



micrometal

Wickeder Group

WHITE PAPER

UNLOCKING THE TRUE POTENTIAL OF PRECISION METAL FABRICATION

Exploiting the power of the next-generation metal fabrication process for the optimised production of ultra-precise parts and components

A Day in the Life of PCE

The photo-chemical etching process used to be one of industry's best kept secrets. Today, however, its proven ability to achieve accuracy and maintain tolerances better than any other metal fabrication process, while at the same time producing burr and stress free parts without any requirement for tooling, sees its use throughout multiple applications across industry.

In fact, you probably inadvertently use photo-chemically etched parts every day without knowing.



Wake up, get out of bed

PCE parts are used in a whole host of micro electronics, including the smart phone that gets you up in the morning.

Smile, you're looking great

PCE even makes you smile, with PCE parts and components use in an array of orthodontic, diagnostic, and medical applications.



Put your foot down

Your car no doubt has hundreds of PCE parts and components on board. PCE is used to make interior trim, speaker grille covers, and under the bonnet is used in the manufacture of fuel cells, fuel injectors, and in a number of safety critical applications.



Take to the skies

The same when you fly. Today's aeroplanes use PCE for aesthetic components and as well as an array of safety critical mechanical parts and components making flying safer, more economical, and more sustainable.



Get to work

Nearly all computers, computer peripherals, and electronic devices at work contain PCE produced parts and components.



Take a break

When you take a break, the filters used in the coffee machine? Probably made using PCE.



Run like the wind

The wearable smart fitness devices that you use when you go for a run will no doubt contain PCE parts and components.

Put your feet up

So you're home, and you have your feet up watching TV. Well, the TV you watch will probably contain PCE parts and components, as will the satellite beaming the programmes to your device.



About Photo-Chemical Etching

In recent years, it has become understood that Photo Chemical Etching (PCE) is now not just a viable alternative to legacy metal fabrication technologies. Instead, it is today seen in many applications as the only technology that can achieve the repeatability, accuracy, and geometric complexity demanded by OEMs from across industry.

The process characteristics of PCE play to many of the goals that OEMs making precision metal parts require in today's highly competitive markets. The process is able to produce intricate parts with tolerances as low as ± 7 microns depending upon material and its thickness, this tolerance attainment being unique among all alternative metal fabrication technologies.

The PCE process is further characterized by the fact that it produces parts without degrading material properties, stress- and burr-free parts being manufactured with no limitations when it comes to complexity. It can also be used on a broad range of metals and alloys, the expertise of innovators in the PCE space often being seen as being in the creation of different etchant chemistries that can manufacture parts from even difficult to process metals such as aluminium and titanium and hardened metals.

About The Etching Group

The Etching Group has been at the forefront of the photo-chemical etching (PCE) revolution for over 30 years. Uniquely, the company brings together the power of three different PCE innovators, micrometal GmbH, HP Etch AB, and Etchform BV.

Each member of The Etching Group is specialist in certain aspects of the PCE process, and together the group offers the most comprehensive and broad-based PCE manufacturing service anywhere in the world, along with additional manufacturing know-how and experience of complementary technologies.

micrometal is the innovator of the fully cross-linked INLINE etching technology, a highly automated and continuous manufacturing process that guarantees the highest degree of repeatability, process stability, and economic efficiency available through the use of PCE. By means of reel-to-reel lithography, a wide variety of geometrically demanding structures can be created. micrometal's proprietary mask technology also enables the control of the PCE process in the 3rd dimension, meaning that specific breakthrough complex geometries can be produced, with a symmetrical or asymmetrical cross-sectional area depending on the exposure and etching parameters.

Etchform supplies complete and customised solutions for thin precision parts in almost all metals, produced using PCE and electroforming. Etchform is expert in forming, precision mechanical/surface/heat treatments, assembly, and clean room packaging.

HP Etch is specialist in high-precision etching of aluminium, thin metals, and thicker materials used in such applications as bipolar plates or heat exchange plates. HP Etch is expert in bending and forming technologies using CNC machines, and also in specialist coating technologies, including Parylene (polymer) coating technology for products that are exposed to extreme conditions and environmental influences.



The Etching Group - Technology Developments and Leadership

It is important when selecting a PCE supplier to realise that not all PCE is the same. The sector has a number of "traditional" PCE technology suppliers, and while traditional PCE is precise, it is much less precise and versatile than the next-generation PCE process developed by The Etching Group.

The Etching Group has taken the PCE process to the next level, and offers unique adaptations of the technology that make its already striking characteristics even more compelling for OEMs pushing the boundaries of what is possible in metal part and component fabrication.

The Etching Group's complete focus is on the industrial production of high precision, repeatably accurate micro metal components, and to ensure this the company is constantly evolving the PCE process to offer far superior results than the legacy PCE processes that proliferate in the market today.

