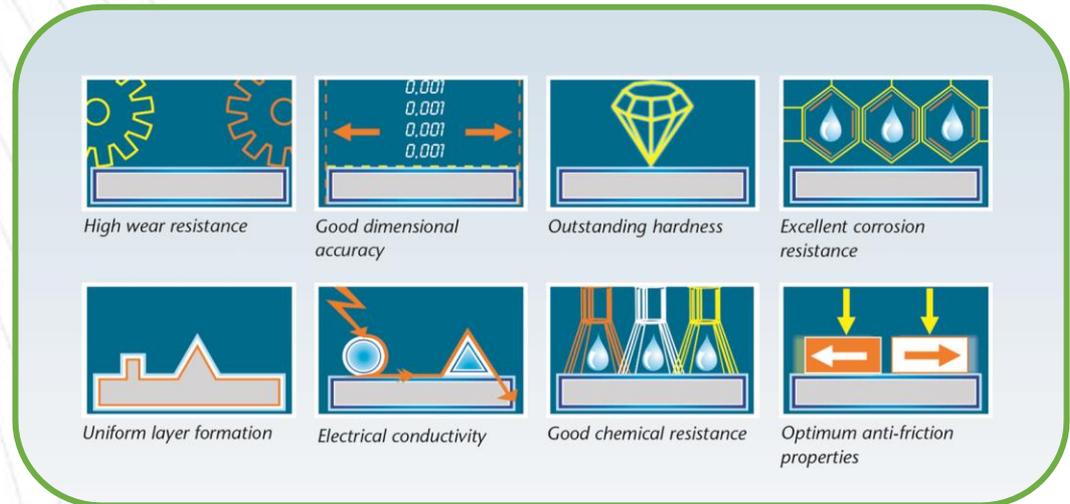
*The big disadvantage*

*Electrode potential of aluminum against other metals and the adhesion of the metal coatings*

## Surface treatment of aluminum

### Alternative electrolytic and electrochemical metal coatings

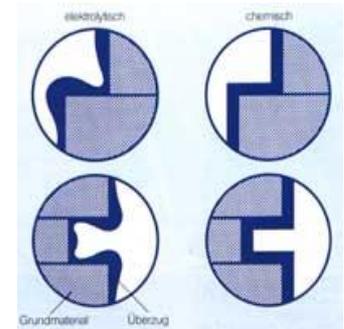
- Wear resistance
- Corrosion resistance
- Electrical conductivity
- Thermal conductivity
- Ductility



## Surface treatment of aluminum

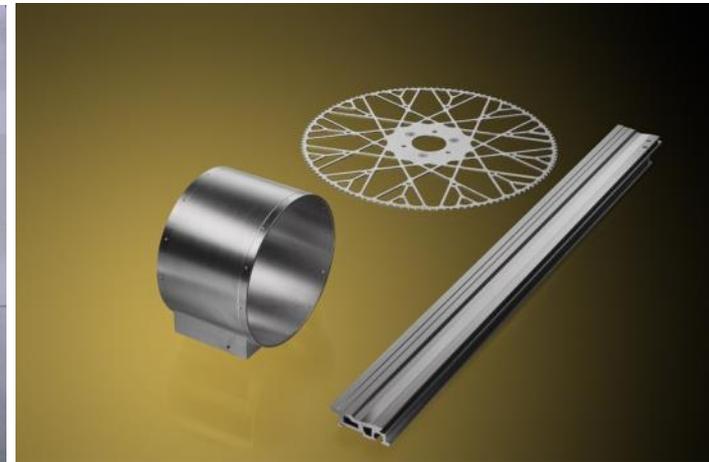
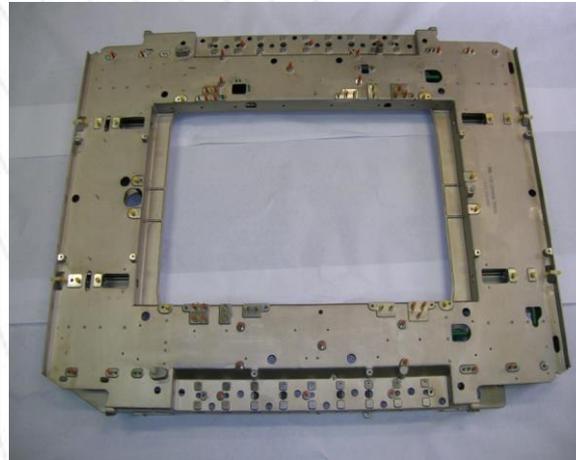
### Chemical Nickel

