Description

Image

Image caption

(1) A Zinc Plating Solution tested in a Hull Cell. © Fstep at Wikimedia Commons [Public domain] (2) Motorbike with chrome plate applied by electroplating © Atoma at Wikimedia Commons (CC BY 2.5)

The process

When, in 1800, Alessandro Volta discovered how make an electric battery, he unleashed the development of electro-chemistry. By 1806 Humphrey Davy, prolific inventor, had developed ways of plating metals from their salts and solutions - ELECTRO-PLATING. The component (cathode) and the metallizing source material (anode) are submerged in the aqueous electrolyte where a direct electrical current drives metal ions from the source material to the component, creating a thin metal coating.

Process schematic

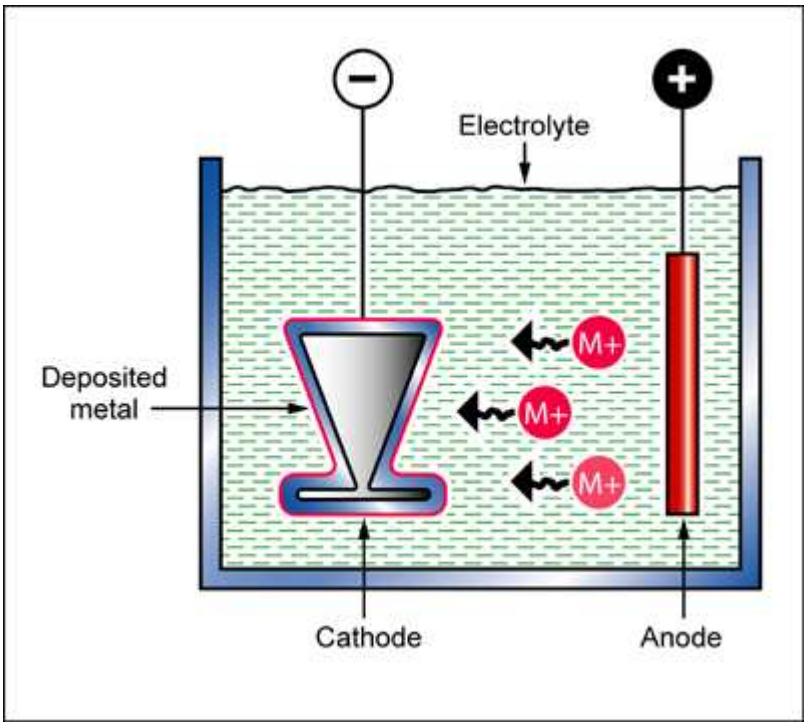

Figure caption

Electro-plating

Material compatibility

Metals - ferrous	✓
Metals - non-ferrous	✓
Polymers - thermoplastics	✓

Function of treatment

Corrosion protection (aqueous)	✓
Corrosion protection (gases)	✓
Corrosion protection (organics)	✓
Hardness	✓
Wear resistance	✓
Friction control	✓
Thermal conduction	✓
Electrical conduction	✓
Magnetic properties	✓
Decoration	✓
Color	✓
Reflectivity	✓
Surface texture	✓

Economic compatibility

Relative tooling cost	low
Relative equipment cost	medium
Labor intensity	low

Physical and quality attributes

Curved surface coverage	Average			
Coating thickness	3	-	125	µm
Coating rate	0.001	-	83	µm/s
Surface hardness	25	-	1e3	Vickers
Processing temperature	9.85	-	76.9	℃

Process characteristics

Discrete	✓

Supporting information

Design guidelines

Plating for aesthetic purposes has its origins in the silver and gold plating of tableware and cutlery ('Sheffield Plate'), and in chrome and nickel plating for shiny, durable surfaces. Most polymers can now be plated, but care must be taken to prevent the coating breaking or peeling in use. The ability to plate convoluted shapes depends on what is called the 'surface coverage' of the plating bath. Some have very poor surface coverage, meaning that only flat or gently curved surfaces can be plated; others - often assisted by mysterious, proprietary additives to the plating bath - can plate complex shapes with re-entrant features.

