



Hightech by Gerster:

**HARD-INOX<sup>®</sup>:**  
**For higher demands**  
**on resistance to wear**  
**and corrosion.**

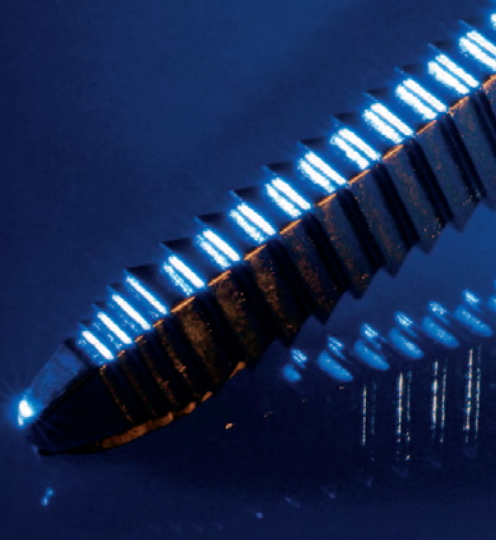
Hightech by Gerster:  
**The HARD-INOX® Program.**

The HARD-INOX® Program was developed by Gerster Technical Heat Treatments in order to use state of the art heat treatment processes to give steel the best possible combination of properties with respect to hardness and corrosion resistance. The program targets two core objectives:

**The difference between HARD-INOX®-P and HARD-INOX®-S.**

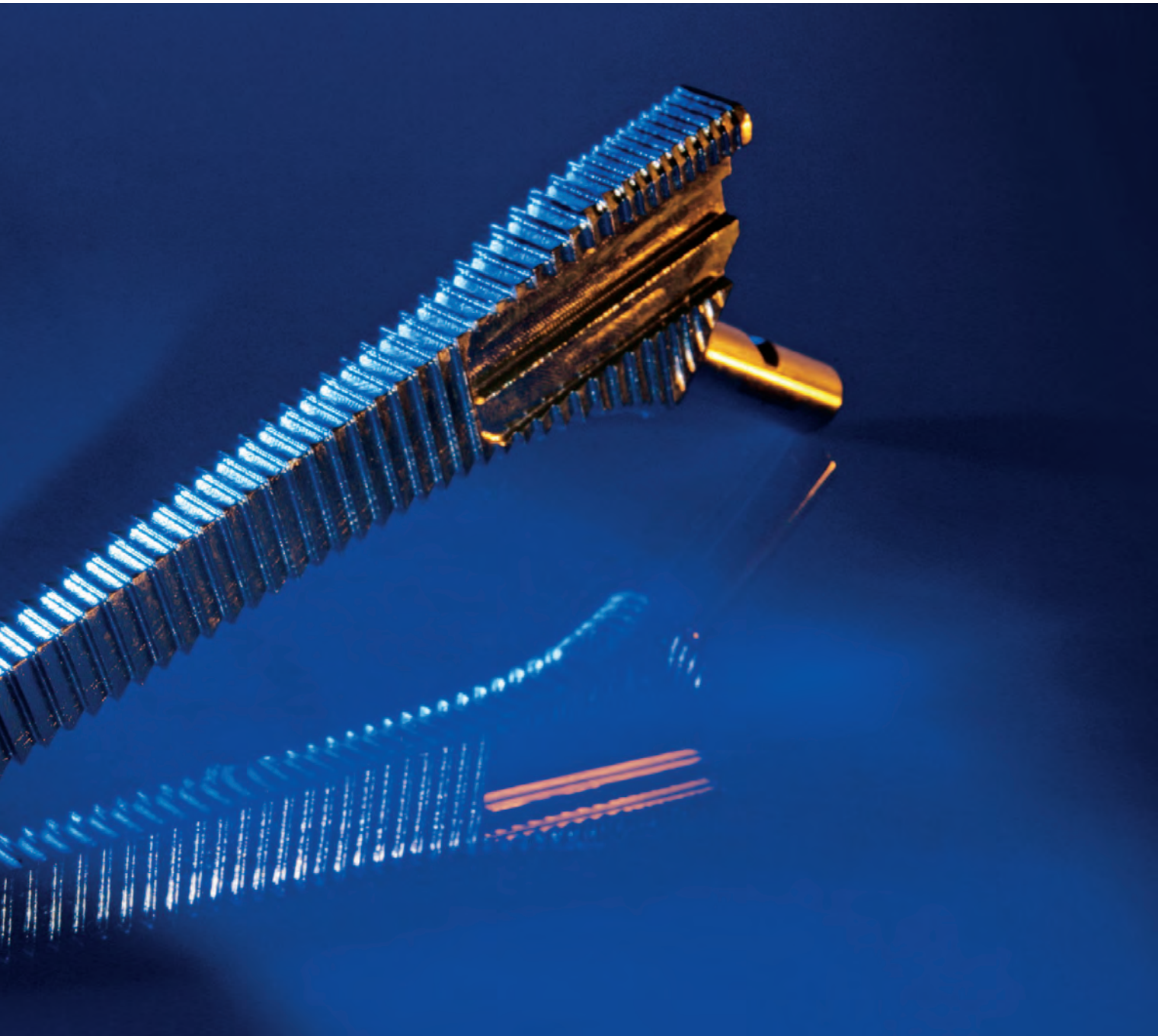
**HARD-INOX®-P** (makes hardenable steel rust-proof) is heat treatment process under partial pressure of nitrogen in a vacuum furnace at high temperatures in the range of 1000 to 1200 °C. The process enables a nitrogen up-take of 0.25 to 0.5% by weight concentration. The nitriding depth can be varied in a range between 0.1 to 1 millimeters by means of the process parameter controls. The result is an increase in hardness of 4 to 10, in extreme cases up to some 30 HRC.

