Chương 2. Biến tính bằng phương pháp xử lý bề mặt (T2,3)

2.1. Phương pháp cơ học (Mechanical treatments)

2.2. Phương pháp nhiệt (Thermal treatments)

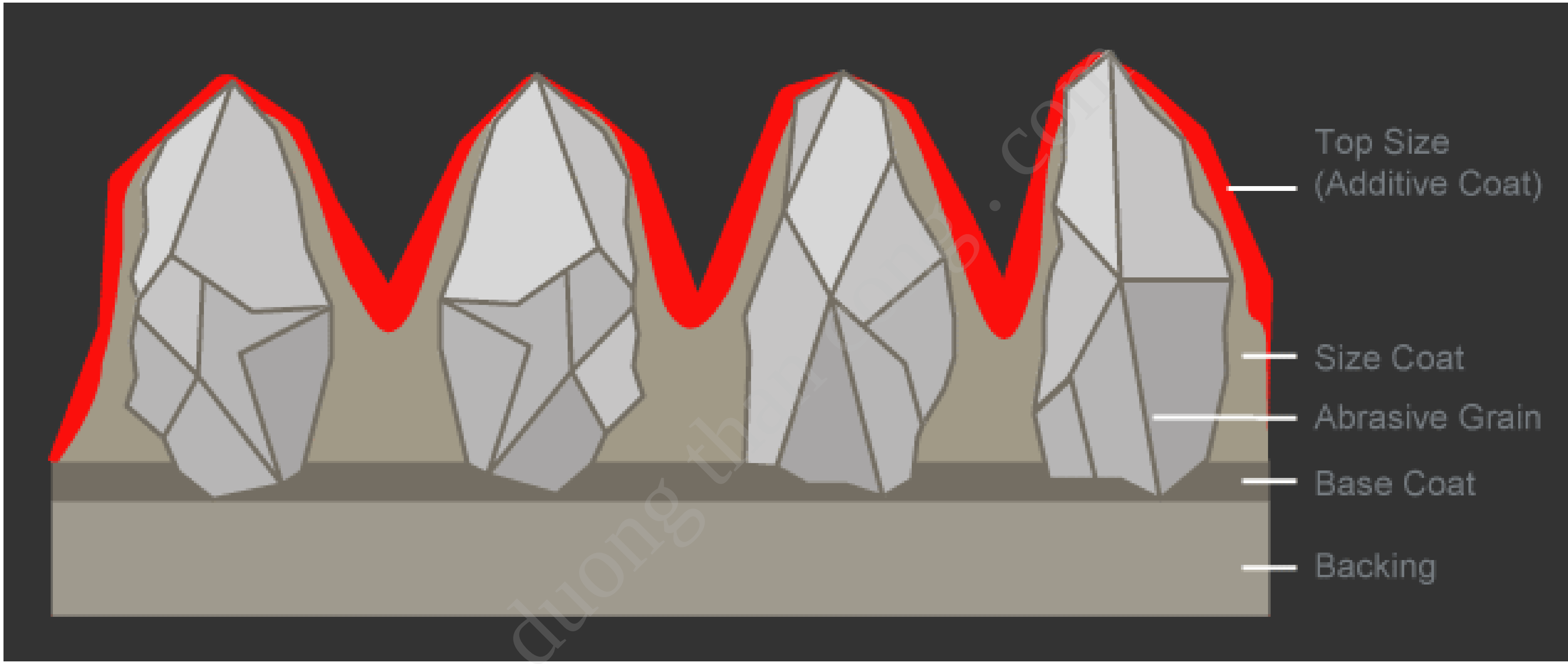
2.3. Phương pháp hoá học (Conversion Coatings)

2.4. Phương pháp điện hoá

2.5. Phương pháp vật lý

1. Mechanical treatments

coated abrasives



Adhesive Bond

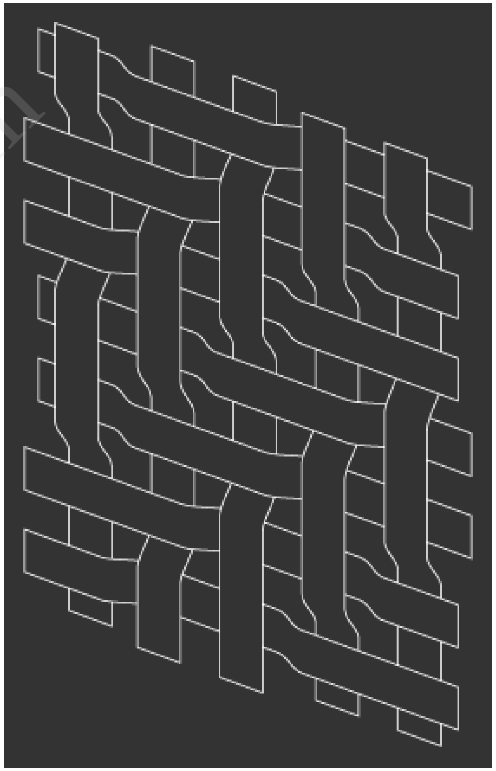
Glue bond: softens under the heat
Urea and Phenolic Resins (phenol formaldehyde): high temperature and pressure operations

Backing Material

Cloth (structurally stronger)

Paper (weight (lbs) per paper maker's ream),

Weight	lbs/Ream (1lbs=0.45359 237 kg)
A	40
C	70
D	90
E	130
F	165



Vulcanized Fiber (cotton rags and treated with harsh chemicals to form a gelatinous substance)

Film (tear resistant and waterproof)

Grinding Aids (Sodium Cryolite and Potassium Perfluoroborate): reduces the temperature of grinding

Abrasive Grains

Natural Grains

Silicon Carbide

White Aluminum Oxide

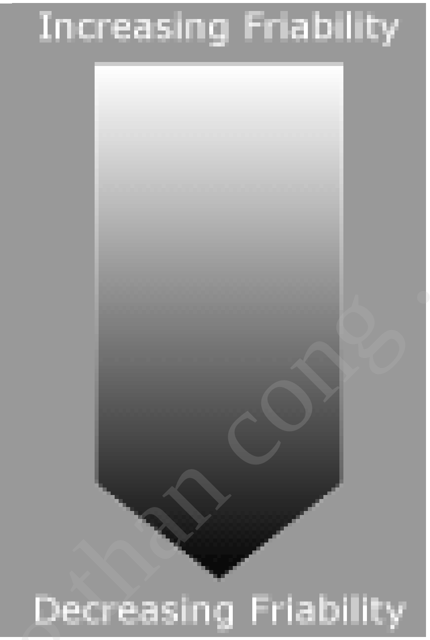
Pink Aluminum Oxide

Brown Aluminum Oxide

Zirconia Aluminum Oxide

Ceramic Aluminum Oxide

Diamond



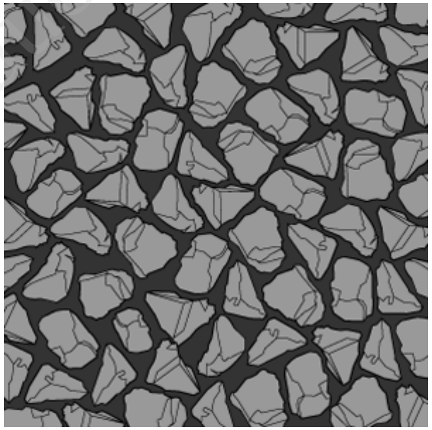
Aluminum Oxide (AO)

