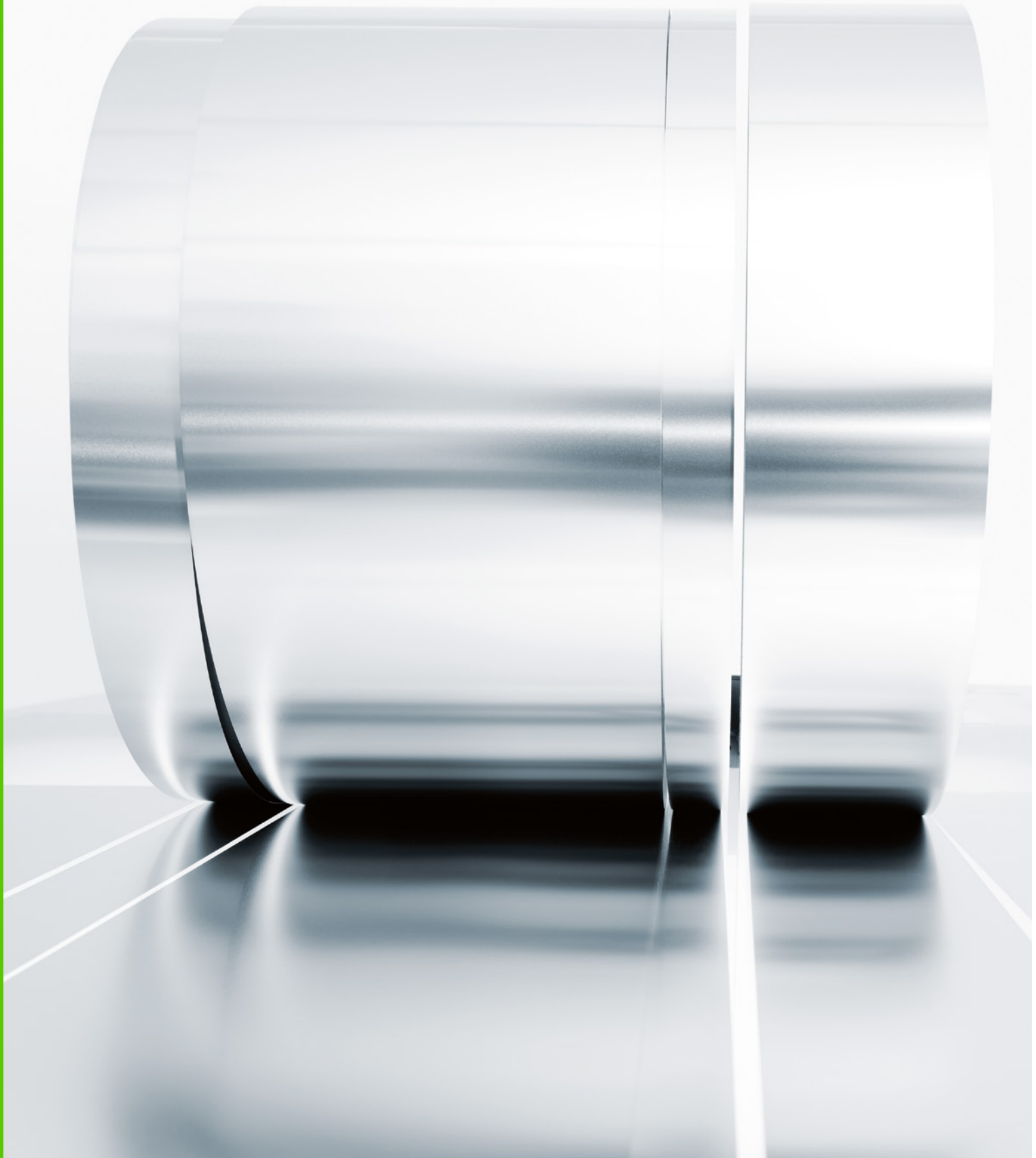





PRECISION STRIP
ETCHING AND LASER CUTTING
APPLICATIONS

New since 1701
Zapp Precision Metals GmbH


ZAPP





The illustrations, drawings, dimensional and weight data and other information included in this brochure are intended only for the purposes of describing our products and represent non-binding average values. They do not constitute quality data, nor can they be used as the basis for any guarantee of quality or durability. The applications presented serve only as illustrations and can be construed neither as quality data nor as a guarantee in relation to the suitability of the material. This cannot substitute for comprehensive consultation on the selection of our products and on their use in a specific application. The brochure is not subject to change control.

