# Description

### Image

### Image caption

(1) Hard disk electroless nickel © Blickpixel at Pixabay [Public domain] (2) Photos electroless nickel © AliceLr at Wikimedia Commons (CC BY 3.0)

### The process

ELECTRO-LESS PLATING (alias autocatalytic plating) is electro-plating without electricity. It relies instead on a difference in what is called electropotential when a metal is placed in a solution containing ions of another metal. Metal ions from the solution are deposited on the catalytic surface of the component by the action of a chemical reducing agent present in a metallic salt solution. In the case of electro-less plating of nickel (the most significant commercial application of the process), the salt is nickel chloride and the reducing agent is sodium hypophosphate. Once started the reaction can continue and there is no theoretical limit to the thickness of the coating. Electro-less plating is used when it is impossible or impractical to use normal electroplating - when complex internal surfaces are to be plated, or when dimensional accuracy of the component is critical, for instance.

### Process schematic

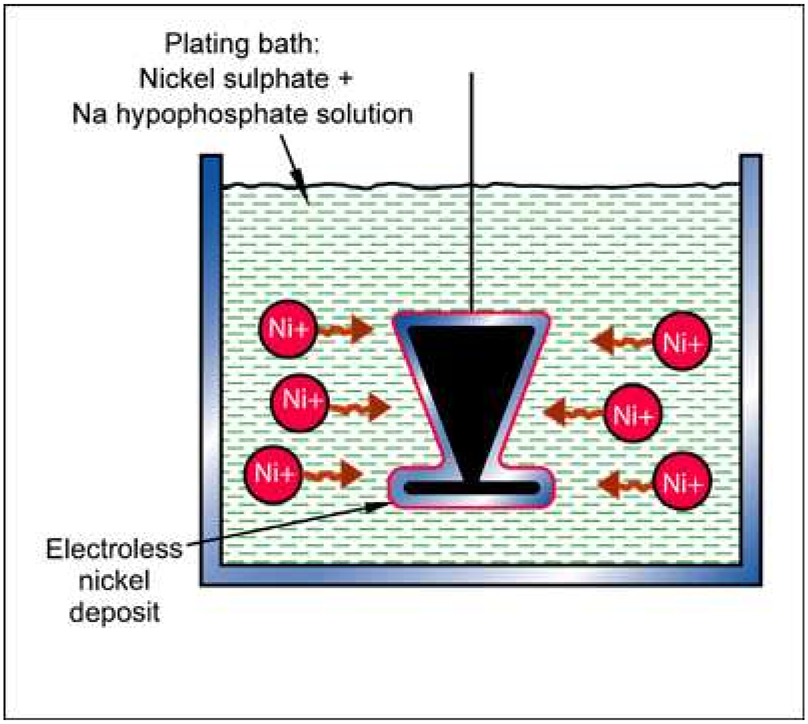

**Figure caption**

Electro-less or auto-catalytic plating

## Material compatibility

| | |
|---|---|
| Metals - ferrous | ✓ |
| Metals - non-ferrous | ✓ |
| Polymers - thermoplastics | ✓ |
| Polymers - thermosets | ✓ |

## Function of treatment

| | |
|---|---|
| Corrosion protection (aqueous) | ✓ |
| Corrosion protection (gases) | ✓ |
| Hardness | ✓ |
| Wear resistance | ✓ |
| Friction control | ✓ |
| Thermal conduction | ✓ |
| Electrical conduction | ✓ |
| Magnetic properties | ✓ |
| Decoration | ✓ |
| Color | ✓ |

## Economic compatibility

| | |
|---|---|
| Relative tooling cost | low |
| Relative equipment cost | low |
| Labor intensity | medium |