Zirconia Alumina

Ceramic

AO or SiC

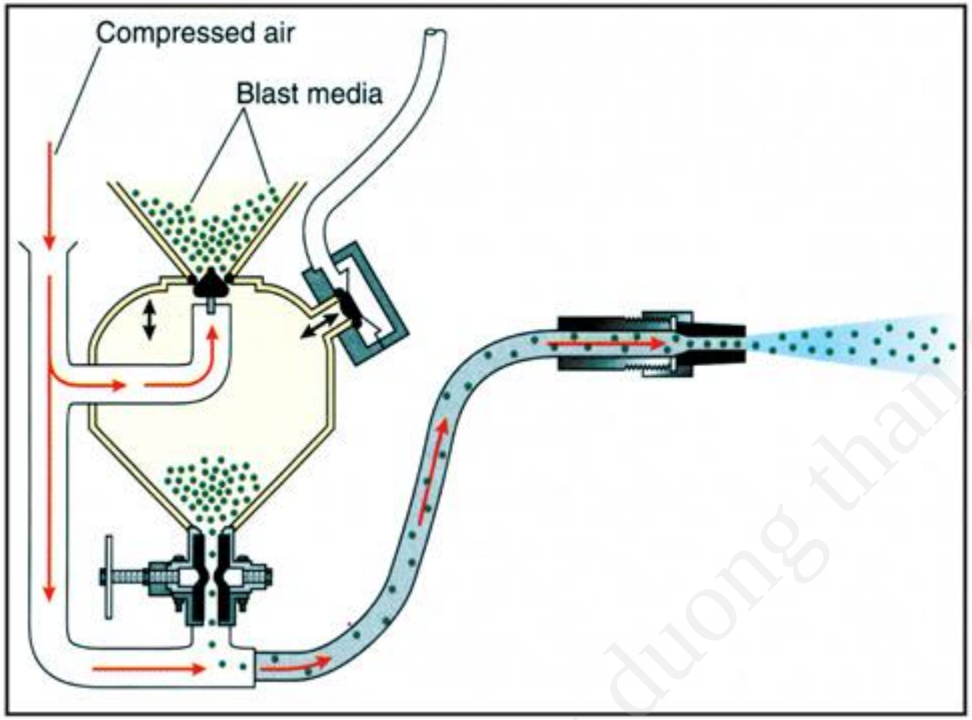
Compact Grain



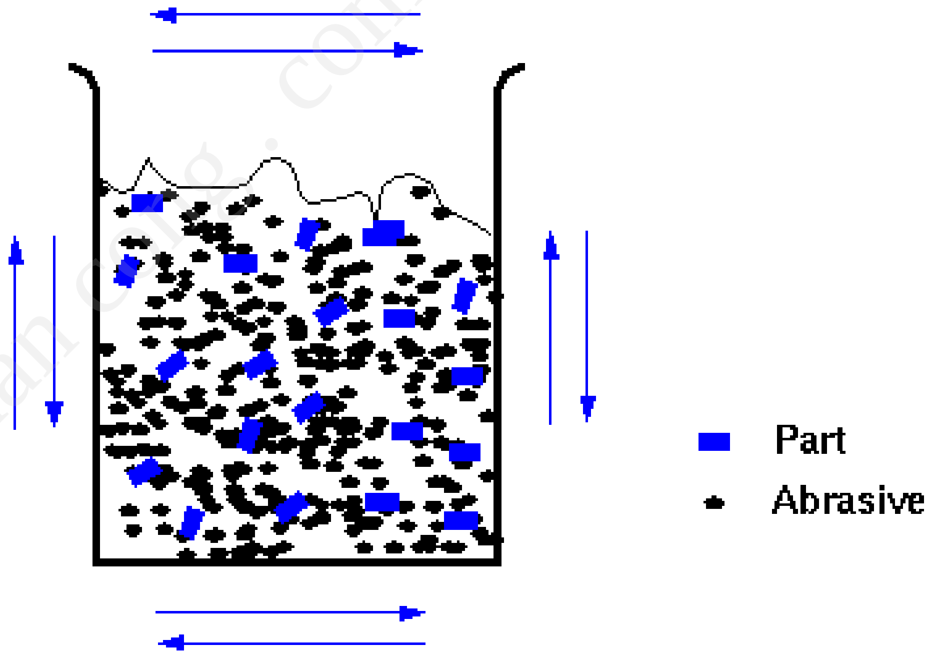
Open Coat & Closed Coat

Loose Abrasive Grains

Aluminum Oxide (Black, Brown, White)
Cast Stainless Steel Shot
Ceramic Beads
Cut Wire (Stainless & Carbon)
Diamond Powder/ Compound
Silicon Carbide …



Air Blast Cabinets

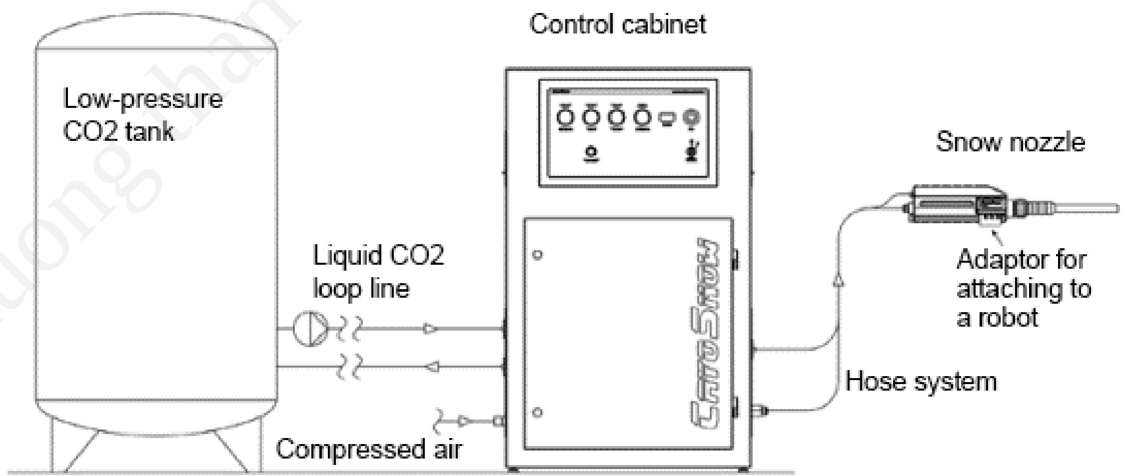


Schematic of Vibratory Finishing Machine

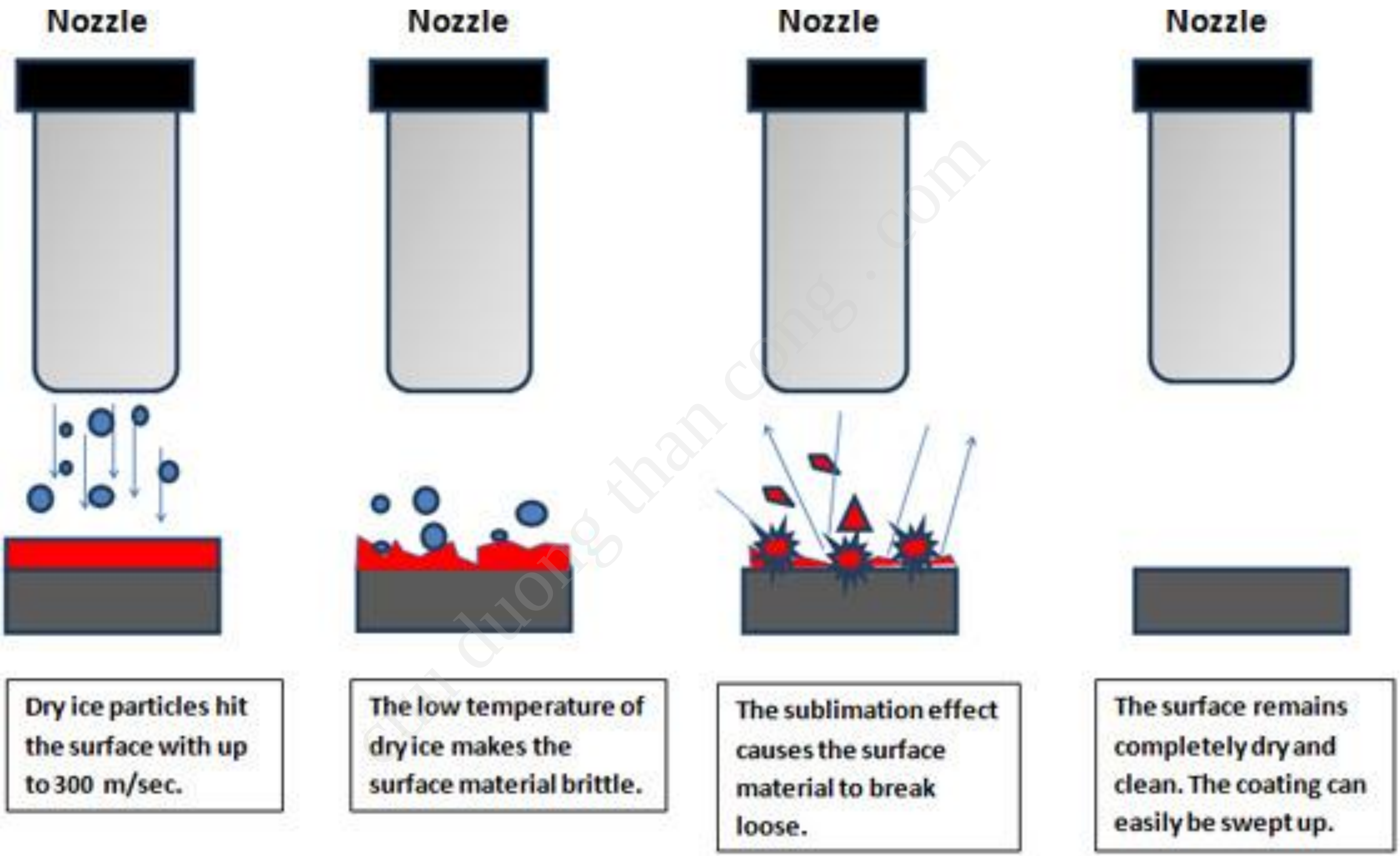
RECYCLING ?