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PRECISION STRIP FOR ETCHING AND LASER CUTTING APPLICATIONS

Precision strip, used to produce etched and/or laser cut components must fulfill a variety of conflicting properties. In cooperation with leading industrial partners, Zapp has developed steel grades to meet the most challenging demands for material processibility as well as final product precision and performance. These demanding requirements can only be met by **defining accurate processes** from the liquid steel until the final delivery to the customer. For over a century Zapp has worked with stainless steel developers to define the highest precision for its customers.

Tailored solutions for complex shapes produced by photochemical machining and laser cutting

Due to the variety of processes used in the photochemical machining industry, photoelectroforming and laser cutting industry there is not one single solution to fit the whole variety of requirements. Individual and **tailored solutions** have been developed to fit the processes and demands of our customers.

Applications

Zapp's precision strip is used for the most demanding etching and laser cut applications such as:

- _ Stencil masks
- _ Fine metal masks
- _ Fine mesh filters
- _ Flexible circuit boards
- _ Complex electrical components
- _ Intricate watch components
- _ Medical components
- _ High quality decorative parts



Leveling line in Unna



HOW DO WE MEET THE REQUIREMENTS FOR ETCHING GRADE MATERIAL?

The results of photochemical etching or laser cutting are determined by **various factors**. The material, the etching or cutting process itself, the etchant, the etching technology and the preparation of the work-piece surface play an essential role. To ensure precise and reproducible processing at the etching plants and

to enable our customers to obtain a final product with tight scatter of properties we fix our processes for each individual item to deliver the same input material into the etching or laser cutting process. **Reproducibility** is incorporated into our precision strip and reduces the variation within the subsequent manufacturing steps.

THE STRIP STEEL PROPERTIES RELEVANT TO ETCHING AND LASER CUTTING APPLICATIONS

Steel strip properties	Photo chemical processing	Applications
Chemical composition	Etching speed	Chemical, mechanical, physical properties
Microstructure	Etching speed resolution	Final shape, surface and function
Shape	Resolution/ease of processing	Resolution
Surface roughness	Adhesion of photoresist	Resolution
Surface cleanness	Uniformity of processing	Resolution and functionality
Avoidance of surface defects	Etching defects	Resolution and functionality
Residual stress	Dimensional stability	Resolution and shape

Simon Trubel
Development Engineer, Precision Strip
Unna Location



ZAPP STEEL GRADES FOR CHEMICAL ETCHING OR LASER CUTTING

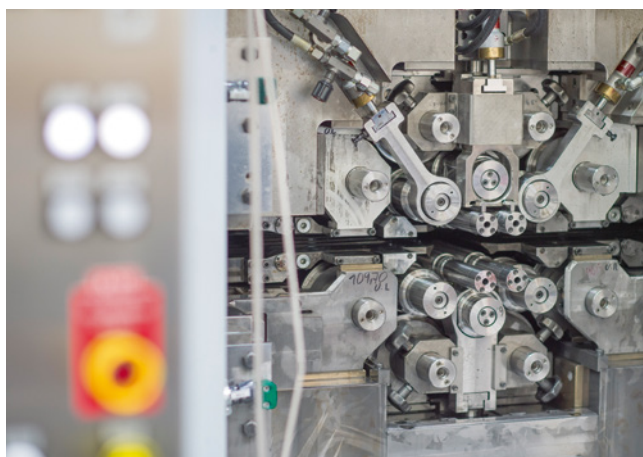
Zapp's etching grade products *Zapp Super-Etch* and *Zapp Micro-Etch* are used by many leading etching companies, to produce high-end parts for global supply chains. Excellent, reproducible quality and delivery performance are the foundations of our company and the aim of all our employees.

Chemical composition

Our portfolio of steel grades contains customized chemistries for each standard. Long established relationships with leading global suppliers have enabled us to **co-develop** a number of propriety Zapp steel grades with tightly restricted chemistries. This ensures that we can select the perfect material to meet your requirements, thereby ensuring reproducible processing and a **low scatter** of final product properties. As an example we carry five Zapp versions within the standard 1.4310 (301) family, each with a specific chemical nuance for optimized performance.

