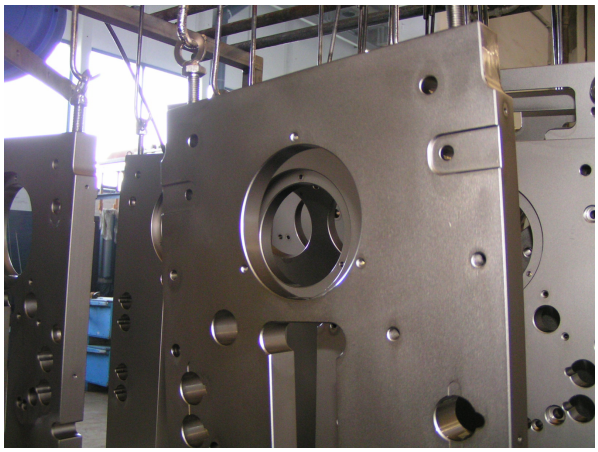
a. h. nichro Haardchrom, Søvangsvej 11, DK-2650 Hvidovre
Tel.: +45 3678 1600; Fax: +45 3678 2416
www.nichro.dk - info@nichro.dk

Worth knowing about ELECTROLESS NICKEL

What is Electroless Nickel?

Electroless nickel is a common term for nickel surfaces, which stains autocatalytic, i.e. without use of electrical power. The surface consists of nickel (88 – 98 %) and other materials such as phosphor, boron, Teflon, graphite or similar.



Electroless nickel is deposited with exactly the same layer thickness throughout the unsealed structure surfaces, as an amorphous alloy with crystals ≤ 6 nm and typical thickness of 1 to 50 microns. Dispersed particles precipitate uniform in the coating.

The content of dispersed particles changes the surface properties and its possible applications.

Where to apply Electroless Nickel?

Electroless nickel is typical used for corrosion and / or wear protection, as coating on lubricating surfaces or surfaces meant for soldering, for "rescue" of items with machining errors, for renovation of worn tool and as a base for other coatings. All applications are closely linked to the unique properties of electroless nickel.

How to treat customer items?

The outcome of “electroless nickel plating” cannot be calculated yet owing the complexity of the chemistry. In spite of this Nichro possess practical knowledge regarding surface composition, properties and applications after plating and can within certain limits tailor the surface coating according to customer wishes.

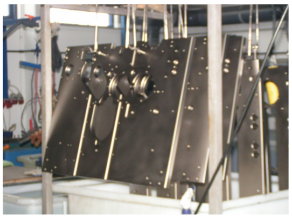
The customer and Nichro discuss and tailor the surface properties of the work piece. Then Nichro performs a test plating of the customer items. Test items are analyzed. The results are discussed and approved by the customer before the actual production is initiated.

Be aware ...

Basic materials such as iron, aluminium, beryllium, copper, titanium and alloys thereof can be plated directly. Other base materials can be plated after proper adjustment of the process.

The electroless nickel coating has no levelling effect. It does not fill any surface cradles, machining marks, holes, etc. The surface finish of the plated item is as the base material before plating.

The base material surface must be homogeneous and free for passive areas to ensure good adhesion.



a. h. nichro Haardchrom, Søvangsvej 11, DK-2650 Hvidovre
Tel.: +45 3678 1600; Fax: +45 3678 2416
www.nichro.dk - info@nichro.dk

Worth knowing about ELECTROLESS NICKEL

Structural properties

Material distribution, temperature, wear- and corrosion resistance, electrical and magnetic properties all add on to the characteristics that make the Electroless nickel to an exciting surface coating.

Corrosion resistance

Electroless nickel precipitates as an amorphous alloy without pores and cracks. The coating provides excellent corrosion protection of the base material at temperatures up to 180°C. The corrosion resistance can be improved increasing the phosphor content since a high phosphor content (10 - 12%) reduces the crystal size to below 1 nm.

Lessons learned from the U.S. oil industry shows that carbon steel coated with electroless nickel is an attractive economical alternative to stainless steel and other high steel alloys exposed to stress corrosion.

Temperature resistance

Electroless nickel coatings have a lower melting point than pure nickel (= 1452 °C). Thus nickel phosphor coatings with 11% phosphor have a melting point of approx. 880 °C. This property is exploited commercially to produce surfaces suitable for soldering and welding.

An electroless nickel surface changes properties when the coating is heat treated, because the size of the surface crystals increases with increasing temperature. The surface content of phosphor or boron converts into phosphides and borides respectively. These are distributed like islands in the coating. The formation of islands and the growing crystals implies tensile stress, leading to cracks, increased corrosion rate and decreased ductility. The coating hardness and the wear resistance are increased.

The surface converts after heat treatment into a coating containing dispersed islands of added materials. This property can be used to change the functionality of the coating in the same way as real plating of dispersed materials like Teflon or similar. The coating properties can be tailored in accordance with potential technological applications such as lubrication, non-stick, etc.

Electrical and magnetic properties

Electroless nickel coatings possess electrical and magnetic properties different from pure nickel coatings. Thus 6 - 7% nickel phosphor leads to a specific electrical resistance of 60 μΩ • cm compared to 6 μΩ • cm for pure nickel.

Electroless nickel is ferromagnetic, while nickel coatings containing more than 11% phosphor looses that property. This feature is used in the production of hard drives for computers, because the non-ferromagnetic electroless nickel-phosphor coating is suitable as substrate for the magnetic cobalt coating forming the hard disk memory.

Wear resistance

At 180 ° C are Electroless nikkelbelægningers hardness of 500 to 750 HV for nickel phosphorus respectively nikkelbor. The hardness increases with increasing temperature up to 1000 -1400 HV nickel phosphorus / nikkelbor.