Surface Cleaning with CO_2 Snow Blasting

The cleaning with CO2 snow blasting is residue-free, environmental friendly and does not damage the surface.

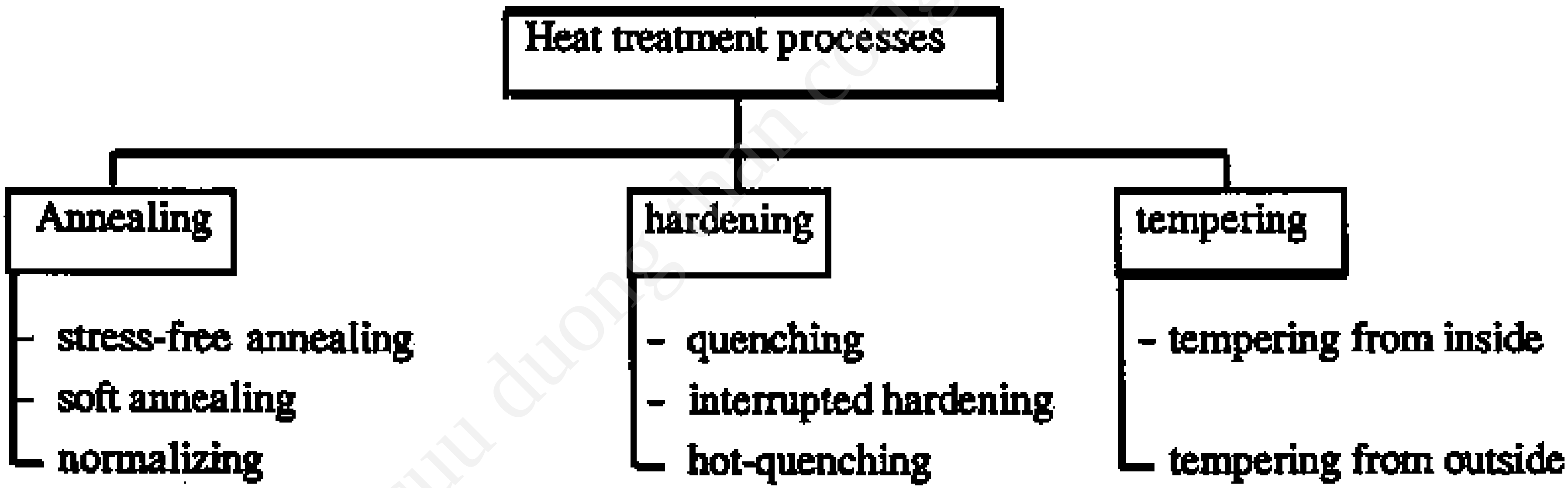


Manual CO_2 snow blasting machine SJ-25 for large surfaces and stubborn contaminations


Nozzle
Nozzle
Nozzle
Nozzle
Dry ice particles hit the surface with up to 300 m/sec.
The low temperature of dry ice makes the surface material brittle.
The sublimation effect causes the surface material to break loose.
The surface remains completely dry and clean. The coating can easily be swept up.

2. Thermal treatments

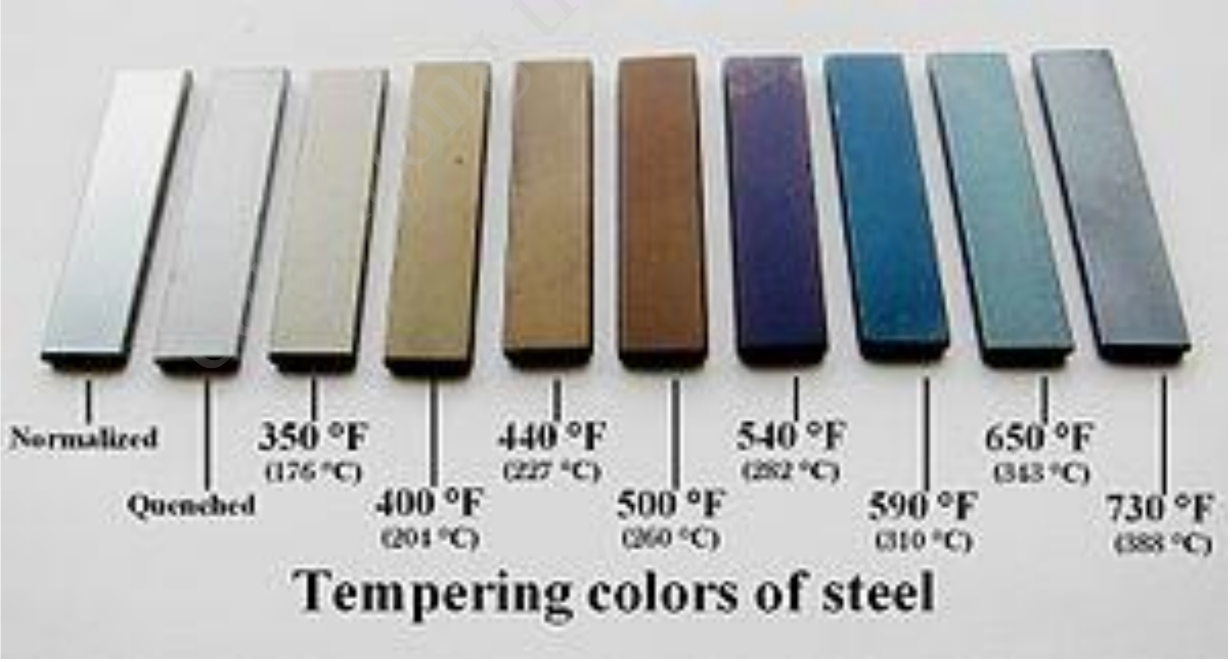
- Surface Heat Treatment
- Diffusion Coating
- Hot-Dip Coatings
- Weld Overlay Coatings



Surface heat treatment: Heating cycles (change the size, shape, grain structure, the constituents, propertie)