- Main properties
  - High wear resistance
  - Good corrosion resistance wenn layer is pore free
  - Uniform layerthickness
  - Basecoating for other metals
  
- Advantages against anodizing
  - No electrostatic charging
  - Chemical resistant in alkaline environment
  
- Disadvantages against anodizing
  - Corrosion when layer is thin and porous
  - Adhesion of the layer



## Surface treatment of aluminum

### Chemical Nickel



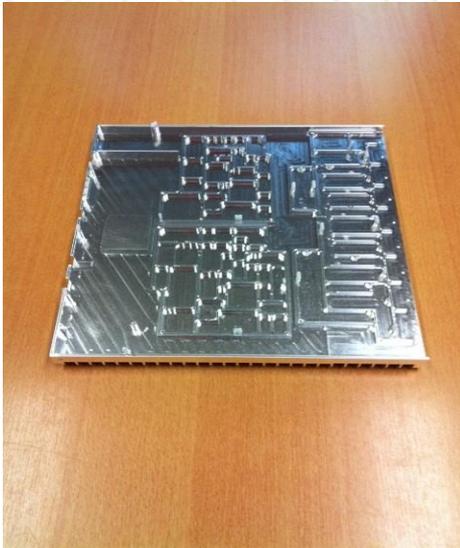
## Surface treatment of aluminum

### Silver

- Main properties
  - High electric conductivity
  - Good chemical and oxidation resistance
  - Solderability
  
- Advantages against anodizing
  - Ductility
  - Chemical resistance in alkaline and acid environment
  - Lubricity
  
- Disadvantages against anodizing
  - Difference electrode potential between silver and aluminum
  - No wear resistance
  - Adhesion of the layer

## Surface treatment of aluminum

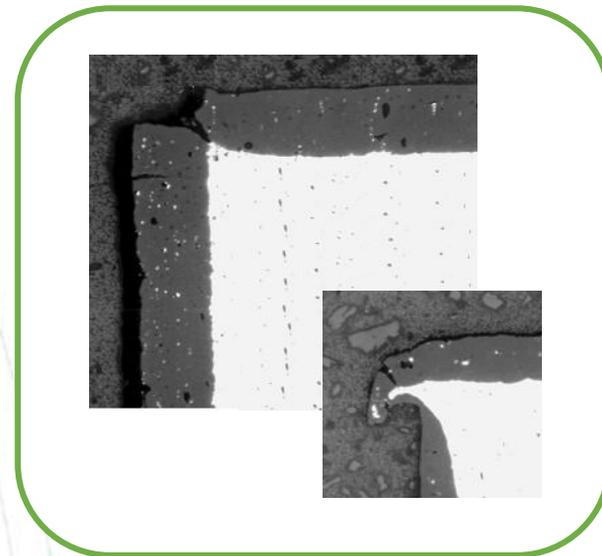
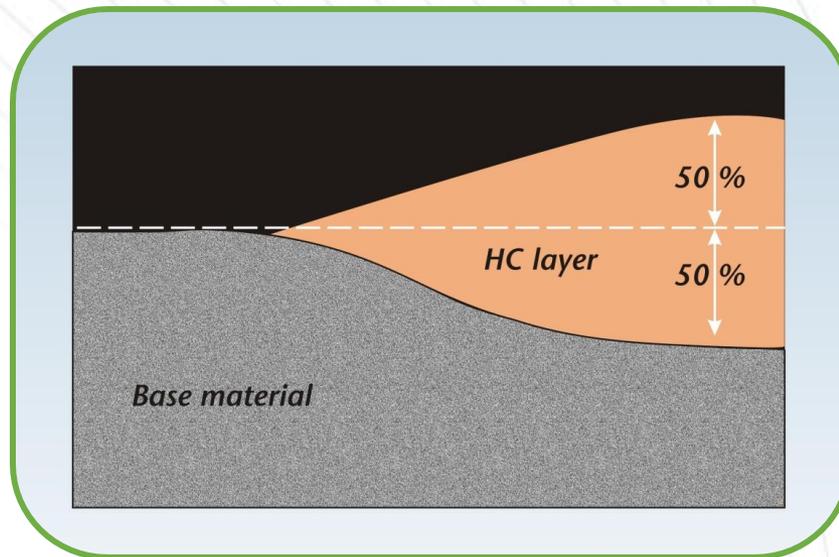
### Silver