The coating is then harder, but more inhomo-gene for increasing temperatures. This means an improvement of the abrasive wear characteristics, ie. increased resistance to abrasion from hard particles or hard protrusions, movements along the pavement, or between two surfaces.

Coating heterogeneity makes the coating is vulnerable to adhesive wear, ie. friction when the sliding contact between two surfaces become too high. Electroless nickel coatings can be constructed with lubricating and friction-lowering properties by medindfælde example. PTFE, molybdenum or graphite.

Coating low ductility opens up erosivt abrasion from particles hitting perpendicularly onto the coating. A ductile material flowing locally, while the particles torn loose from a brittle material's surface. The erosive wear countered however by Electroless nikkelbelægningers high modulus.

Electroless nikkelbelægningers properties of dispersionsudfældning tailored taking into account the adhesive wear, corrosive wear and fatigue wear. The improvement of the abrasive wear properties can be performed if the Electroless nickel coating is used as a substrate for example. chrome.

a. h. nichro Haardchrom, Søvangsvej 11, DK-2650 Hvidovre
Tel.: +45 3678 1600; Fax: +45 3678 2416
www.nichro.dk - info@nichro.dk

Heat treatment of Electroless Nickel

Properties of Electroless Nickel

Surfaces of electroless nickel change properties if the topic heat treated after nikkelplettering because the amorphous or microcrystalline, crystals grow in size with increasing temperature. The surface content of phosphorus and / or boron, respectively, nickel phosphides and borides, which are distributed like islands in the coating.

Corrosion

The coating provides excellent corrosion protection for up to 180 ° C, since it is pore and revnefri. A subsequent heat treatment dramatic changes on this property

The surface recrystallised to form, respectively. nickel phosphides / nikkelborid crystals. Grain boundaries and any tensile stresses in the coating provides increased access to basic material with consequent increased corrosion.

The following table shows how wrong things can go if it does not take into account the base material and tensile stresses ie. phosphorus / boron content and other Electrolesss in the process bath.

Varmebehandling	Hårdhed HV	Korrosionshastighed µm/år
Ingen	480	15
190°C i 1,5 timer	500	20
290°C i 6,0 timer	900	1900

Korrosionstesten viser egenkorrosionshastigheden af kemisk nikkel udført i 10% saltsyre ved stuetemperatur. Varmebehandling af belægningen viser et dramatisk fald i egenkorrosionsbestandigheden af en amorf kemisk nikkelbelægning. Det kan konkluderes, at en afbrintning af højstyrkestål, ikke vil påvirke egenkorrosionsbestandigheden.

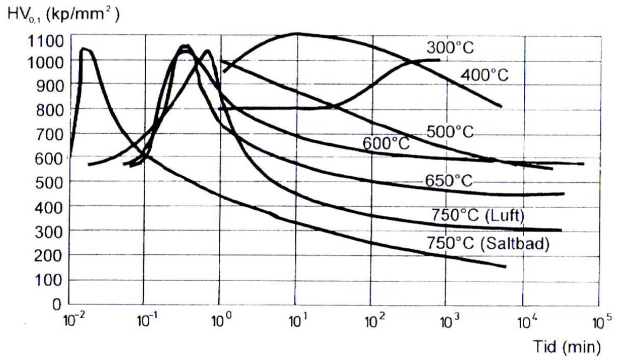
Choice of heat treatment technology

A typical process flow for example. tool steel (stavax) may be forming tool - cured - tempering - fine-tuning tolerances - electroless nickel - heat treatment & tempering - finished tool.

In this case, heat treatment is carried out in 1 to 2 hours at 250 to 300 ° C, giving a heat-treated electroless nickel surface with a hardness of about 800 HV and a corrosion rate of size 50 to 100 microns / year for a Electroless nikkelbad with high phosphorus content .

Wear

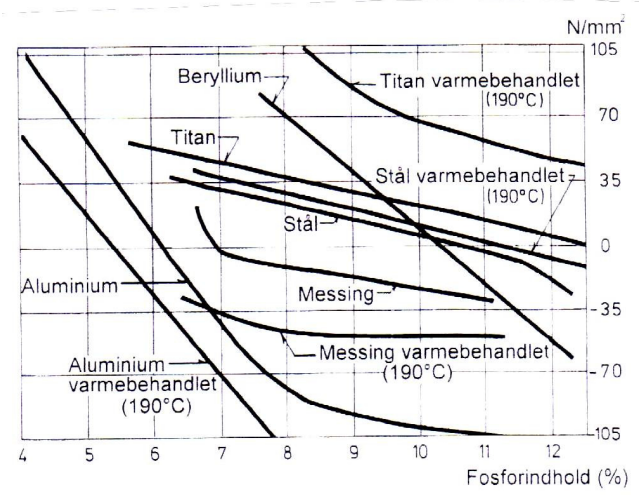
At 180 ° C, Electroless nickel coatings in a typical hardness of 500 HV. The hardness can be increased by heat treatment. The theory says up to 1400 HV. In practice, the limit is lower due to loss of corrosion resistance. Hardnesses from 800 to 900 HV is not unrealistic, depending on heat treatment choice.



Hårdheden som funktion af tiden og temperaturen ved hærdning af kemiske nikkelbelægninger.

Choice of heat treatment conditions

The optimum heat treatment selected having regard to the base material, process chemistry and customer preferences in relation to the increase in hardness at the expense of corrosion protection.



Internal tensions vs. forforindhold. Press Tensions are negative

For heat-treated steel, for example. optimal to use a process baths that give a phosphorus content of approx. 10 to 11%, since this leads to a tension-free surface coating.