Annealing

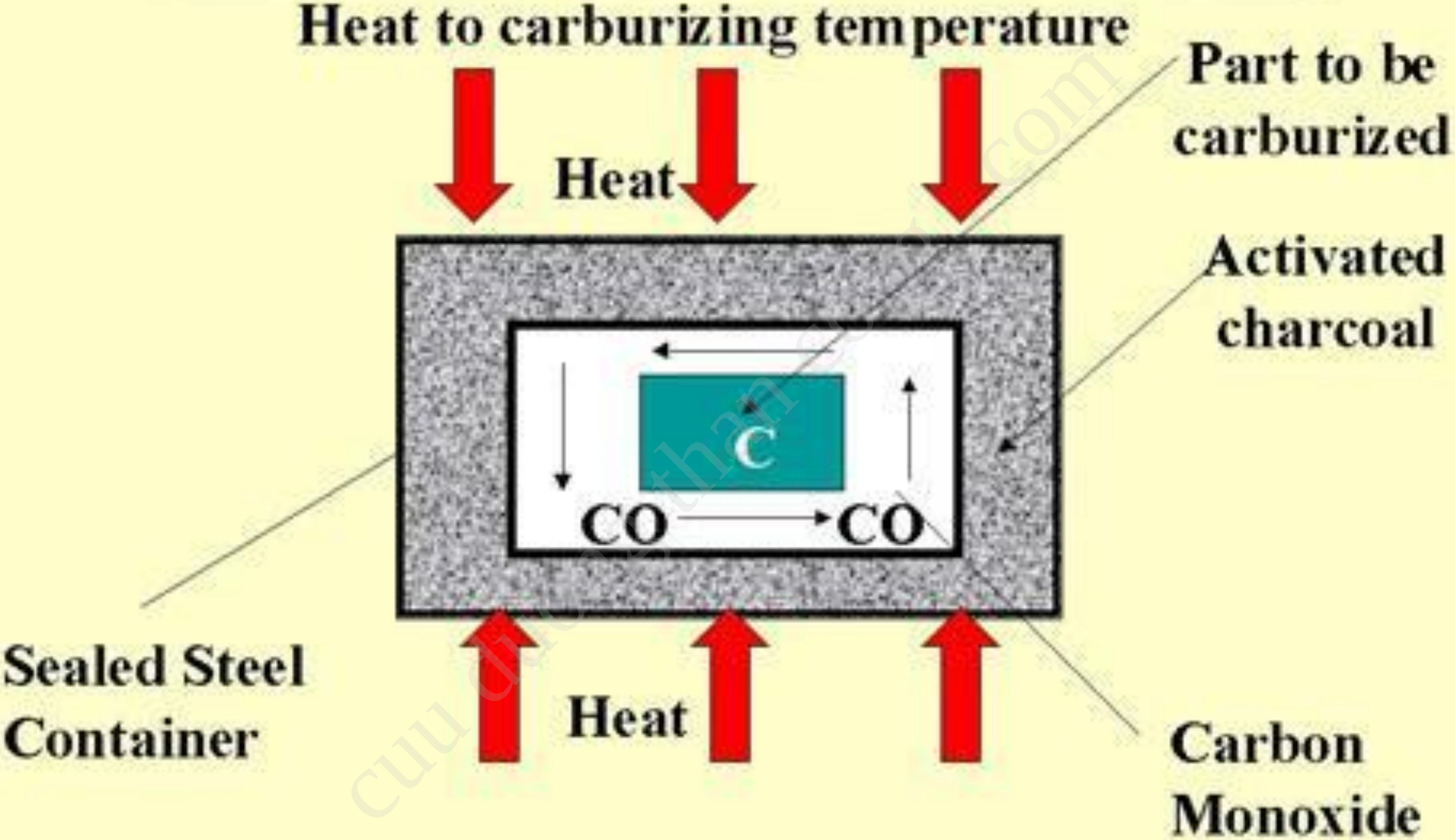
flame hardened



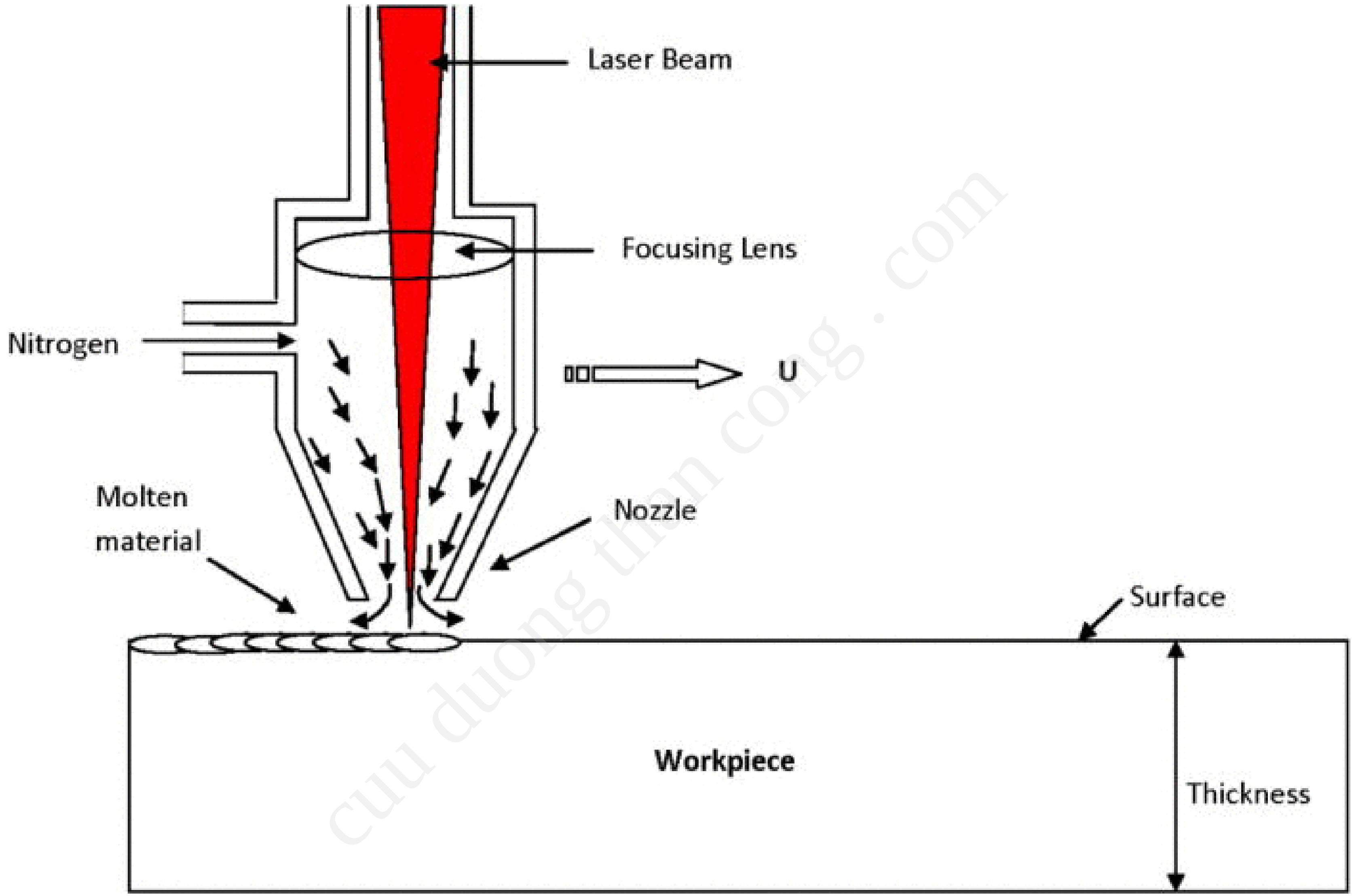
Diffusion Coating

- The surface can be enriched by diffusion of C or N into surface (low carbon steel)
- Carburizing: heat steel to austenitic range (850-950 ^{o}C) in a carbon rich environment, then quench and temper
- Nitriding
  - Nitrogen diffusion into steels @ 500-560 ^{o}C to form a thin hard surface
  - Good for Cr, V, W, and Mo steels. Will embrittle surface of Aluminum.
- Metal Diffusion: Chromizing (Chromium diffuses into surface to form corrosion resistant layer), Aluminizing (to increase the high temperature corrosion resistance of steels and super-alloys)