Technical notes

Almost any metal can be electroplated. Polymers (ABS, PEC, ABS/polycarbonate, polyphenylene oxide, polysulfone, polypropylene, nylon, polyester, polyacetal, polystyrene, polycarbonate, epoxy/glass) and other non-electrically conductive materials must be first coated with an electrically conductive material. Cleaning and surface preparation are essential. The usual range of coating thickness is 1 to 50 microns, though thicknesses up to 1mm are routine. Thicker coatings can generally be produced more cheaply or conveniently by other processes: thermal spraying, hot dipping or cladding. The processing temperature is in the range 5 - 80oC. Coatability - the ease with which an electro-plating can be applied - increases in this order: aluminum, mild steel, brass, copper. Many electro-platings have internal stresses; these can be reduced by heat treatment.

Typical uses

A flavor for the immense range of applications of electroplating, technical and aesthetic, can be tasted by scanning the following list. Aluminum: electro-plating can substitute for hot dipped aluminum, but is infrequently used. Brass: lamps and trays, low cost trim, interior automotive hardware, tubular furniture, household goods, toys, casket hardware, novelties, promote adhesion of rubber to steel. Bronze: inexpensive jewelry, door plates, hardware, trophies, handbag frames, undercoat for nickel and chromium, bearing surfaces, tableware, household fixtures. Cobalt: alloy electroplates, mirrors, reflectors, applications where high hardness is required. Co-Ni: magnetic recording, permanent magnet coating on memory drums in digital computers, electro-forming. Copper: undercoat (improved adhesion, prevention of hydrogen embrittlement), wire coatings, stop-off coatings during heat treatment and chemical milling, lubricant during drawing, thermally conductive coatings on cooking utensils, electro-forming. Gold: pen points, jewelry, watch and vanity cases, musical instruments, reflectors, name-plates, eyeglass frames, bracelets, trophies, novelties, electrical contacts, springs, electronic parts, laboratory apparatus. Nickel: heavy base for thin chromium electroplates, trim for automobiles, appliances, business machines and consumer goods, electro-forming, build-up worn and mis-machined parts. Rhodium: resistant finish for costume jewelry, insignia, emblems, musical instruments, medical and surgical parts, laboratory equipment and optical goods, electrical contacts, reflectors and mirrors. Silver: tableware, candlesticks, cigarette lighters and musical instruments, bearings, surgical instruments, chemical equipment, electrical contacts. Tin: food and beverage containers, refrigerator evaporators, food and dairy equipment, hardware, appliance and electronic parts, copper wire, bearings. Tin-Nickel: cooking utensils, analytical weights, surgical instruments, watch parts, chemical pumps, valves and flow control devices, resistance to marine corrosion. Tin-Zinc: radio and television parts, cable connectors, relay assemblies, galvanic protection of steel parts contacting aluminum. Zinc: appliances and automotive parts, finishing small parts (pipe couplings, bolts, nuts, rivets, washers, nails, hinges, hangers, hooks), electrical conduit pipes, silo and tie rods, screening, telephone exchange equipment.

The economics

The equipment cost for electroplating is relatively high, but tooling costs are low. For thin deposits, particularly on small components or areas, large batch processing can make this a very competitive technique.

The environment

Many electro-plating baths pose environmental and health hazards. Some contain disagreeable chemicals - those with cyanogens are just nasty. Protection from chemical pollutants and toxic vapor requires special precautions, as does the disposal of the plating medium. Cadmium is toxic, and now banded as plating in many European countries. Alternatives to chromium plating, one of the more unpleasant of processes, are sought but not yet found. Nickel can cause allergies and should be kept away from skin contact. Such gloomy news is not, however, universal: tin, for instance, is non-toxic.

Links

MaterialUniverse

Reference