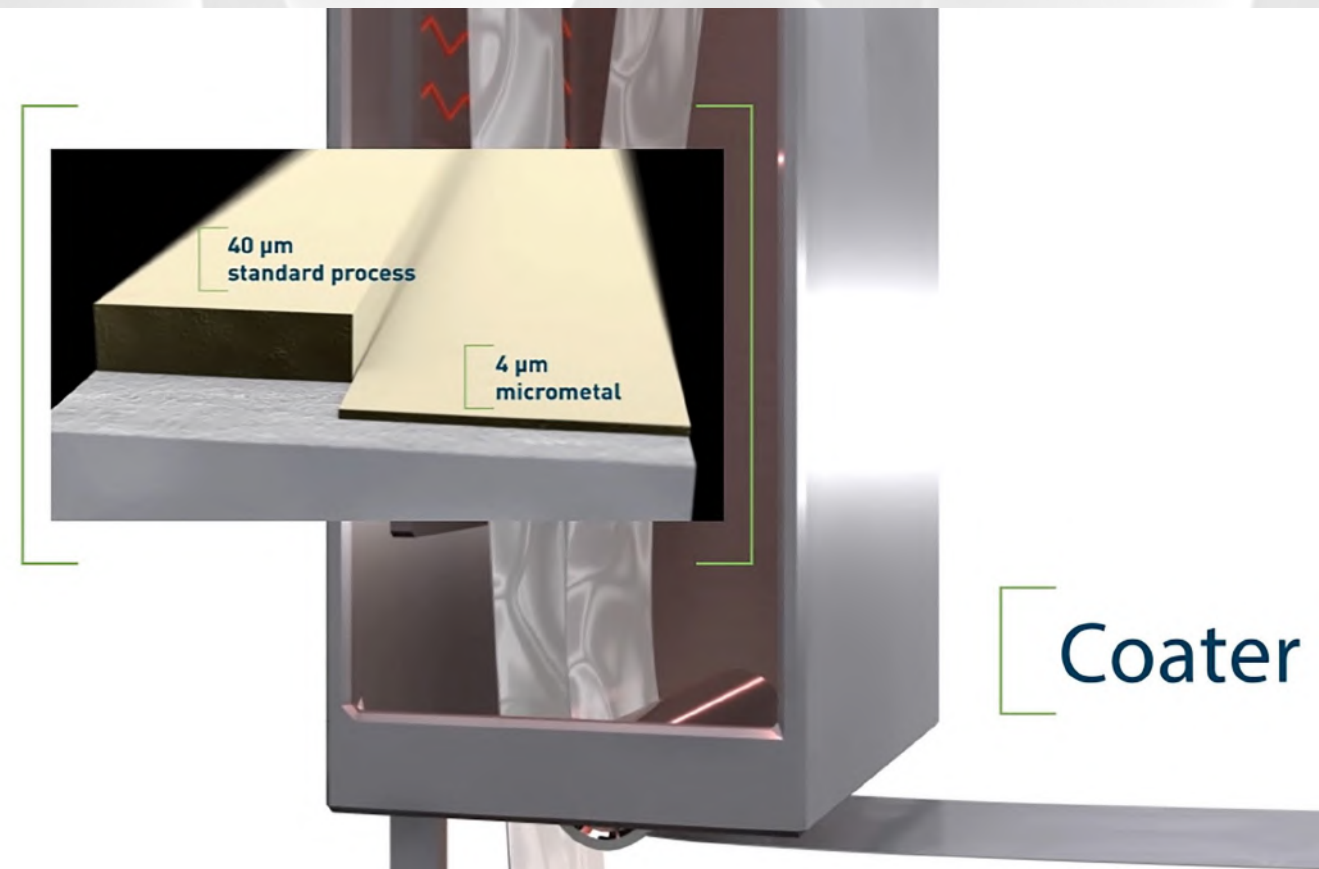
So how does the Etching Group's next generation PCE process differ from conventional PCE processes.

Basically, there are 3 key enhancements.

1 Liquid Resist System

First. The Etching Group uses a special liquid resist system to obtain ultra-thin (2-8 micron) photoresist layers enabling a higher degree of precision in the chemical etching process. It allows us to achieve extremely small feature sizes of 25 microns, a minimum hole diameter 80% of the material thickness, and single digit micron tolerances repeatably. In addition, along with our optimised exposure system we can avoid the parallax problems typically associated with PCE. A parallax error is the apparent shift in an object's position as it is viewed from different angles. Traditional PCE uses relatively thick dry film resist which compromises ultimate part precision and the tolerances that are available, and it is only able to achieve 100 micron round hole feature sizes and a minimum hole diameter of 120% material thickness.

Our PCE process enables ultra-precise contours to take shape, and as such we can produce metal parts with unique features and a level of complexity that cannot be matched. Because of this our next generation PCE process is a true enabling technology, producing hitherto impossible metal parts and components, and therefore driving industrial innovation for our customers.



2 Continuous PCE Process

Second, The Etching Group offers a continuous PCE process, meaning that metal can be processed continuously from the introduction of initial raw material (typically on a reel) to the final packaging step (which can see finished parts delivered on a reel). The company's continuous production technology allows for the manufacture of endless strips of components (so-called reel-to-reel production) enabling the manufacture of customer specific highly precise parts in industrial volumes wound onto reels for ease of further processing post-delivery. Metal strip thicknesses can be between 25 and 400 microns. The continuous PCE process also avoids problems associated with batch-to-batch variations, effectively processing one large batch rather than a number of smaller batches. It is only in this way that PCE can truly claim that the first and the millionth part will actually be the same, something legacy PCE process may claim but cannot achieve.