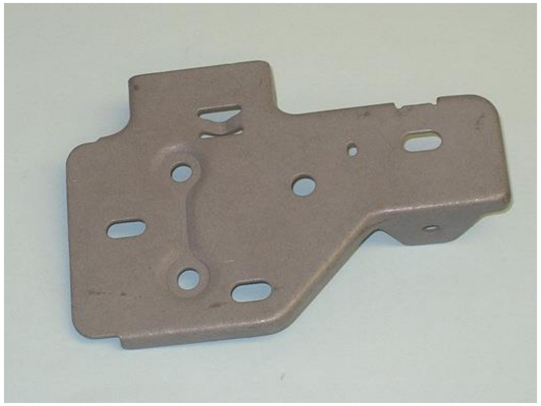
PACK CARBURIZING PROCESS

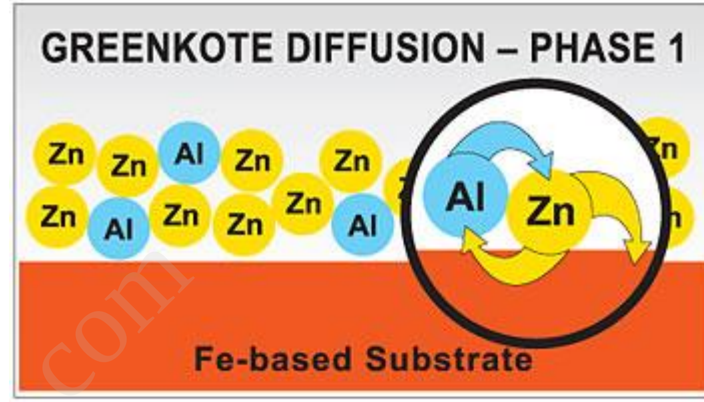


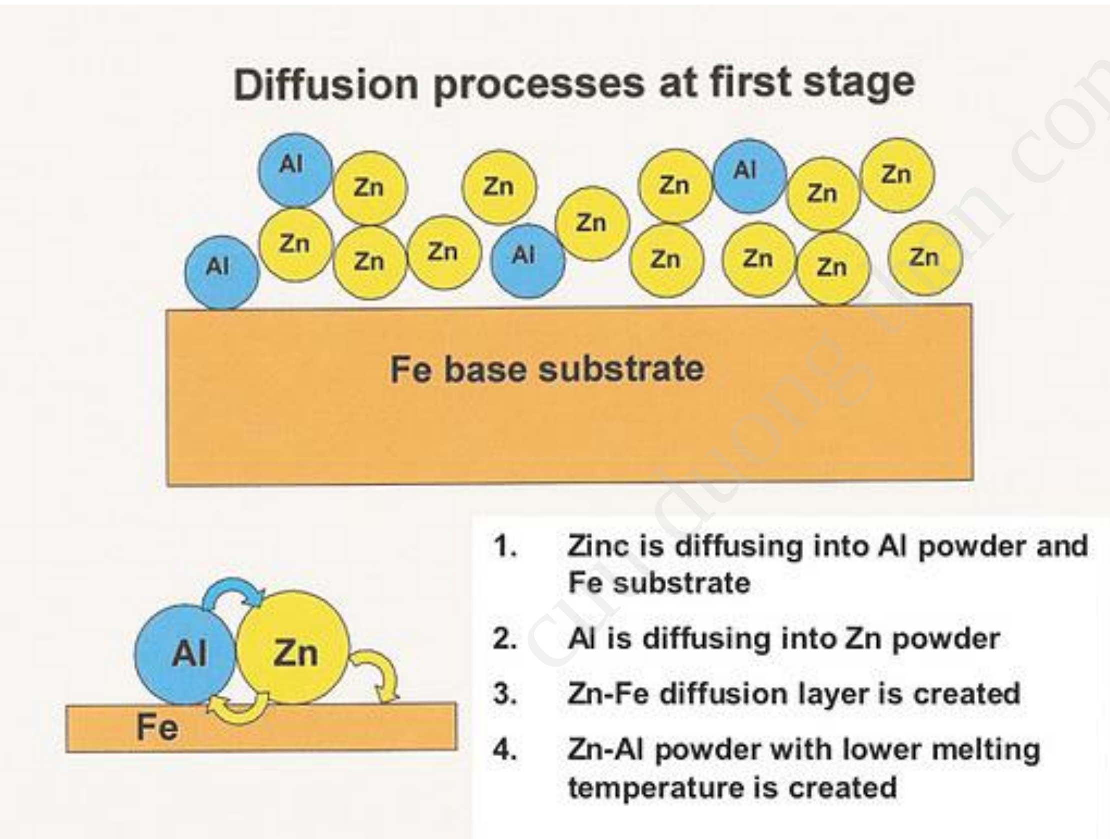
C = Carbon on the surface of the part
CO = Carbon monoxide gas that is circulated around the part

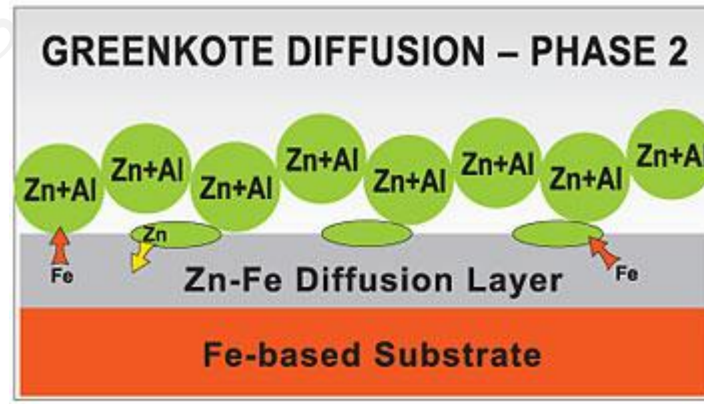


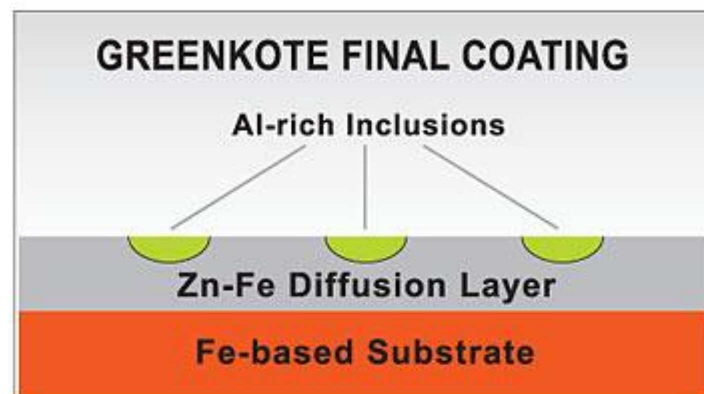
The experimental setup of a laser gas nitriding process







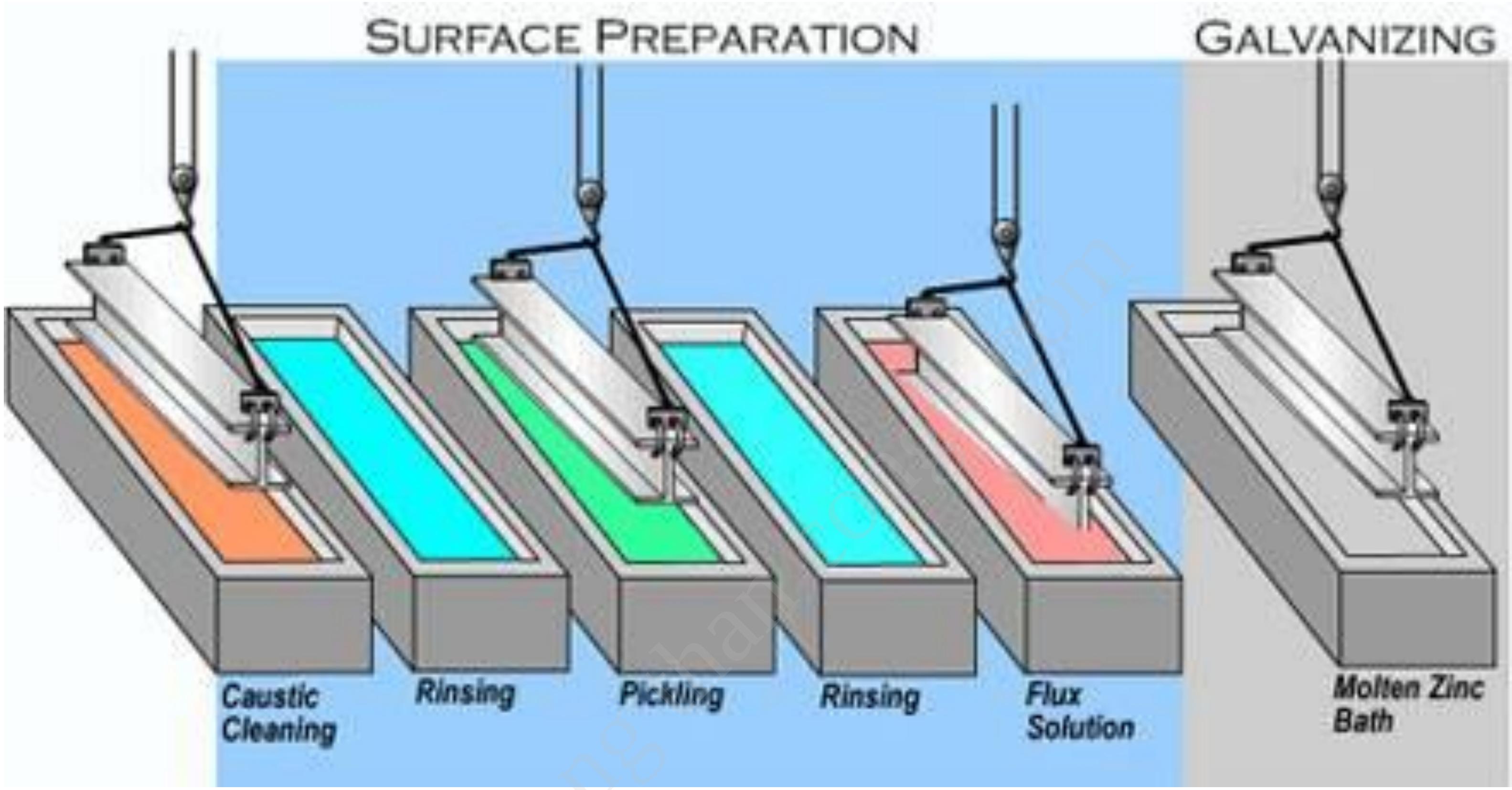




Greenkote TD patented PM coatings work by thermo-chemical surface modification.