**HARD-INOX®-S** (makes rust-proof steel hard) is a nitriding process at comparably low temperatures in the range of 400 °C. The process enables a nitrogen up-take of up to 10% by weight concentration and thereby makes the development of an ultra-hard diffusion zone possible. A nitriding depth of 10 to 30 micrometers can be obtained. Through avoiding chromium-rich precipitations the corrosion resistance of the base metal is maintained. A significant advantage of this process is the extremely low distortion due to thermal treatment.



► **HARD-INOX®-P:** Increasing the corrosion resistance of martensitic-hardenable chromium steels to the level of austenitic chromium-nickel and chromium-nickel-molybdenum steels.

► **HARD-INOX®-S:** Creating an ultra-hard diffusion zone resistant to corrosion, sliding abrasion and fretting wear in austenitic chromium-nickel and chromium-nickel-molybdenum steels.



Hightech by Gerster:

**The areas of application for  
HARD-INOX®-P and HARD-INOX®-S.**

When deciding, which of the two processes should be used, three main criteria are decisive: the tolerability of a magnetic product, the operational demands of the end product, and the demands on the dimensional and contour accuracy of the component to be hardened.

**The HARD-INOX®-P process is preferred**

- ▶ if a magnetic material can be tolerated,
- ▶ if the end product will be exposed to high abrasive and/or extreme stress (knocks, for instance) and
- ▶ if there is a high warpage tolerance, i.e.: if the workpiece can be reworked subsequent to hardening.

**The HARD-INOX®-S process is preferred**

- ▶ if components need be non-magnetic,
- ▶ if the end product will be exposed to adhesive stress that will lead to fretting,
- ▶ if the warpage tolerance is low, i.e.: if the workpiece, subsequent to hardening cannot be reworked.

**The Process Comparison.**

Criterion	HARD-INOX®-P	HARD-INOX®-S
Process temperature	1000–1200 °C	< 450 °C
Hardening depth	0.1–1 mm	10–30 micrometers
Hardness	up to ca. 800 HV1	900–1200 HV0,1
Warpage	minor, major	none
Suitability for austenitic, non-magnetic steels	only for increasing corrosion resistance	yes, somewhat for 1.4103, 1.4404, 1.4435
Suitability for hardenable, magnetic steels	yes, also for steel type 1.4104, 1.4016, 1.4113	yes



Hightech by Gerster:  
**The HARD-INOX®-P Process.**

HARD-INOX®-P stands for a heat treatment process in a vacuum furnace under partial pressure of nitrogen.

The process enables a nitrogen up-take of 0.25 to 0.5% by weight concentration and a controllable nitriding depth of around 0.1 to 1 mm depending on the alloy composition of the base metal. Applied to martensitic-hardenable chromium steels (see graphic) it brings about a hardening increase of some 4 to 10 HRC and a pitting resistance increase of around 4 to 8 PREN units (PREN: Pitting Resistance Equivalent Number). The extraordinary hardness increase of over 30 HRC for steels 1.4016, 1.4104 and 1.4113 is a consequence of the nitrogen induced transformation of the solution