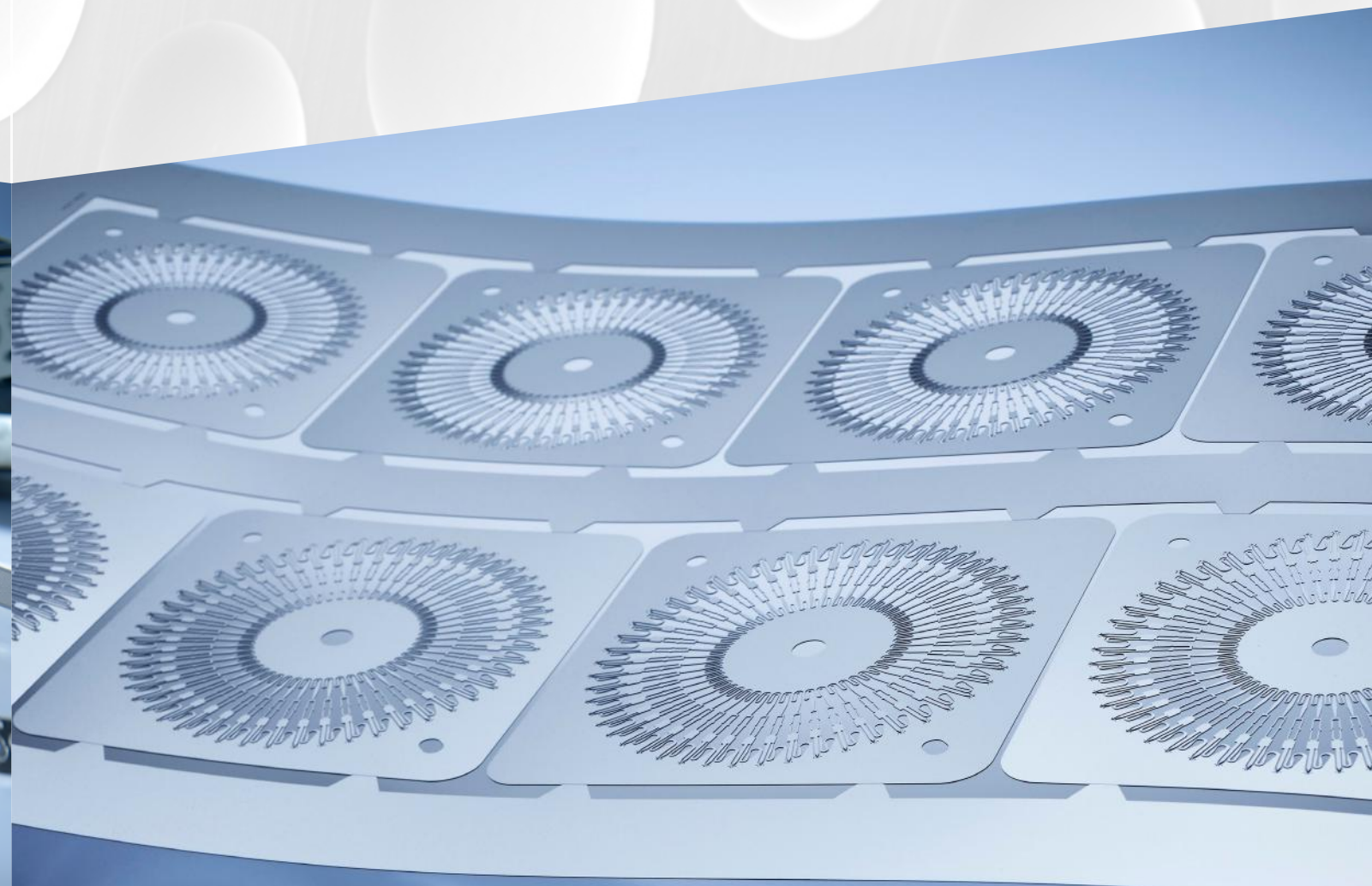
Uniquely in the industry, The Etching Group can process and deliver up to 800-meter-long metal strips on reel, and these are often requested in industries that already demonstrate a high degree of automation in their own processing. Thus, the etched parts provided in reels by can be selectively coated or used by 'Pick & Place' at the final point of production. Such procedures are already widely implemented in the medical and automotive industries where The Etching Group services a number of market-leading and blue-chip OEMs.

3 Glass Tooling

Third, The Etching Group's PCE process uses digitally produced photo-tooling created on glass instead of the traditional digital photo-tooling favoured by legacy PCE providers. This provides superior reproduction, resolution, and a longer life-time at much reduced cost when compared with tools for traditional stamping processes. Such tooling can be adapted very quickly and at little cost, therefore accommodating small prototype runs to mass production volumes, and allowing design engineers to tweak and alter designs inexpensively to produce optimised end products.

The use of photo-tooling created on glass means we can cater for applications that require extreme precision which traditional PCE cannot achieve. Glass photo tooling can attain tolerances in the range of 1-2 microns (and hole tolerances of < 1 micron can be achieved), and negates issues with distortion due to environmental factors such as humidity that are a constant problem when using film tooling.

By way of example, over a 700mm etch area, the EG can consistently achieve 5-10 micron tolerances on thin materials, whereas PCE companies using film-based tooling can only claim 20-30 micron positioning tolerances. This is why the EG is the go-to supplier for intricate, often safety critical, precision metal parts and components for leading names across a range of high-tech industry sectors.