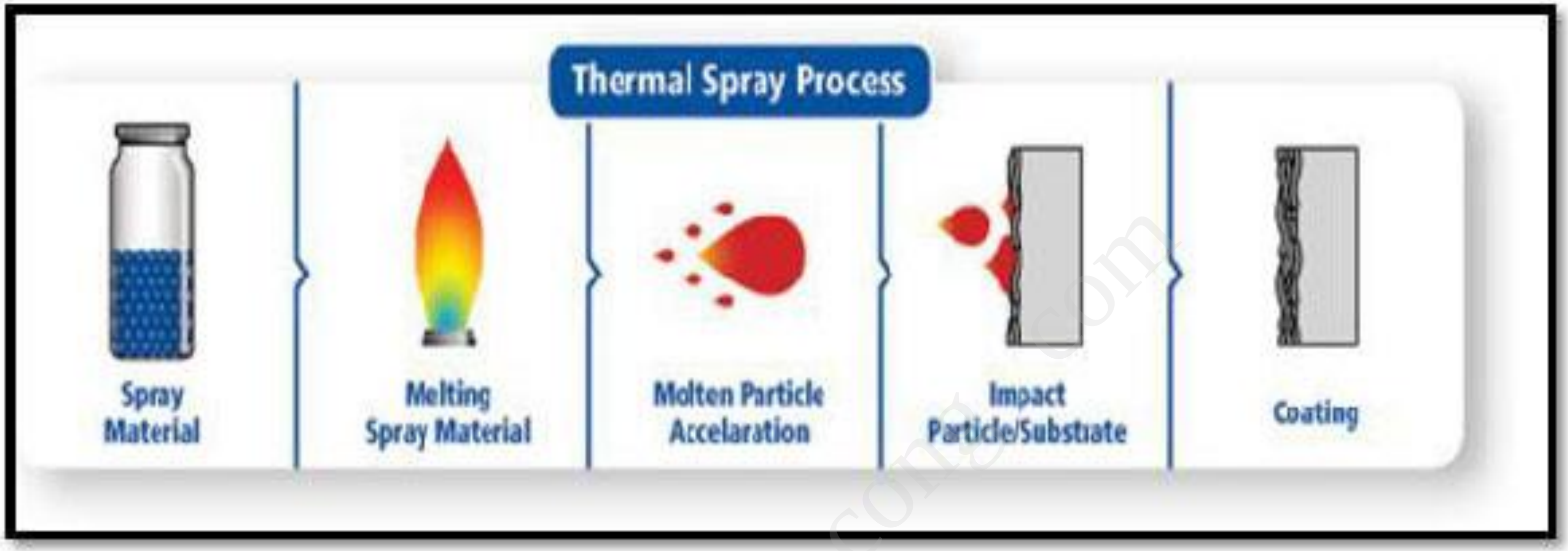
Hot-Dip Coatings
(for corrosion protection)

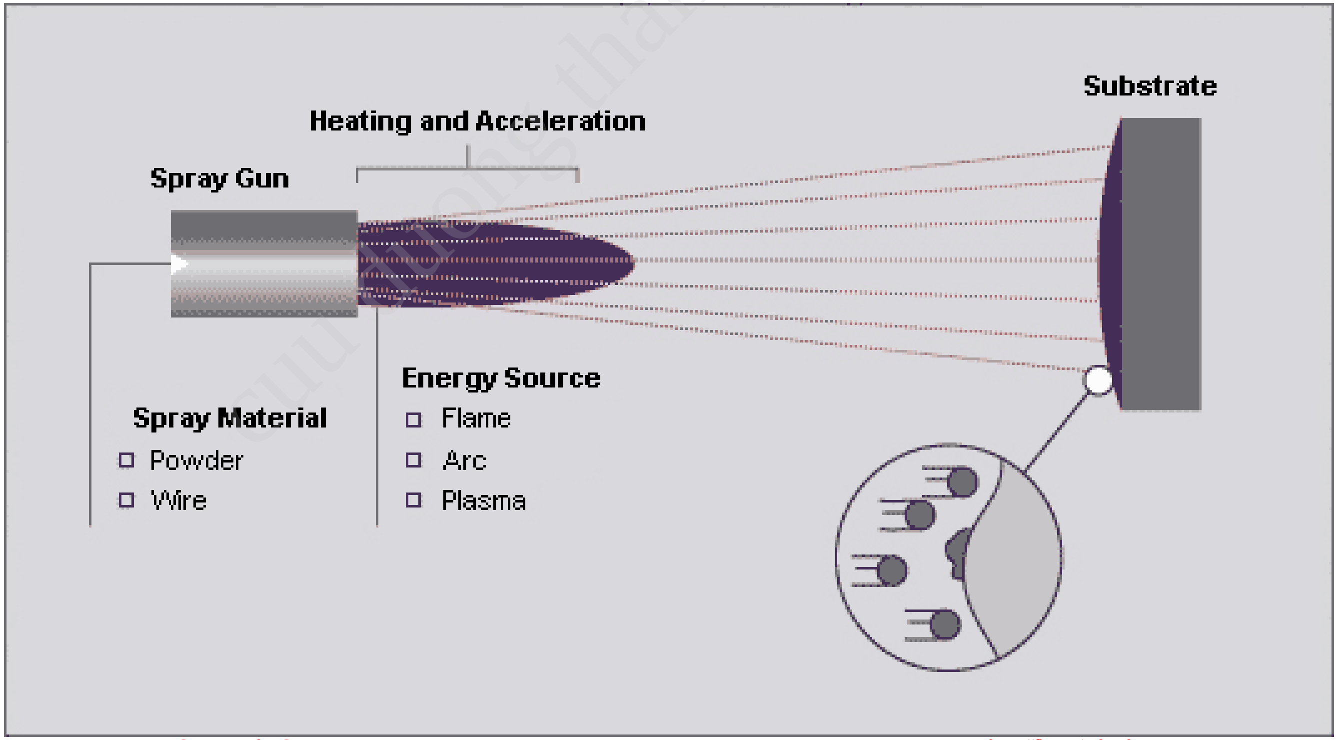
- Galvanizing: Parts are dipped into a molten zinc bath
- Galv-annealing: Galvanized parts are then heat treated to 500 ^{o}C to form Fe-Zn inter-metallic
- Zn-Al Coatings: Gives a different corrosion protect and a more lustrous appearance, reduce spangles easily observed on galvanized parts.
- Aluminum Coatings:
  - Alloyed with Si
  - Coatings used on steel for high temperature applications that need a lustrous appearance (Automobile exhaust…)