OVERVIEW OF MAIN ETCHING GRADES

Zapp brand name	EN DIN	AISI	JIS	Cr	Ni	Mo	C	Si	Al
Ni36	1.3912	K93603	-	-	36	-	-	-	-
Ni36 SuperClean	1.3912	K93603	-	-	36	-	-	-	-
1.4016IM	1.4016	430	-	16	-	-	-	-	-
1.4021YB	1.4021	420	420J1	13.5	-	-	0.2	-	-
1.4028MO	1.4028	-	-	13.5	0.5	1.0	0.38	-	-
1.4122YL	1.4122	-	-	16.3	-	1.0	0.42	-	-
1.4301PA	1.4301	304	-	18	9	-	-	-	-
-	-	302	-	18.1	8.2	0.03	0.06	0.60	-
1.4310FM	1.4310	301	-	16.7	6,6	-	0.10	0.90	-
1.4404LA	1.4404	316L	-	17	8	2.5	-	-	-
1.4568GA	-	17-7PH	-	16.3	7.2	-	-	-	1



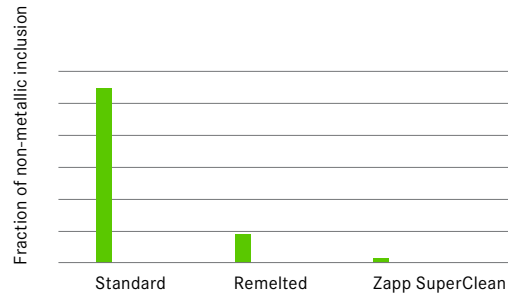
20-high-rolling-mill

TAILORED MICROSTRUCTURES FOR ETCHING APPLICATIONS

World class cleanness

Any non-metallic inclusion can affect the accuracy of the etch. Patterns can deviate from the ideal nominal shape as non-metallic inclusions are often chemically inert and do not dissolve during the process. For very precise micro-patterns our metallurgists have developed special metallurgical routes with our suppliers to meet the highest demands. In addition, to the standard metallurgical routes we have access to refined melting processes such as electro slag remelting (ESR) and vacuum arc remelting (VAR) with **improved cleanness**. For special applications we can offer our even cleaner *Zapp SuperClean* material for patterns down to a few microns. With respect to very small inclusions the material is significantly cleaner than remelted material.

CLEANNES OF Ni36 (1.3912) FOILS FREEDOM FROM NON-METALLIC INCLUSIONS



Microstructure

Metallic materials are not homogeneous. They are composed of various features, which behave differently in etching solutions. Therefore, it is important to understand the requirements imposed by a given application, in order to tailor the appropriate microstructure for our steel strip products.

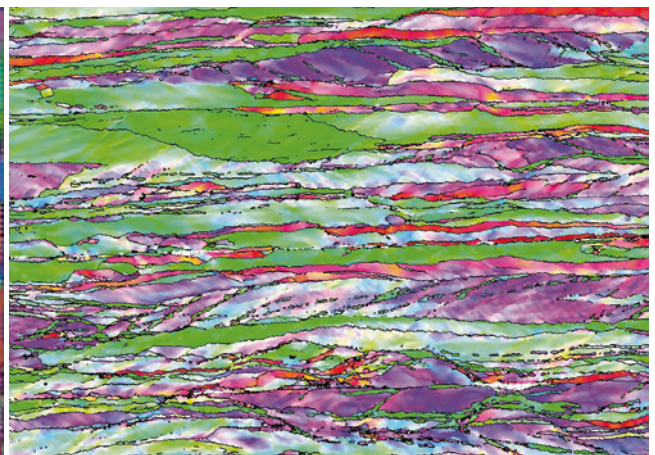
The crystal orientation of a material determines the etching speed and resulting surface characteristics. Zapp has developed processes enabling grain size and tight texture control for the production of fine grain materials with reproducible precision.

Iron-nickel alloy (UNS K93603/Ni36) annealed condition



30 μm

Iron-nickel alloy (UNS K93603 or Ni36) in work-hardened (cold-rolled) condition



70 μm

SHAPE CONTROL

On-line shape control systems, on our modern rolling mill and tension leveling line, allow for optimum material **flatness** and **straightness**. This avoids differences in waviness across the length and width of material, which can severely impair the production of fine-structured patterns via reel-to-reel etching operations.