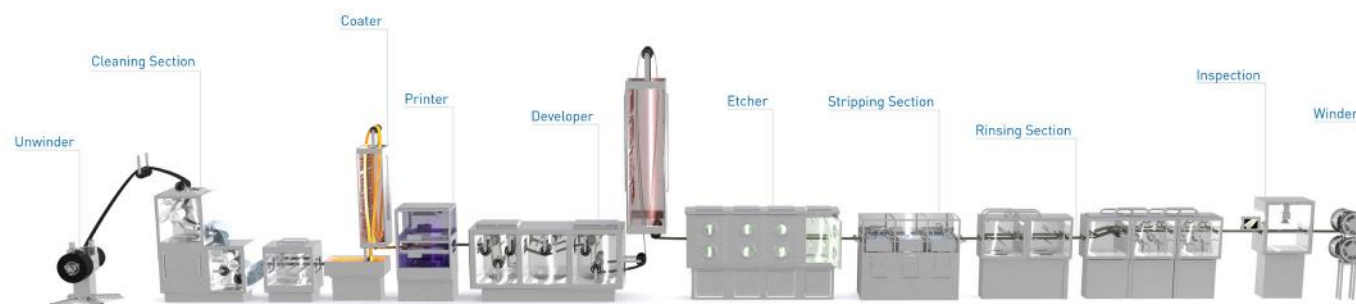
Up Close and Personal - How The Process Works

As detailed, the PCE process developed by The Etching Group in most instances surpasses laser processing, precision stamping, and most importantly traditional PCE processes.

The Etching Group PCE process works as follows:

- 1** Customer CAD data is processed to create a glass tool (glass templates plotted on a laser image setter) which boast significantly higher image fidelity, fine structure, and length stability than flexible photo film templates used in conventional PCE processes.
- 2** The selected metal alloy in a coil is cleaned
- 3** It is then coated with photo-resist on both sides using The Etching Group's proprietary wet paint system which produces the thinnest photo-resist layers possible, the effect of this being significantly higher precision.
- 4** The metal strip is exposed using the glass tool
- 5** High precision contours and structures are then created in the etching chamber
- 6** The metal strip is then etched creating highly precise and intricate geometries
- 7** After etching it is cleaned and dried
- 8** The etched strips are then subject to comprehensive automated validation and quality control procedures
- 9** According to customer requirements, the etched parts are either assembled on reels (the so called The Etching Group reel-to-reel process) or in individual panels.

[Click image to play video](#)



The Etching Group's Advantages at a Glance

- Glass tools are quick and inexpensive compared to stamping tools to produce and have a long service life.
- The patented wet paint system means we create extremely small features — such as hole diameter compared to the material thickness — an absolute unique selling point.
- Our inline etching process enables etching in the quasi-steady state by linking the individual process steps. This enables the highest levels of accuracy to be achieved while maintaining the tightest tolerances.
- Using our specially developed mask technology, we are able to control the etching process in the third dimension in a defined manner, allowing specific opening geometries to be produced three-dimensionally. This means that The Etching Group can produce complex geometries for lancets, scalpels and blades in large series.
- Thanks to the exceptional size of the glass photo templates, the design area can be up to 760 mm long and 280 mm wide. The starting material — often stainless steel — can be up to 320 mm wide.
- Liquid paints are more suitable for high-precision mass production in continuous processes when compared to dry film (10 to 50 µm) due to the significantly lower paint thickness (4 µm). The result is higher imaging accuracy.
- The minimum hole diameter that can be realized with our continuous etching technology is around 80% of the material thickness. 25 µm is the thinnest standard material thickness that we work with. The metal etching process thus enables tolerances in the single-digit micron range to be maintained.
- A variety of hole shapes can be etched, and the position of structures introduced on both sides can be matched very precisely.

Benchmarking

When comparing metal processing technologies for very precise applications, typically the choice is between stamping and PCE. Both technologies are able to produce intricate metal parts at volume.

Key PCE Advantages

- PCE produces burr and stress-free parts
- Unmatched accuracy, tolerance attainment, and repeatability
- Can be used on extremely thin metals (< 100 µm)
- There is no material degradation
- There is almost no limit on part complexity
- It can be applied to a huge range of metals and alloys
- Glass tooling means zero tool wear, meaning the first part is the same as the millionth
- Tooling can be adapted and changed quickly and with minimal cost
- PCE promotes design optimisation without financial penalty
- PCE supports a low risk entry strategy and easy product updating
- Turnaround time 90% less than for stamped parts
- Agnostic to part complexity
- All parts produced are absolutely flat
- Can achieve tolerances and precision beyond all other processes