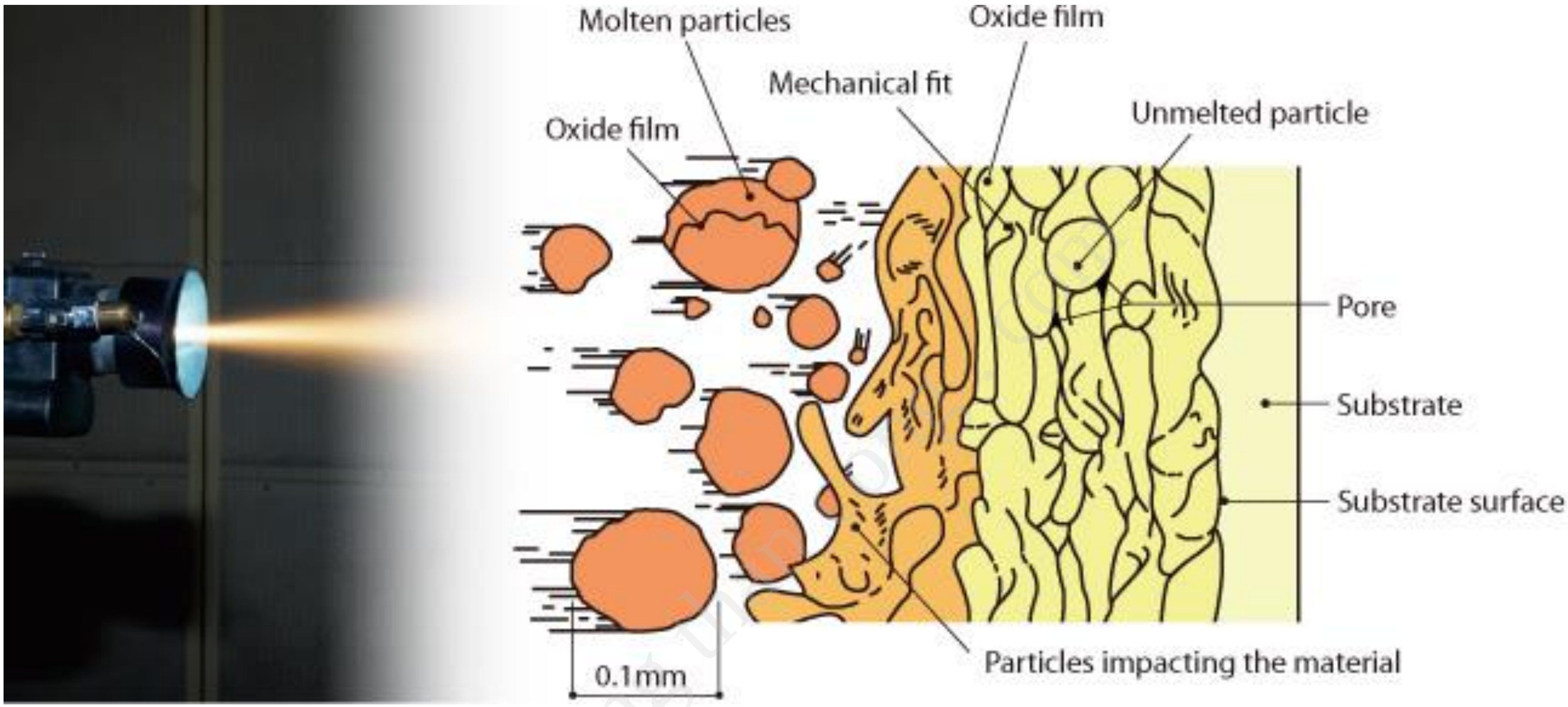

SURFACE PREPARATION
GALVANIZING
Caustic Cleaning
Rinsing
Pickling
Rinsing
Flux Solution
Molten Zinc Bath

Weld Overlay coatings (to improve wear resistance)

- Typically used to Hard Facing
  - Weld buildup of parts – alloy composition controls final properties (cutting tools, rock drills, cutting blades)
  - Cladding of material for corrosion resistance
- Thermal spraying
  - Molten particle deposition – a stream of molten metal particles are deposited on the substrate surface
  - Major difference from hard facing is that the surface of the substrate is not subjected to welding. Instead it just undergoes a bonding process with the molten particles.


Thermal Spray Process
Spray Material
Melting Spray Material
Molten Particle Accelaration
Impact Particle/Substrate
Coating


Substrate
Heating and Acceleration
Spray Gun
Energy Source
Flame
Arc
Plasma
Spray Material
Powder
Wire



Thermal spraying is a surface modification technology in which metals and ceramics are heated to a molten or semi-molten state and then made to collide with and accumulate on the surface of a substrate thereby forming a coating.

The plasma transferred arc (PTA) weld hard-facing process was developed to produce high quality weld overlays with relatively low heat input and very low dilution of the substrate into the weld overlay.

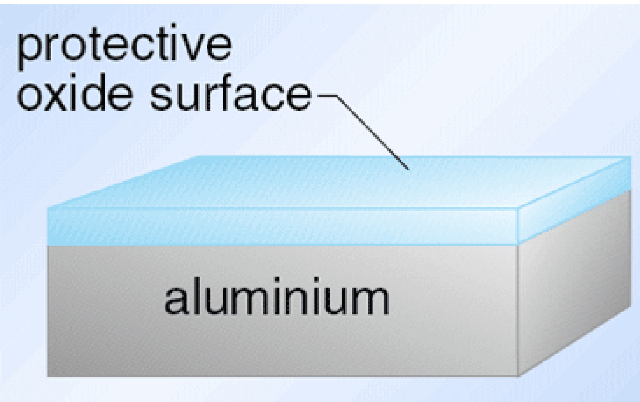
Conversion Coatings

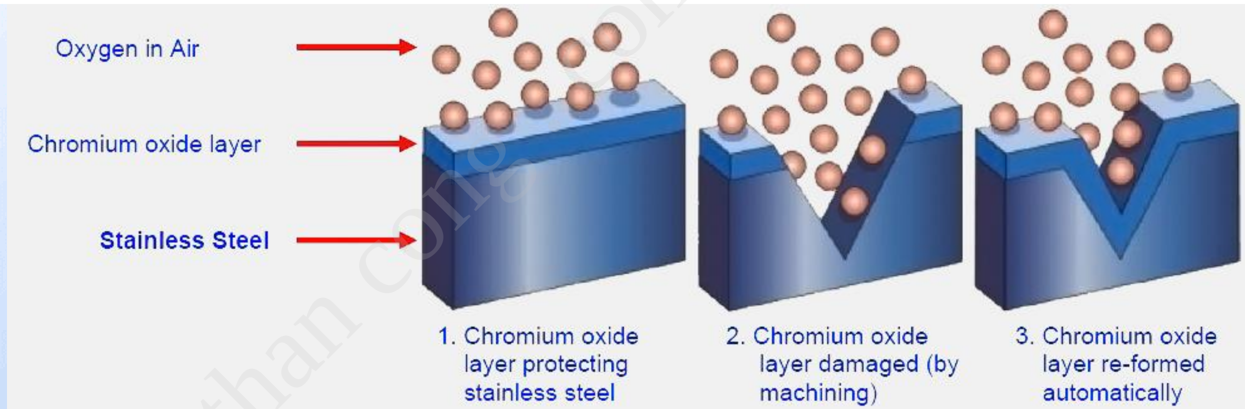
- Oxidation
- Phosphate Coatings
- Chrome Coatings

Metal Coatings

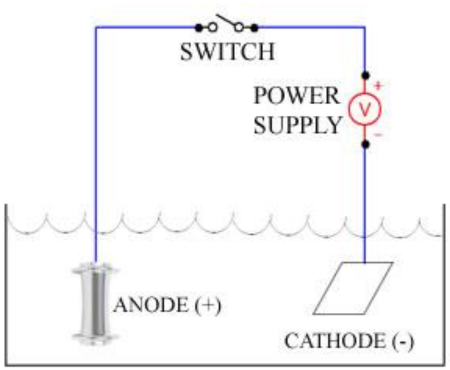
- Electroplating
- Electroless Coatings
- Metallizing of Plastics and Ceramics

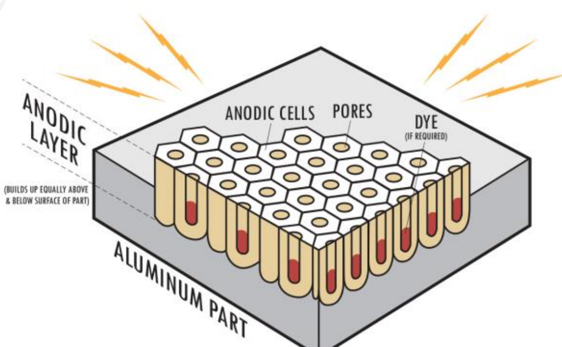
- Oxidation: Not all oxides are detrimental – many are tightly adhering leading to passivation and hardening of surface (Al_2O_3, Chromium in Stainless steel rapidly corrodes to passivate the surface)





Anodizing – electrochemical conversion, Usually done to Aluminum, 2-25 μm thick typically, Multiple colors possible, Improved Corrosion and Wear Resistance





- Gun-bluing: Heat steel to 700 F in steam or oil, Blue coating offers some corrosion resistance, but little wear benefit
- Chemical Baths: similar in nature to gun-bluing

Black Oxide (blackening): chemical application, typically applied to steel, copper and stainless steel

The piece is 'dipped' by automated part carriers for transportation between tanks contain: alkaline cleaner, water, caustic soda (at high temp) and the sealant (usually oil).