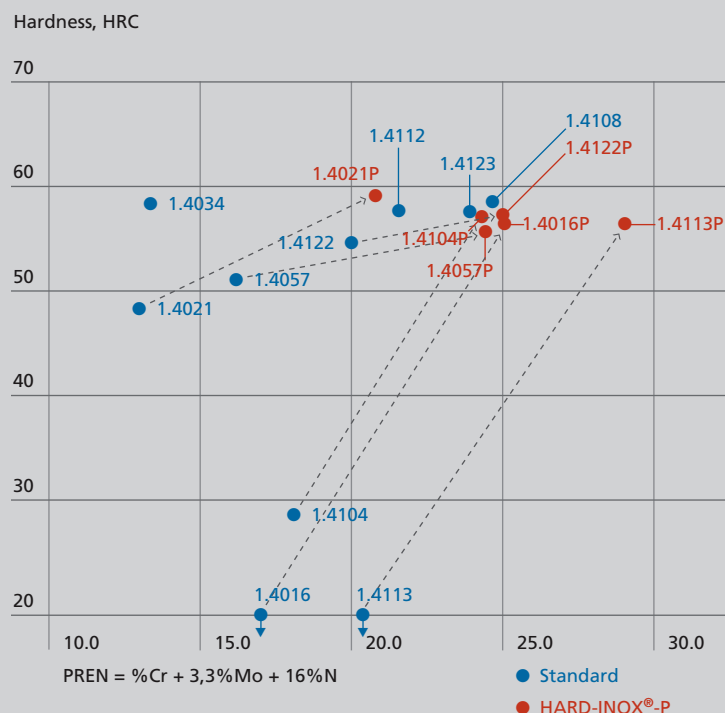
nitrided zone from a non-hardenable, ferritic steel into a martensitic-hardenable steel. Application of HARD-INOX®-P to austenitic stainless steels (see graphic) likewise brings about a pitting resistance increase of around 4 to 8 PREN units. Solution nitriding here additionally augments the resistance against repeating impact-like load.

A comparison of both graphics shows that the PREN ratings of austenitic chromium-nickel and chromium-nickel molybdenum steels can also be achieved by a HARD-INOX®-P treatment of the martensitic or ferritic chromium steels.

**HARD-INOX®-P:**  
 Nitriding treatment at process temperatures above 1000 °C.

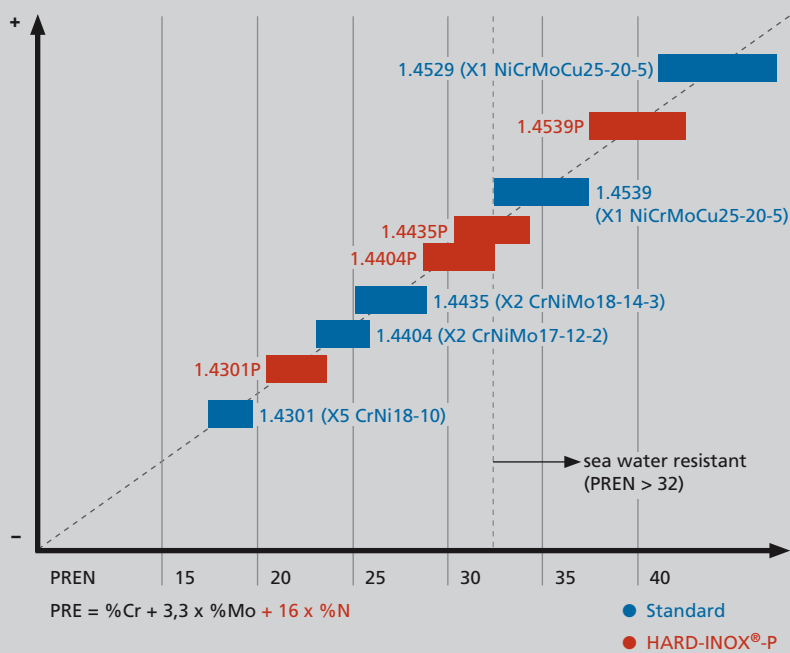
- ▶ surface hardness: up to 750HV10
- ▶ hardening depth: 0.1–1mm
- ▶ favored for high and abrasive stress factors
- ▶ suitable for applications where ferromagnetism and/or warpage due to heat treatment can be tolerated because of the possible reworking after heat treatment

Increase of hardness and corrosion resistance achieved through a HARD-INOX®-P treatment.





Corrosion Resistance



Hightech by Gerster:  
**The HARD-INOX®-S Process.**

HARD-INOX®-S stands for  
a nitriding process at comparably  
low temperatures.

The process enables a nitrogen up-take of up to 10% by weight concentration and a penetration depth of some 10 to 30 micrometers. In-diffusion of nitrogen leads to formation of the S-phase. It is characterized by hardness in a range between 900 and 1200 HV and is seamlessly bonded with the base metal. The process is implemented foremost on austenitic chromium-nickel and chromium-nickel-molybdenum steels, to increase resistance against slide abrasion and fretting wear. Through avoidance of chromium-rich precipitates during low-temperature nitriding, and owing to the high corrosion resistance of the S-phase, the corrosion resistance of the base metal is maintained.