Drawbacks of Stamping

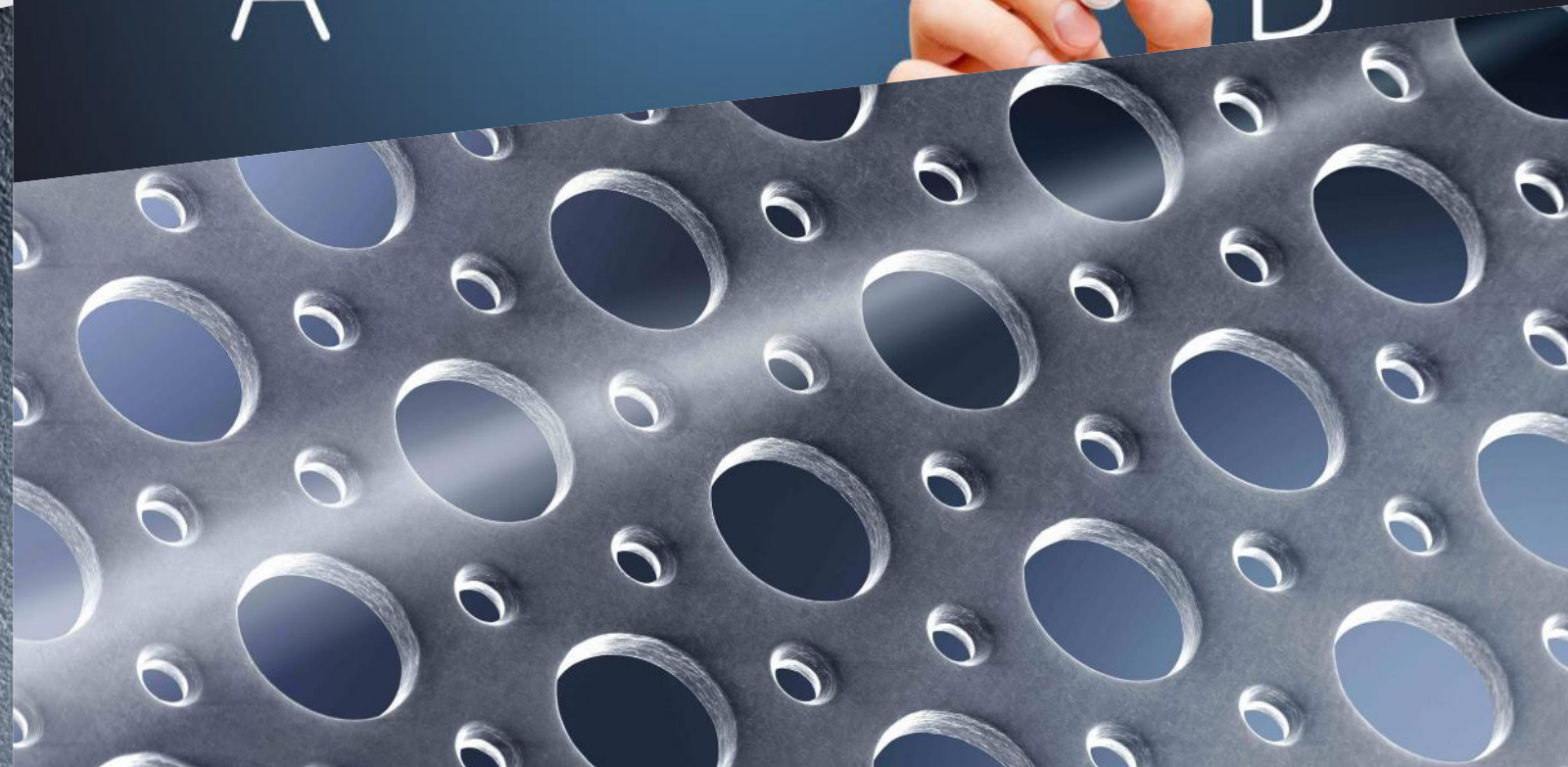
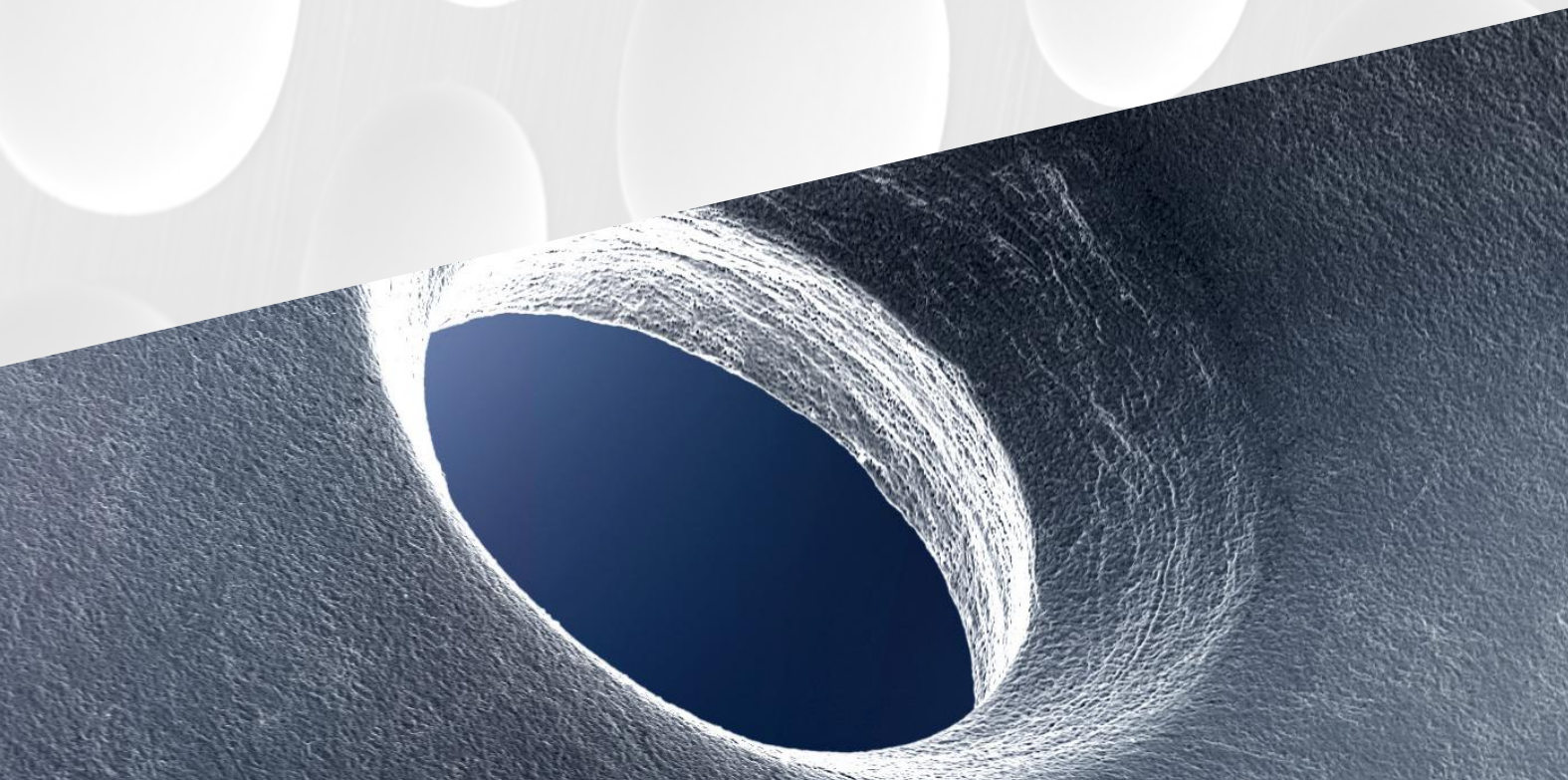
- Degradation of the material being processed due to high impact
- Parts produced are not always flat meaning costly post-processing
- High cost of tooling
- Tool degradation
- Lack of tool adaptability
- Cost increases with geometric complexity
- Struggles with ultra-fine details and Z-axis features