Flatness

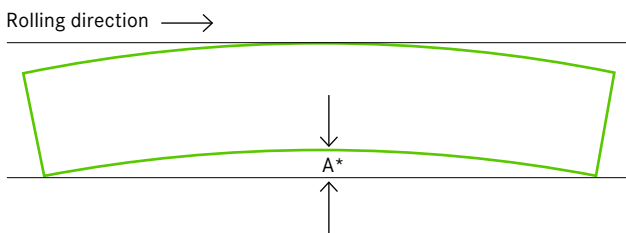
- _ Flatness in rolling direction (waviness)
max. 3 I-Units
- _ Flatness in transverse direction (cross bow)
max. 0.20 % of the width

Camber

- _ Max. 1.5 mm/m and tighter if requested

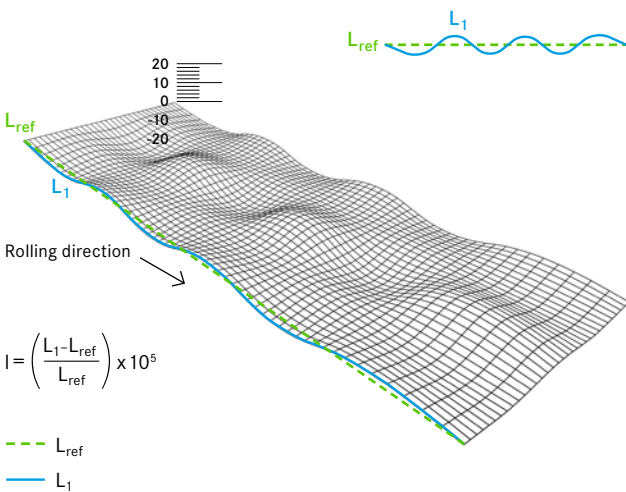
Close control of strip camber (defined as the greatest deviation of a coil edge from a straight line) is essential for ensuring efficient steering through reel-to-reel etching lines. Furthermore, to achieve the desired pattern on a strip exhibiting excessive camber, the material must be put under tension during exposure. The release of this stress can result in distance deviation from the centre to edges of etching patterns. Our **tight control** of strip form and shape allows our customers to significantly increase their final product yields and run-times.

CAMBER



A*: Greatest distance of a coil edge from a straight line

FLATNESS



Julia Urbanczyk
Quality RQM-WE, Precision Strip
Unna Location

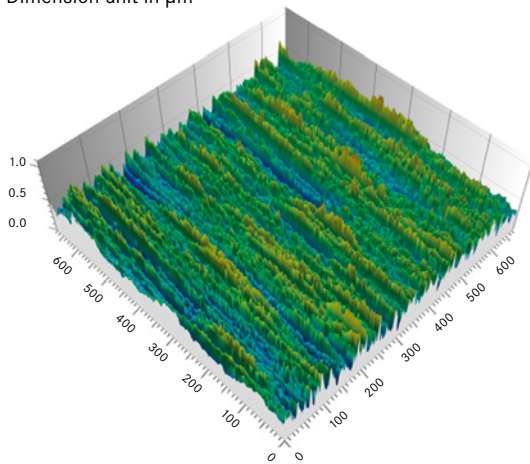


SURFACE ROUGHNESS

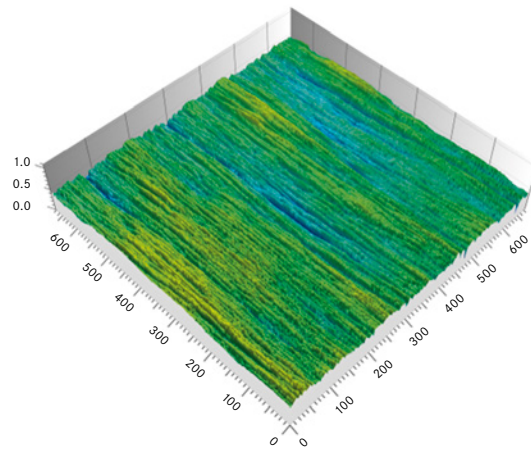
Depending on the coating method (wet or dry) the strip surface can play a crucial role in achieving the **optimum thickness** of photo-resist in turn ensuring the correct exposure time. Furthermore, the bonding strength, or adhesion, is dependent upon the surface roughness.