## Physical and quality attributes

| | | | | |
|---|---|---|---|---|
| Surface roughness (A=v. smooth) | B | | | |
| Curved surface coverage | Good | | | |
| Coating thickness | 10 | - | 120 | µm |
| Coating rate | 0.0014 | - | 0.011 | µm/s |
| Surface hardness | 600 | - | 1.1e3 | Vickers |
| Processing temperature | 29.9 | - | 150 | °C |

## Process characteristics

| | |
|---|---|
| Discrete | ✓ |

## Supporting information

**Design guidelines**

Heat treatment at low temperatures can improve adhesion. Ageing the coating for one hour at 400 C increases the hardness on cooling to approximately 1000 HV. Most electroless nickel solutions operate at too high temperature for plastics. High temperatures may cause plastics to warp. In addition the large difference in coefficient of thermal expansion between plastics and electroless nickel may cause adhesion failures during cooling. Thus, electroless nickel for plating on plastics operates at low temperatures (20 to 50C).Most ferrous metals, non-ferrous metals and plastics can be coated. The coating is typically applied to non-metallics as a conductive base for subsequent electroplating with both decorative and functional deposits to give resistance to abrasion or environmental attack. The uniformity of the coating is good, even on parts of very complex shapes. Base Materials: Special processing steps are needed for plastics because they are non-conductive and do not catalyze the chemical reduction of nickel. Adhesion results only from mechanical bonding of the coating to the substrate surface. To improve this, plastics are typically etched in acidic solutions or organic solvents to roughen their surfaces and to provide more bonding sites. A typical pre-treatment sequence for plastics is degreasing, etching, neutralization, catalyzation, acceleration, electroless nickel deposition. Surface has to be very clean. Adhesion can be improved by annealing. Coating Materials: The main electro-less coatings in current use are nickel (Ni, NiP, NiB, and nickel composite coatings containing SiC, PTFE) and copper. Ferromagnetic alloys Co-P, Ni-Co-P, Ni-Fe-P have also been auto-catalytically plated on magnetic tapes and discs. Only in specimens containing gaps or hollow spheres where air or evolved gas can be captured, will these areas not be plated. Electroless nickel: even small diameter tubes and holes can be uniformly plated if the position ensures that gas is not trapped. good resistance to corrosion and wear excellent uniformity and solderability and brazability better abrasion resistance than electrolytic or wrought nickel. Hardness is relatively high. No distortion. Brittleness lower plating rate as compared to electrolytic methods. Electro-less plating is more costly than electroplating: about 50% more for nickel plating. Deposition rates are much slower and chemical costs are higher; equipment and energy costs, however, are less. Despite these cost differences, the choice between the two processes is a result of physical rather than economical factors or production quantities.

**Technical notes**

The main electro-less platings in current use are nickel (Ni, NiP, NiB, and nickel composite coatings containing SiC or PTFE) and copper. Ferromagnetic alloys Co-P, Ni-Co-P, Ni-Fe-P can be plated on magnetic tapes and discs. Special processing steps are needed for polymers because they are non-conductive and do not catalyze the chemical reduction of nickel; in this case adhesion results only from mechanical bonding of the coating to the substrate surface. To improve this, polymers are typically etched in acidic solutions or organic solvents to roughen their surfaces and to provide more bonding sites. A typical pre-treatment sequence for polymers is degreasing, etching, neutralization, catalysis, acceleration, electro-less plating of nickel.

**Typical uses**

Electro-less nickel is the principal application. It is used in heat sinks, bearing journals, piston heads, landing gear components, loom ratchets, radar wave guides, computer drive mechanisms, computer memory drums and discs, chassis, connectors, rotors blades, stator rings, compressor blades and impellers and chain saw engines.

**The economics**

Electro-less plating is more costly than electroplating: about 50% more for nickel plating. Deposition rates are much slower and chemical costs are higher; equipment and energy costs, however, are less. Despite these cost differences, the choice between the two processes is a result of physical rather than economical factors or production quantities.

**The environment**

The usual problems with disposal of chemical waste, but otherwise

## Links

MaterialUniverse

Reference