The Complexity Conundrum

Many of today's products are extremely complex and also very fragile. Geometric complexity and the requirement for extremely exacting tolerances and precision mean that PCE is in many instances the "only" viable technology.

For PCE it makes no difference how complex the geometry of the part is and therefore the complexity of the glass tooling. Costs and lead-times do not increase with this increased complexity.

Whether in low, medium, or high-volume applications, the complexity of a part adds cost when stamping. The complexity of a product requires complex tooling, and complex tooling means increased costs, increased chance of tool failure, and more time for satisfactory completion.



Applications

The Etching Group serves multiple industry sectors including the automotive and e-mobility, medical, electronics, filtration, aerospace, and consumer / lifestyle.

Within these sectors, PCE is especially advantageous when the demand is for flat, burr and stress-free parts with highly intricate geometries which need to be produced repeatably, in volume, and with zero failure rates.

As such, typical applications include the following.

Filters & Screens

The Etching Group makes filters for customers requiring complexity and the achievement of extreme precision. We make filters and screens for a variety of applications in the petrochemical, food, medical and automotive industries where complexity and precision is often combined with a need for high tensile strength. We offer special features and customised opening shapes with no cost-increase, and a decisive advantage of free structural geometry.



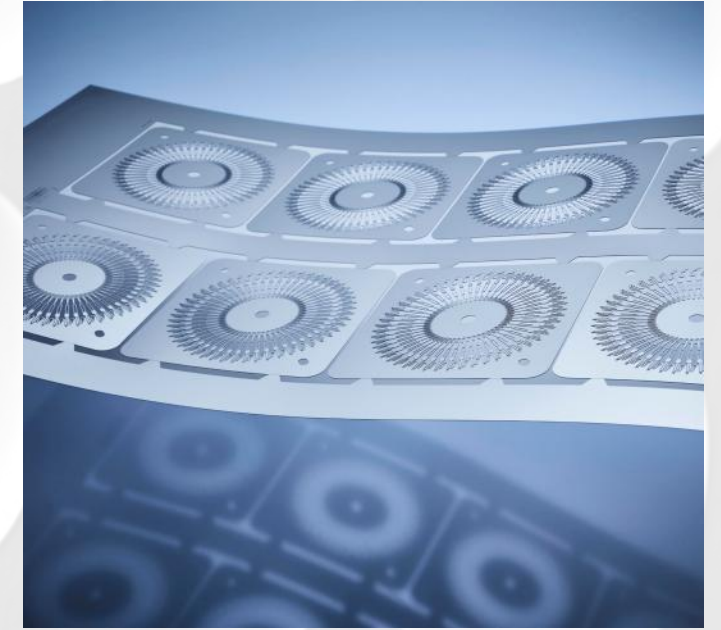
Bipolar Plates - Fuel Cells

Fuel cells have far higher requirements for the compression and supply of air. The air must be completely particle-free at a constant pressure level in order to increase the longevity of the sensitive fuel cell. Thanks to the precision of The Etching Group PCE process and our ability to etch the finest geometries, we can produce metal parts that exactly meet these requirements.



Needles & Blades

Medical devices are now manufactured with greater precision and complexity. The Etching Group PCE process is used to manufacture a variety of needles and blades for medical applications. Our glass tooling is inexpensive to alter, promoting design optimisation as multiple iterations are possible. The Etching Group PCE process has been developed to enable precise control of the etching process in the Z-axis. This means we can produce burr- and stress-free parts with innovative features and excellent tolerance control, promoting sharpness and well-defined cutting edges in blades, and pain-free tip geometries in needles.



Applications

EMC Shields

The Etching Group has extensive experience in manufacturing EMI shields, frames, bushings, gaskets and other shielding elements. Our chemical etching production method offers the unique ability to design complex geometries — such as custom vent hole patterns — without the added expense of expensive tooling.

Springs

With the Etching Group PCE process, spring properties can be specifically defined and implemented thanks to the high level of design freedom. In addition to the spring effect, further product features can be created such as specific passages, positioning aids, etc. at no extra cost. Even very hard materials can be easily processed using PCE as there is no tool wear which is an issue when using punching.