## Surface treatment of aluminum

### The anodized coating

- Anodized aluminum

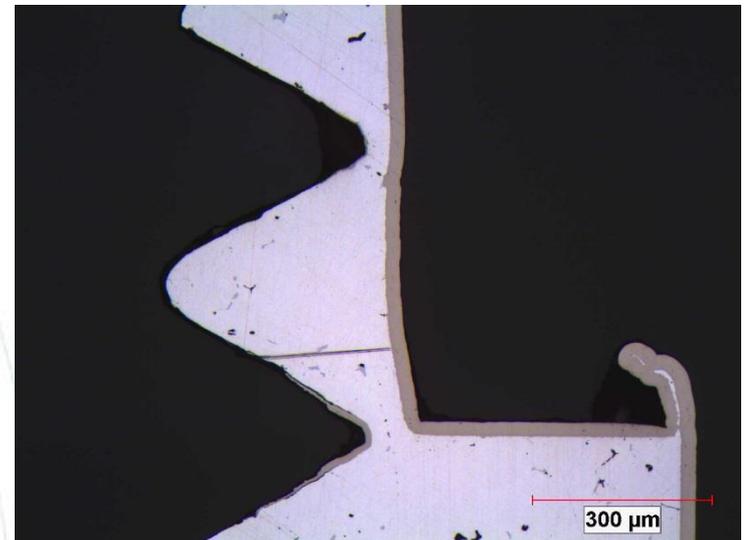
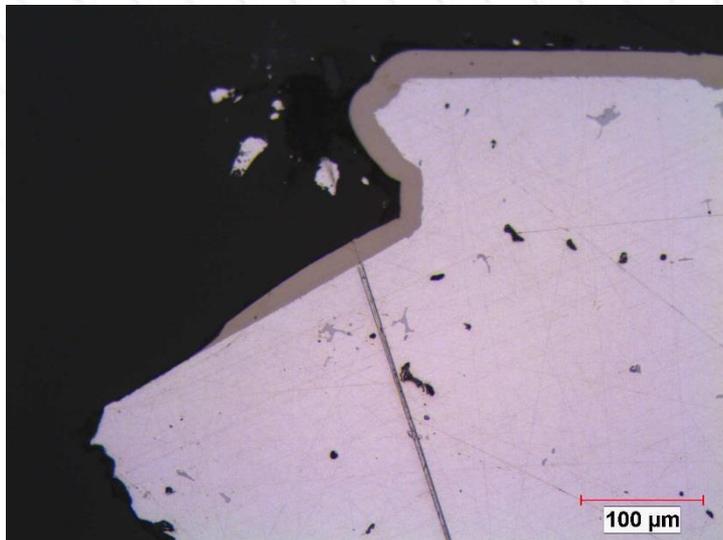


- The anodized layer is formed out of the material itself
- In principle always a good adhesion of the coating

## Surface treatment of aluminum

### The plated metal coating

- Chemical nickelplated aluminum

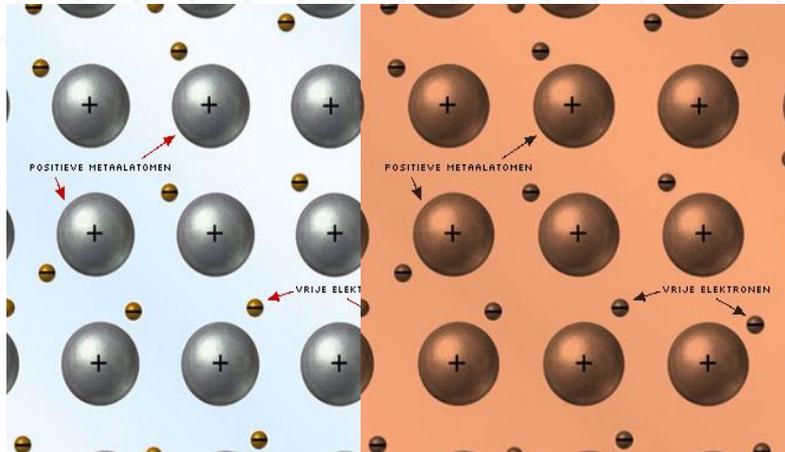


- The chemical nickel layer is plated on the aluminum
- Adhesion of the coating is not always good