Zapp can accurately measure, and carefully control, the surface roughness of our strip products. We offer a variety of surface finishes, which are achieved by our precision in-house roll grinding and polishing operations. We can produce **surfaces** from extremely smooth/ mirror-finish up to tailored textured surfaces. Indeed, we have recently developed our *NDF Surface* (Non-Directional Finish) specifically for precision etching applications.

Dimension unit in μm



Standard surface after hardening and tempering



Polished surface of hardened and tempered product

Depending on requirement

_ $0.05 \mu\text{m} \leq R_a \leq 0.30 \mu\text{m}$

_ $1.0 \mu\text{m} \leq R_t \leq 3.0 \mu\text{m}$

Roughness

Four surface finishes are available:

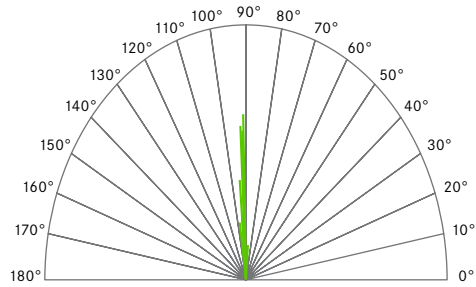
_ Fine

_ Medium

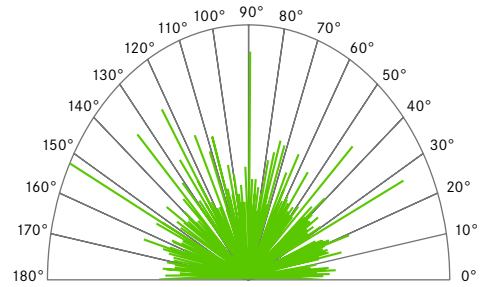
_ Rough

_ Non-directional finish

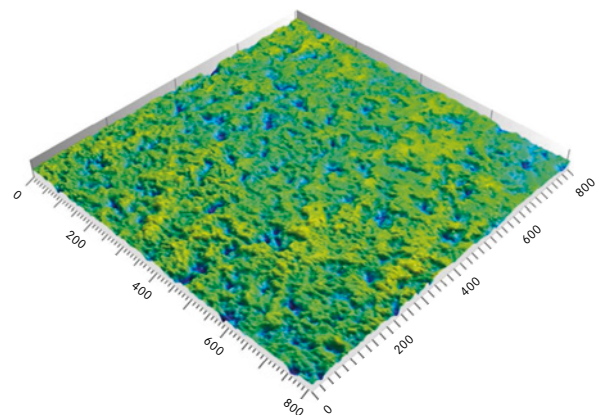
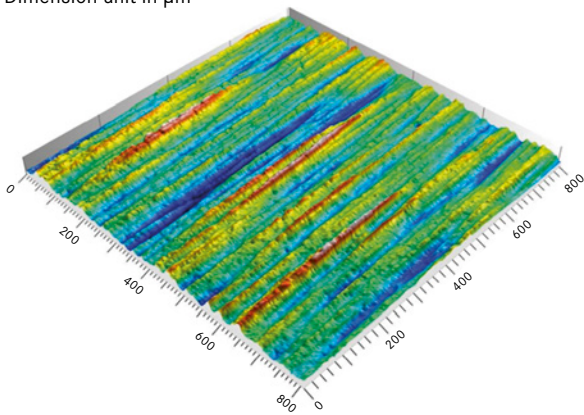
STANDARD COLD ROLLED SURFACE



NON-DIRECTIONAL SURFACE



Dimension unit in μm



Surface exhibits directionality along rolling direction

Isotropic surface

Nadine Dierlich
Trainee, Precision Strip
Unna Location



DIMENSIONAL STABILITY

Residual stress

The removal of strip residual stress is essential in ensuring the accuracy and final tolerances of any precision etched component. Our modern tension leveling line optimizes the material **flatness**, however this process inherently imparts some degree of residual stress into the strip. This is subsequently removed via one of two specialist heat treatment operations. Our unique tension annealing line allows for the almost complete removal of any residual stress. Zapp has developed an **in-house etching test** to quantify the amount of residual stress in our products.

Zapp Micro-Etch and Zapp Super-Etch products are tailored to meet the exact requirements of our etching and laser cutting customers. The development of these precision products has helped our business partners to produce tight tolerance components via reproducible, reliable processing. We would welcome the opportunity to discuss how we may support your development aspirations.