Contacts, Pins, Connectors

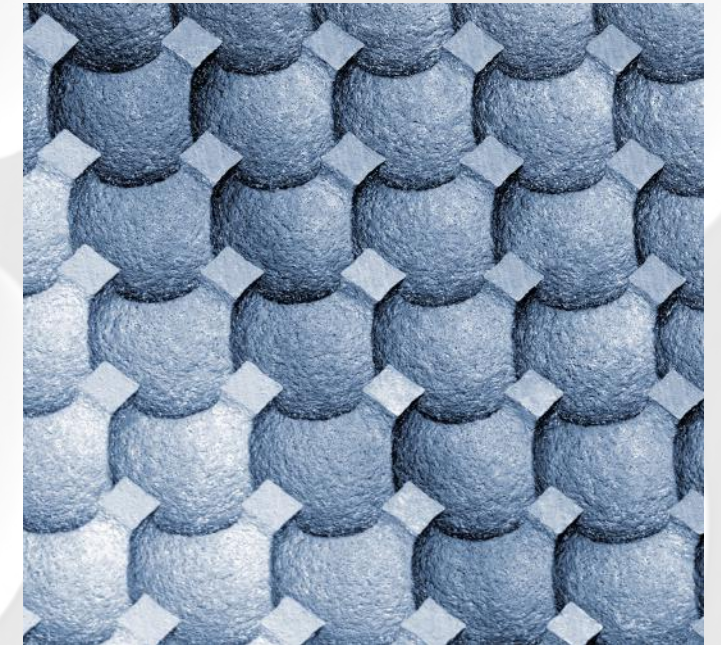
In micro-electronics, the demand is for ever smaller plug connections and pins. The Etching Group PCE process achieves maximum precision while adhering to the tightest tolerances. Material properties are not affected by PCE, since there are no thermal and mechanical influences. This means the production of optimal pins for SMD components. The easily altered glass tooling also facilitates rapid product evolution in a fast moving industry

Diffusers

When using the Etching Group PCE process, a wide variety of diffusers can be produced, which keep fluid flow in the turbulent range. The formation of a laminar flow is prevented by precise diffusers/flow disruptors in lines and tubes, while the homogeneity of the medium remains unaffected. Due to the high precision and the absence of burrs in the etched parts, the desired flow profile is achieved exactly.

Heating Elements & Heat Exchangers

The Etching Group PCE process can be used to create micro-channels with a defined width and depth in heat exchangers for the heat-dissipating media of your choice in a very small area. There are almost no limits to the design of channels. Our photo-optical / glass tools produce high-quality workpieces with highly repeatable accuracy. Individual microchannel plates can be connected to various 3D geometries, e.g. by diffusion welding.



Complex Discs & Rings

Discs and rings can be produced in very complex structures using The Etching Group PCE process. Extremely low positioning tolerances can be maintained. The parts are absolutely free of burrs and very easy to separate due to etched, deliberately weakened attachments in order to feed them to the next processing step.

Functional Surfaces

The Etching Group is able to process the metallic surface of parts. We can provide roughened surfaces for improved adhesion, back etchings or special hole geometries in the edge area for a better hold when overmoulding or gluing, as well as logos, QR codes, and other engravings.

Support & Allied Technologies

We strongly believe that our customers receive optimised outcomes when working with the EG if we enter into a true product development partnership. Our decades of experience and unparalleled in-house expertise can be focused on design for PCE, material selection and process optimisation for specific applications.

We also realise that the production of intricate parts and components via our patented PCE process is not the only service that you require, so we also provide a range of ancillary processes and services.

Ancillary Processes

- Forming — bending, deep drawing, or rolling
- Coating — blackening and gold and silver plating
- Overmoulding and gluing
- Laser and diffusion welding

Ancillary Services

- Storage of finished goods
- Flexible delivery options, individual parts, on a sheet or in a roll
- Complete traceability
- Sophisticated metrology
- Process and product analysis and evaluation
- Total end-to-end quality control ensuring zero failure rates

Supplier Selection Questions

Success of a product development program is as much a lesson in supplier selection as it is in technology selection. And in the area of PCE, a supplier is so much more than just an etching company. It is a company with in-depth design experience, a material expert, a tooling expert, a validation expert, and of course a production and assembly expert.

So where do you begin when selecting your PCE product development partner?

Here are some questions that you may wish to ask your short-listed PCE suppliers.

What insight can you give into the subject of Design for Photo Chemical Etching (DfPCE)?

The engine for success is ensuring that the design of a part is optimised for the PCE process and also uses the ability of PCE to make parts impossible using alternative processes to its fullest.

How sustainable will future supply be?

Does your chosen partner have the infrastructure and resources to scale up to mass production and supply for the medium to long term and is the business robust enough to ensure continuity of supply through pandemics and economic turbulence?

What are the fundamental characteristics of the PCE process championed by your chosen supplier?

Seek evidence of the precise nature of the PCE process used. Ask about repeatable tolerance attainment, range of metals available, thickness of metal processable, use of dry or wet photo-resist, use of film or glass tooling.

What level of vertical integration is there in the PCE process chain?

Product development is all about risk mitigation, ensuring that tolerance “drift” is managed and kept within the parameters that ensure integrity of end-use parts and components. The focus is therefore on control, with as much of the design to end product completion process under one roof.

How much does your supplier value partnership?