## Surface treatment of aluminum

The bonding of a coating on a metal substrate

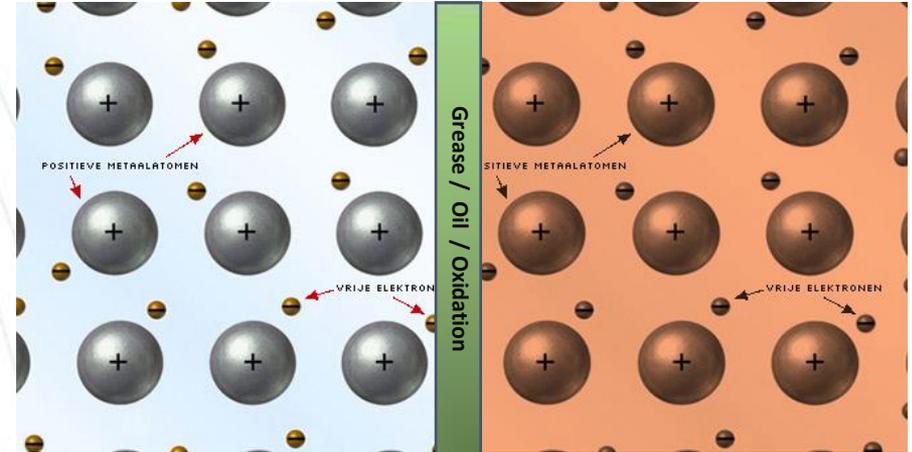
Good adhesion



Aluminum

Nickel

Bad adhesion



Aluminum

Nickel

Pre-treatment is necessary

## Surface treatment of aluminum

### Pre-treatment before anodizing

- Alkaline cleaning in Aluminium cleaner
- Rinsing
- Etching in alkaline Aluminium etch
- Rinsing
- Desmutting in oxidizing acid
- Rinsing



Anodizing



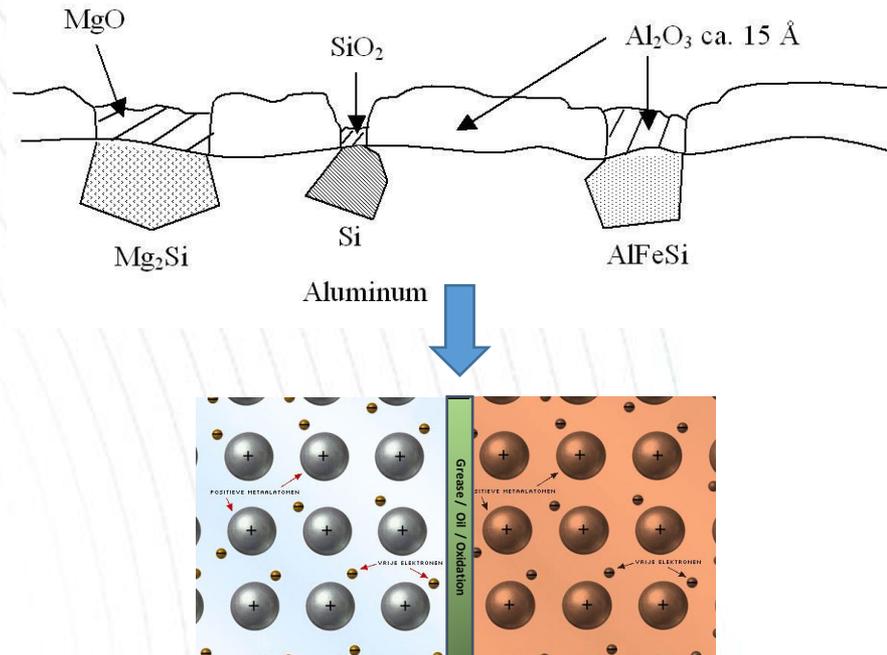
Plating



## Surface treatment of aluminum

The reason of the bad adhesion on aluminum

Due to its low standard potential aluminum will always form a thin aluminumoxide layer in an oxygen containing environment



## Surface treatment of aluminum

### The principle of plating aluminum

- Aluminum is covered with a zinc layer by ionic exchange
- Aluminum cannot form oxidelayer
- Zinc layer dissolves in the plating bath
- The metallayer is plated on the oxidefree aluminum



Good adhesion

## Surface treatment of aluminum

### Conventional Pre-Treatment before plating

- Alkaline cleaning in Aluminium cleaner
- Rinsing
- Etching in alkaline Aluminium etch
- Rinsing
- Desmutting in  $\text{HNO}_3$  \ HF acid
- Rinsing
- Zincate treatment
- Rinsing