1. Standard (non -etching applications)
2. Zapp Super-Etch
3. Zapp Micro-Etch

Strip width up to 750 mm stress relieved.



- ①
- ②
- ③



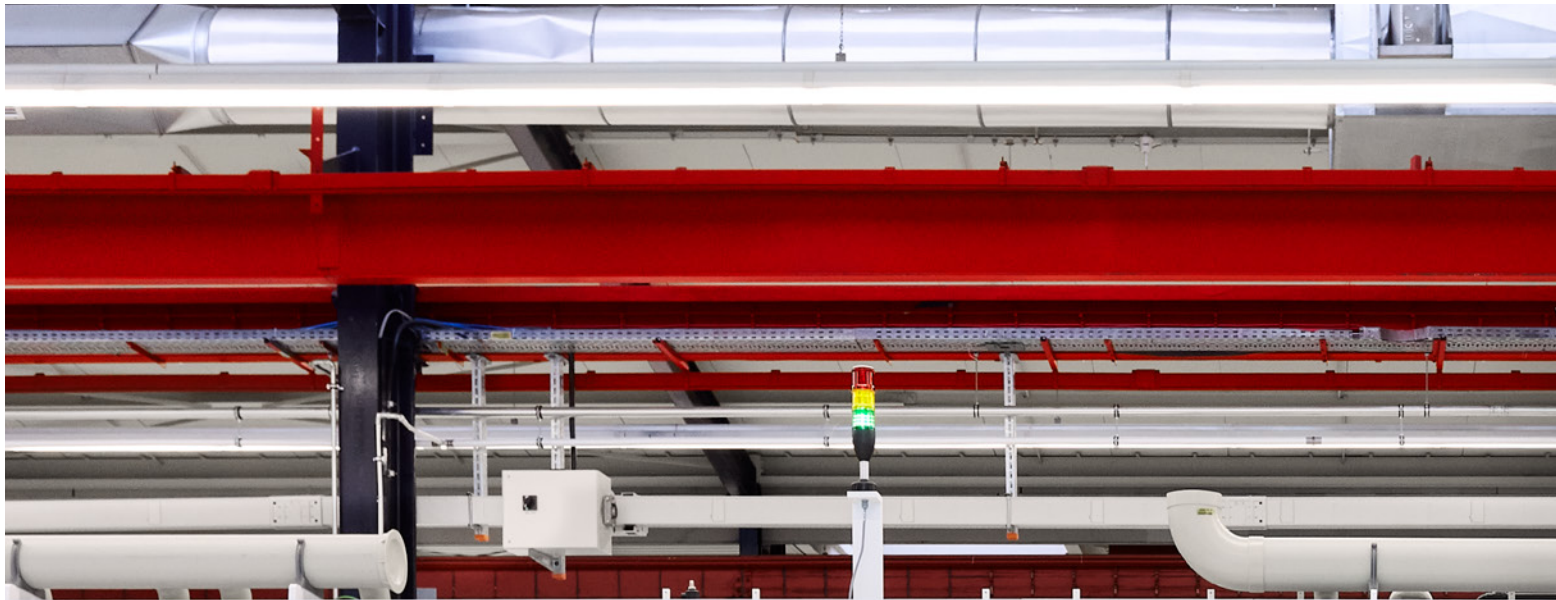


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620,0000
Produktions-Nr.
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Gewicht 0,350
Produktions-Datum 26.09.2014
Lager-Nr. 3819772
LTP 1072

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- 0,2500
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Gewicht 0,2500
Produktions-Datum 09.09.2014
Lager-Nr. 1323894
LTP