Phosphate Coating

- Immersion in a Zn-P bath with Phosphoric acid causes growth of a crystalline zinc phosphate layer
  - Iron, Zinc or Manganese Phosphate layer formed
- Typically applied to C-steel, low alloy steel and cast irons
  - Sometimes applied to Zinc, Cadmium, Aluminum and Tin
- Typically very thin ~ 2.5 μm

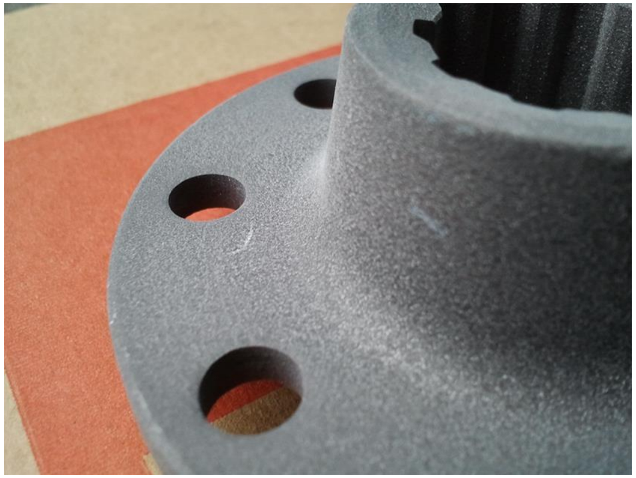
Type M - Manganese Phosphate Coatings

Type Z - Zinc Black Phosphate Coatings

Three Stage Process:
1. Clean/phosphate
2. Rinse
3. Rinse/seal

Five Stage Process:
1. Clean
2. Rinse
3. Activated rinse
4. Phosphate
5. Rinse

Or
1. Clean
2. Rinse
3. Phosphate
4. Rinse
5. Seal



Zinc phosphate coating

Manganese Phosphate Coating

Phosphating Plants

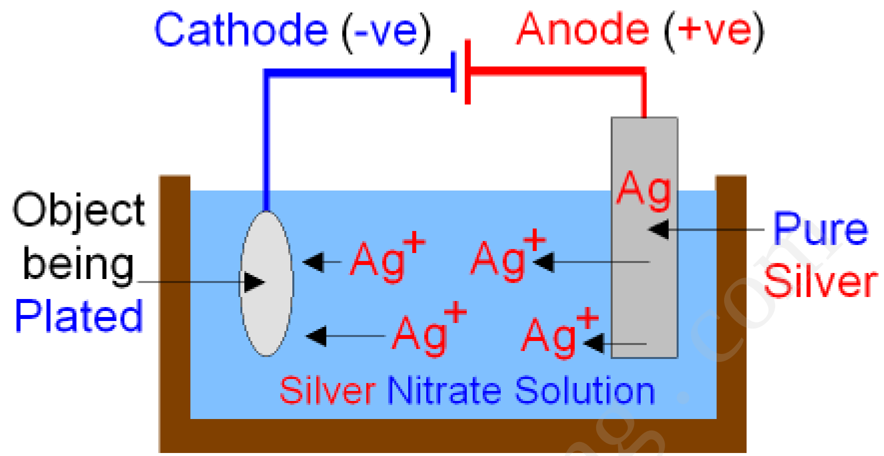
Phosphating tanks

Chrome Coating

- Food cans
- Immersion in a chromic acid bath (pH ~ 1.8) with other chemicals to coat surface
- Known carcinogen chemicals used, so alternatives are currently under research
  - Molybdate chemicals currently best subsititute for aluminum coatings
- Very good to minimize atmospheric corrosion
  - Many household goods – screws, hinges (yellow brown appearance)
- Typically very thin < 2.5 μm

Electroplating

- Used to increase wear and corrosion resistance
- Electrochemical process used to create a thin coating bonding to substrate
- Process is slow so coating thickness can be closely controlled (10-500 μm)
- Applications
  - Tin and Zinc are deposited on steel for further working
  - Zinc and Cadmium are deposited on parts for corrosion resistance (Cadmium is toxic and can not be used for food applications)
  - Copper is deposited for electrical contacts
  - Nickel for corrosion resistance
  - Chromium can be used to impart wear resistance to dies and reduce adhesion to workpieces such as aluminum or zinc
  - Precious metals for decoration or electronic devices


Cathode (-ve)
Anode (+ve)
Ag
Object being Plated
Ag+
Ag+
Ag+
Ag+
Pure Silver
Silver Nitrate Solution

Tin Plating

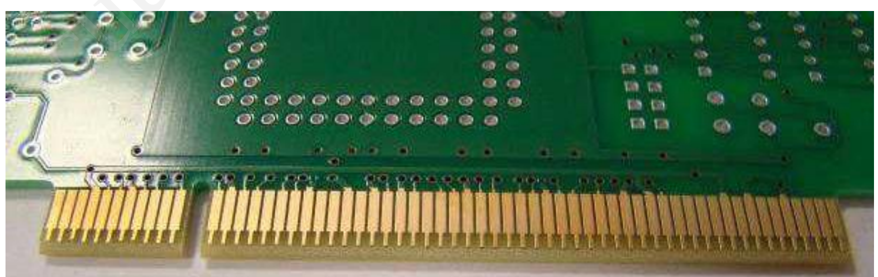
Zinc Plating

Nickel Plating

Copper Plating

Copper Plating

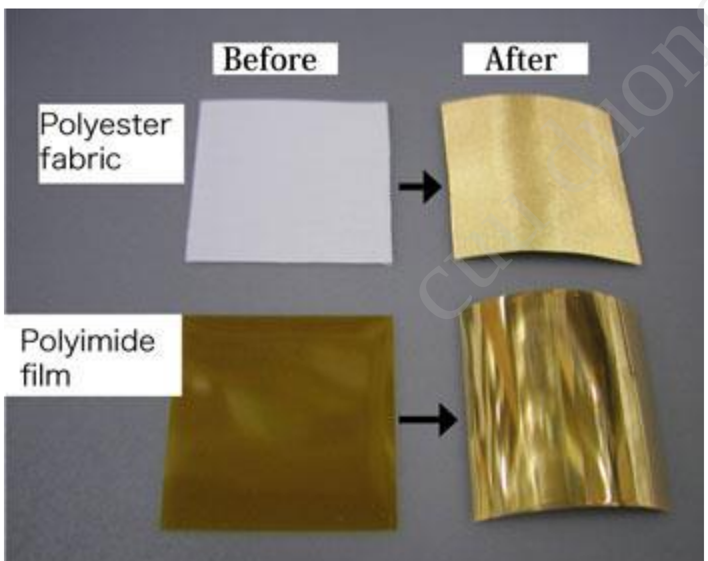
Gold Plating



Gold plating for edge connectors

Electroless Coatings

- Part is submerged into an aqueous bath filled with metal salts, reducing agents and catalysts
  - Catalysts reduce metal to ions to form the coating
- Excellent for complex geometries as deposition is uniform across surface regardless of geometry (except very sharp corners (0.4 mm radii))



gold plating

$$2HAuCl_4 + 3H_2O_2 \xrightarrow{Pt} 2Au + 3O_2 + 8HCl$$

Vapor Deposition

- Physical Vapor Deposition (PVD)
  - Thermal PVD
  - Sputter Deposition
  - Ion plating
- Chemical Vapor Deposition (CVD)

Organic Coatings - paint

- Enamels (Form film primarily by solvent evaporation, 30 % Volatile Organic Content (VOC)
- Lacquers – solvent evaporation
- Water-base paints – water evaporation
- Powder Coating