Anodizing

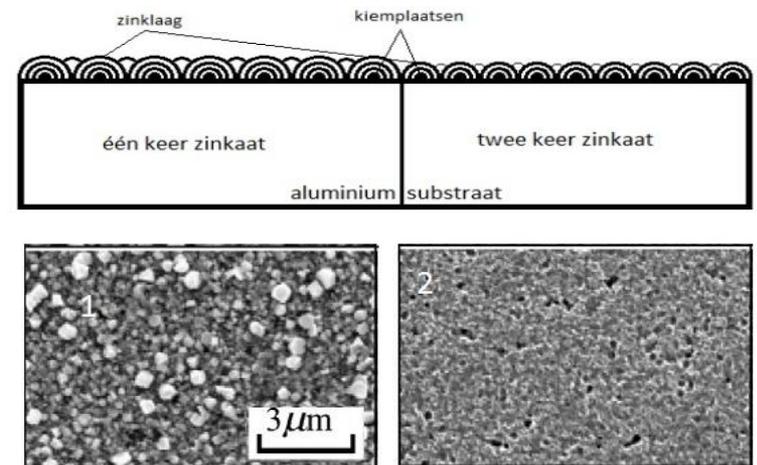
Plating



## Surface treatment of aluminum

### Optimized Pre-Treatment before plating

- Alkaline cleaning in Aluminium cleaner
- Rinsing
- Etching in alkaline Aluminium etch
- Rinsing
- Desmutting in  $\text{HNO}_3$  \ HF acid
- Rinsing
- Zincate treatment
- Rinsing
- Removal of zincate layer in  $\text{HNO}_3$
- Rinsing
- Zincate treatment
- Rinsing



## Surface treatment of aluminum

### Details of the pre-treatment

- Alkaline cleaning
  - Removes oils and grease
  
- Alkaline etching
  - Removes the aluminiumoxide
  - Removes the outside surface of the aluminum which contains contamination
  - Does not remove the metal alloy elements and the silicon particles
  - Roughens the surface of the material
  - Alternative processes ( dull or bright etching )available

## Surface treatment of aluminum

### Details of the pre-treatment

- Desmutting in  $\text{HNO}_3$  \ HF acid
  - Removes the metal alloy elements and the silicon particles
  - Also dissolves some aluminum
  - Very stable and reliable process
  - Parts become dull
  - Problem with dimensions when parts have to be replated
  - Environmental problems when using HF
- Zincate treatment
  - Solution is a mixture of an alkaline etch and zincate ions
  - Etches the aluminum surface and replaces it by zinc
  - Several commercial solutions available
  - Some solutions contain also other metals than zinc



## Surface treatment of aluminum

### Details of the pre-treatment

- Advantages of this process

- Very stable and reliable process
- Suitable for every aluminum alloy
- There is a lot of experience with this process



- Disadvantages of this process

- Roughens the surface of the material
- Parts become dull
- Problems with dimensions when parts have to be replated
- Environmental and health related problems when using HF



## Surface treatment of aluminum

### Alternative pre-treatment before plating

- Alkaline cleaning in Aluminium cleaner
- Rinsing
- **Ultrasonic cleaning in alkaline cleaner**
- Rinsing
- **Etching in mild alkaline Aluminium etch**
- Rinsing
- **Desmutting in oxidizing agent**
- Rinsing
- **Ultrasonic cleaning in alkaline cleaner**
- Rinsing
- **Desmutting in oxidizing agent**
- Rinsing
- Zincate treatment
- Rinsing
- **Removal of zincate layer in oxidizing agent**
- Rinsing
- Zincate treatment
- Rinsing



## Surface treatment of aluminum

### Alternative pre-treatment

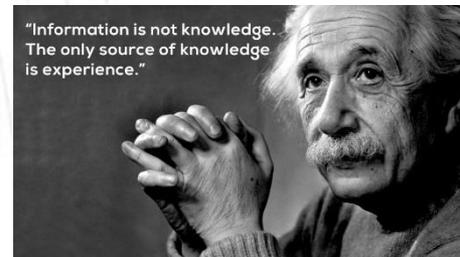
- Advantages of this process
  - Does not roughens the aluminum
  - Does not change the surface condition of the part
  - Suitable for every aluminum alloy
  - Parts can be replated several times
  - No health or enviromental problems
- Disadvantages of this process
  - More pre-treatment steps
  - More expensive
  - The treatment is more critical
  - Not that much common experience with this process



## Surface treatment of aluminum

### Resume

- Plating can be a good alternative for anodizing aluminum when conductivity and chemical resistance is required
- Corrosion resistance of plated coatings is not as good as anodizing due to the difference in cathode potential
- Plating aluminum is more difficult and more critical than anodizing
- Plating aluminum requires know how and experience



[www.ahc-surface.com](http://www.ahc-surface.com)