Dr. Paul Campbell
Sales Manager, Precision Strip
Unna location



SCHMID

PRECISION M19

CASCAD-ETCH M18

CASCAD-ETCH M17

POST-ETCH M16



STRESS FREE PRECISION ETCHING WITH ZAPP SUPER-ETCH AND ZAPP MICRO-ETCH

1415

PRECISION STRIP
ETCHING AND LASER CUTTING APPLICATIONS



DIMENSIONS AND THICKNESS TOLERANCES

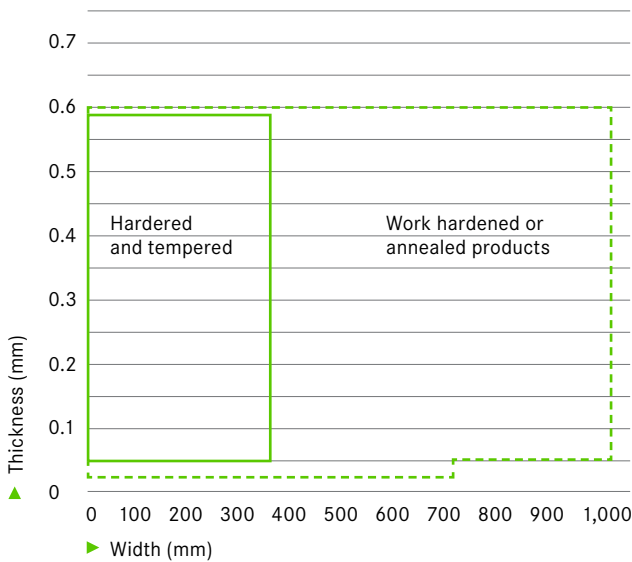
Best in class thickness control

At a very basic level, etching time depends on the material thickness. Any thickness variation in the strip material will increase the scatter of the final through hole diameter. Our advanced production equipment, with modern software systems allows us to offer the **tightest thickness tolerances** available on the market for stainless foil and strip.

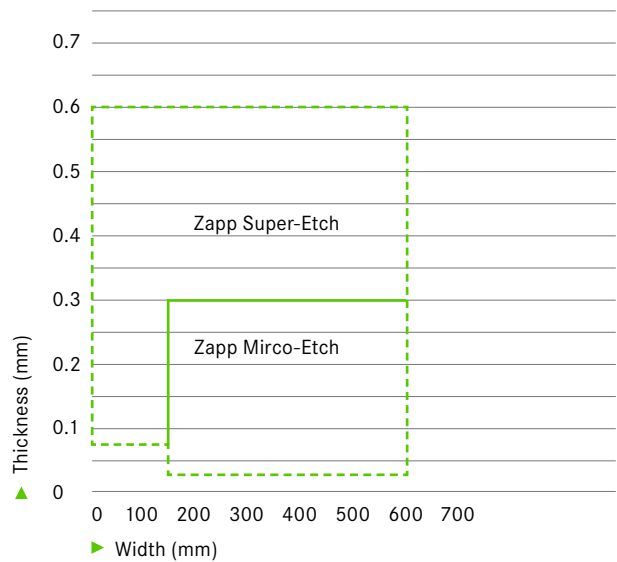
THICKNESS TOLERANCES $\pm 1/1000$ mm

Thickness (mm)	Width (mm)	Standard (C4)	Micro (C5)
0.020 – 0.050	450	2	1
0.05 – 0.099	- 600	3	2
0.100 – 0.124	- 250	3	2
	251 – 400	4	3
0.125 – 0.159	- 250	4	3
	251 – 400	5	4
0.160 – 0.199	- 250	4	3
	251 – 400	5	4
0.200 – 0.249	- 250	4	3
	251 – 400	6	5
0.250 – 0.314	- 250	5	4
	251 – 400	6	5
0.315 – 0.399	- 650	6	4
	251 – 400	6	5
0.400 – 0.450	650	6	4

DIMENSION FOR STANDARD PRODUCTS



DIMENSION OF TAILORED PRODUCTS FOR ETCHING OR LASER CUTTING INDUSTRY



SIZES

Grade	Thickness (mm)	Ultimate tensile strength (MPa)	Zapp Super-Etch	Zapp Micro-Etch
1.3912/Ni36 (UNS K93603)	0.025 to 0.20	700 ± 50	○	○
1.4016 (AISI 430)	0.05 to 0.50	700 ± 100	○	
1.4028MO (AISI 420)	0.075 to 1.0	1800 ± 100		
Zapp Super-Fatigue	0.075 to 1.0	1900 ± 100	○	
1.4301 (AISI 304)	0.025 to 0.60	1200 ± 100	○	○
1.4310 (AISI 301)	0.05 to 0.60	1400 ± 100	○	○
1.4310 (AISI 301)	0.05 to 0.60	1600 ± 100	○	○
1.4404 (AISI 316L)	0.038 to 0.25	1200 ± 100	○	○

Surface finish

- _ Bright
- _ Polished
- _ Special



Thomas Wegler, Martin Bischoff
Manager Development and
Development Engineer, Precision Strip
Unna Location





Giuseppe La Paglia
Head of Laboratory, Precision Strip
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