**HARD-INOX®-S:**  
Nitriding and carburizing treatment at  
processes temperatures below 450 °C.

- ▶ surface hardness: 900-1200 HV  
hardness depth: 10-30 micrometers
- ▶ preferred when slide abrasion and fretting wear is predominant
- ▶ suitable for applications where ferromagnetism and/or warpage due to heat treatment cannot be tolerated





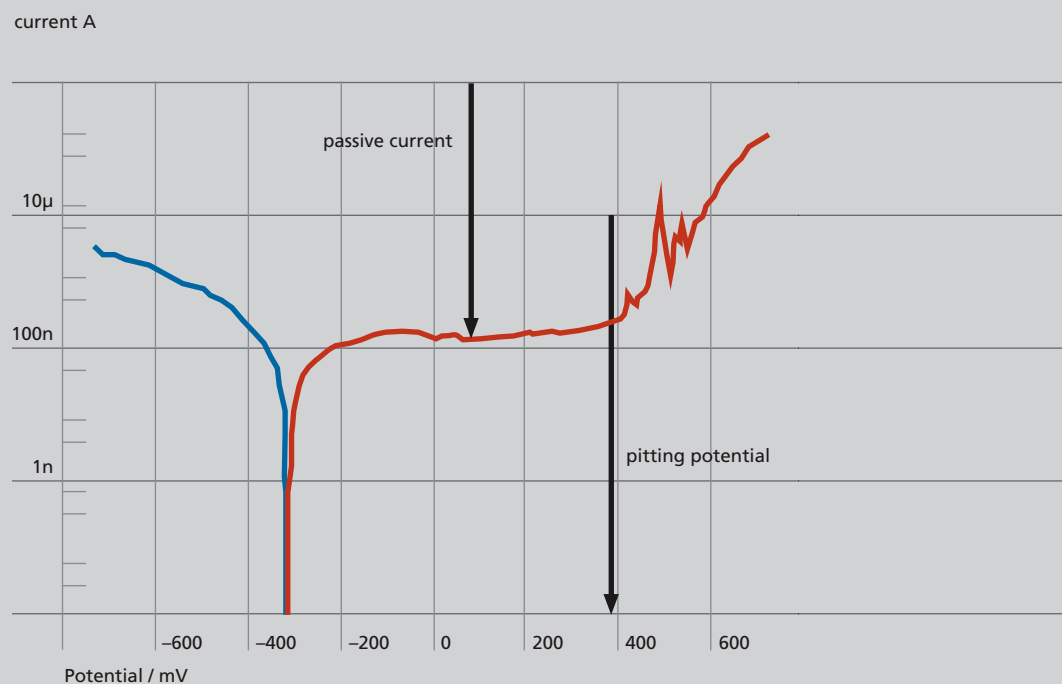
Corrosion resistant S-phase on an austenitic stainless steel (316L) with a hardness in a range between 900 and 1200 HV generated by a HARD-INOX®-S treatment.