You may have questioned your chosen partner about their expertise, capabilities, scalability, and sustainability to see your project through. But you must insist upon — and see evidence of — collaboration and transparency in client supplier dealings.

Ask for evidence of relevant experience?

See if your chosen supplier can show you historical applications that resemble yours.



A Design Engineer's Guide to Photo-Chemical Etching

Once design engineers select PCE it is important that they fully appreciate the specific aspects of the technology that can affect — and in many instances enhance — product design. So what should be considered?

Metal & Sheet Sizes

At the Etching Group we can process thin sheets from 10 microns to 2000 microns (0.010 – 2.00 mm) with a maximum sheet/component size of up to 600 x 800 mm. Metals that can be processed include steel and stainless steels, nickel and nickel alloys, copper and copper alloys, tin, silver, gold, Molybdenum, aluminium. and hard to machine metals including highly corrosive materials such as titanium and its alloys.

Standard Etching Tolerances

As a guide, the Etching Group can process stainless steel, nickel, and copper alloys up to 400 micron thick with feature sizes down to 80% of material thickness and tolerances of $\pm 10\%$ of thickness. Stainless steel, nickel, and copper above 400 micron thickness, and other materials such as tin, aluminium, silver, gold, Molybdenum and titanium can have feature sizes down to 120% of material thickness with tolerances of $\pm 10\%$ of thickness.

Burr- and Stress-Free Machining

When stamping, stress is applied to the metal being processed, and this leaves residual burrs. Tool wear is also an issue. PCE produces burr- and stress-free parts, and is characterised by zero tool wear and speed of supply.

Unique Features at No Additional Cost

Unique characteristics can be designed into products manufactured using PCE due to the inherent edge “cusp” during the process. By controlling etch cusp a range of profiles can be introduced allowing the manufacture of sharp cutting edges, such as those used in medical blades, or conical openings such as those used to direct fluid flow in filtration meshes.

Low-Cost Tooling & Design Iterations

The tooling used in the Etching Group's PCE process is inexpensive to produce, and therefore inexpensive to change even close to the commencement of manufacturing. Unlike stamping, the cost of digital tooling does not increase with part complexity, which stimulates innovation, as designers focus on optimised part functionality rather than cost.

Cost Savings

With PCE, you pay by sheet area, not by the part, which means components with different geometries can be processed at the same time from a single tool. This ability to produce many part types in one production run is the key to the enormous cost savings inherent in the process.

Case Study

Here we present a real-time case study what one particular company has been able to achieve through the use of the Etching Group's PCE process. PCE stimulates innovation and disrupts the way that precision metal parts are made, allowing the design and production of parts and components previously deemed impractical or impossible to make.

PCE & Coffee Filtration

High-resolution sieves used in the consumer industry require precision in the micron range and mass production needs to be cost-effective. Photo-chemical etching (PCE) meets both these challenges, and as an example of its usefulness and agility, the use of PCE by an Italian Company which makes coffee machines using highly precise coffee filters is a perfect example.

Coffee filter sieves must be able to withstand high stresses caused by pressure in the coffee making process or cleaning. This requires that the sieves are made of high-strength stainless steel for a long service life. Hole geometry is also important, and through the use of PCE, it is possible etch holes that are strongly funnel-shaped (conical), meaning the narrow opening of the holes on the filtration side do not have any depressions, stopping solid particles getting stuck in the holes.

Hole sizes and tolerance are optimally matched to the size and size distribution of the coffee powder. For brewed coffee, a small ratio of hole size to average coffee grain diameter ($> 65 \mu\text{m}$) is used to avoid undesirable powder residues in the coffee. For optimal crema and fine sediment in espresso, a slightly larger ratio is chosen. A filter of approx. 100 mm diameter designed for this application contains up to 420,000 conically shaped micro-holes.

For such an application, photo templates are created on the basis of a technical customer drawing and the given product specifications. The metal material to be etched is unwound from a strip, cleaned and coated on both sides with a light-sensitive liquid layer. Then a glass tool with the negative image is placed on both sides of the coated tape and directly contacted by applying a vacuum. Subsequently, the etching template is exposed. The coated and exposed metal is developed and the unexposed areas on the tape surface are removed.

Combining suitable photo templates with the specific unique characteristics of the etching process allow a wide variety of breakthrough shapes and surface textures to be created when making sieves and filters. Obvious pan-industrial applications in addition to coffee filtration include filters and screens, coding discs, catalytic converter foils for the automotive industry; lead frames, RF shielding, and connectors for the electronics sector; springs, vapour deposition masks, shaving foils, fuel cells, diffusers for various industrial applications; needles, implants, and microfluidics for medical application; and decorative etching products and jewellery.

“We have a long and successful relationship with micrometal. micrometal GmbH has been incredibly supportive in the transition from pure technology development and R&D to the commercialization of our product. I highly recommend micrometal as a supply chain partner.”
Mel Waite, Vice President of Operations, Metronome Health Inc., Laguna Hills, CA, USA.

“We really appreciate that the experts at micrometal GmbH think and act in the interests of the customer along the entire value chain. A technically better and more cost-effective result is often achieved if product properties are developed accordingly before photochemical processing.”
Dr. Paul Campbell, Head of Sales at Zapp Precision Metals GmbH, Schwerte, Germany





micrometal

Wickeder Group

Contact & Customer Engagement

micrometal GmbH
e. info@micrometal.de
w. www.micrometal.de/en
t. +49 7631 936 88-0