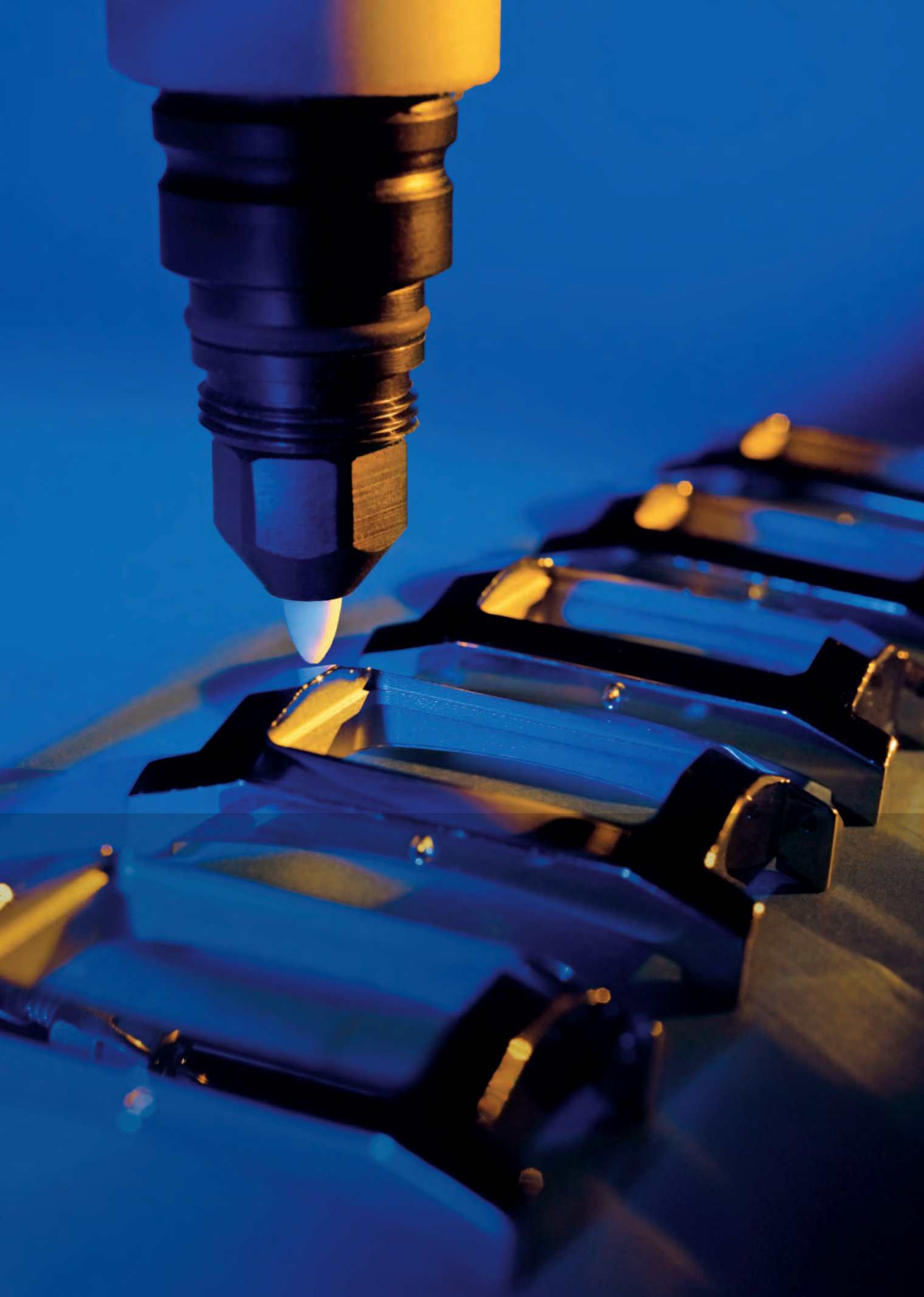
Hightech by Gerster:  
**The Corrosion Test.**

Corrosion resistance can be tested by repeated submersion tests and salt spray tests or by electrochemical measurement of current-potential curves (see graphic). With the EC-Pen (see image) Gerster Technical Heat Treatments provides a testing method which enables a non-destructive determination of the electrochemical parameters of the corrosion.

Testing is done locally on a polished component surface of approximately 1 cm<sup>2</sup> in size. The most important parameters in this regard are the passive current and the pitting potential (see graphic). A low passive current and a high pitting potential indicate a good resistance against uniform corrosion and pitting.

Current-potential curve,  
measured using an EC-Pen





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ISO 9001:2008  
ISO 14001:2004 Environment  
ISO/TS 16949:2009 Automobile  
ISO 13485:2003 Medicine



## Hightech by Gerster.

### The Product Line:

#### Surface hardening

- ▶ Induction hardening
- ▶ Dual frequency hardening
- ▶ Impulse hardening
- ▶ Flame hardening
- ▶ Non-destructive determination of hardening depth

#### Laser technology

- ▶ Laser hardening

#### Through hardening/annealing

- ▶ Hardening under inert gas conditions
- ▶ Vacuum hardening with pressurised gas quenching
- ▶ Tempering
- ▶ Annealing under inert gas conditions
- ▶ Stress relief treatments
- ▶ Cryogenic treatments down to  $-180^{\circ}\text{C}$
- ▶ Precipitation hardening of aluminium alloys

#### Brazing

- ▶ Under vacuum conditions
- ▶ Under inert gas conditions
- ▶ Inductive
- ▶ With flame

#### Thermochemical diffusion methods

- ▶ Carburising
- ▶ Carbonitriding
- ▶ Case hardening
- ▶ Gas nitriding
- ▶ Oxinitriding
- ▶ Gas nitrocarburisation
- ▶ Pronox
- ▶ Micropulse-Plasma nitriding
- ▶ Plasox
- ▶ Boronising
- ▶ Heat treatment of stainless steels SolNit-A®, SolNit-M®, HARD-INOX®

#### Consulting and additional services