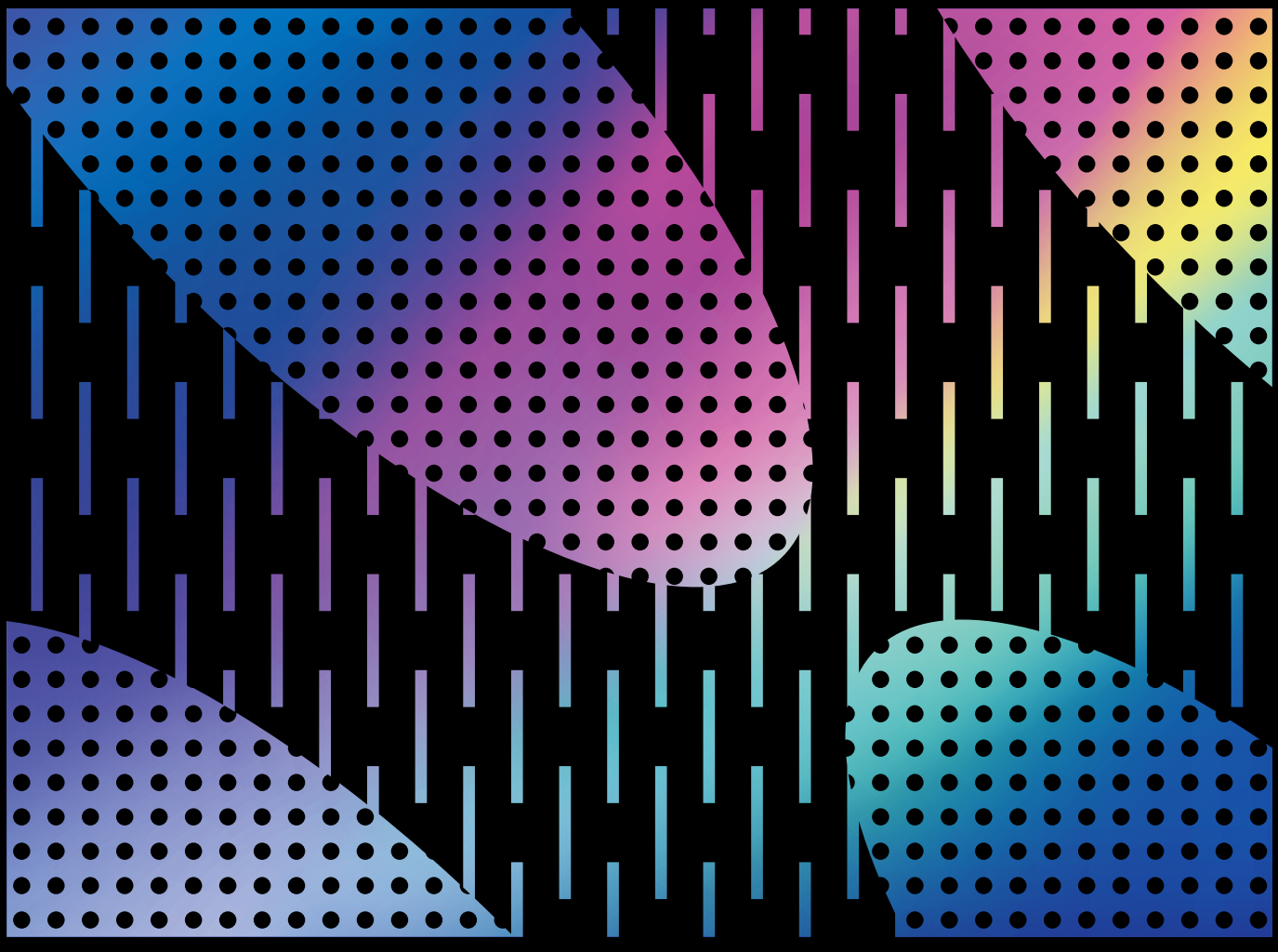
whitepaper electroforming

in a world of precision engineering

veco



world leader in micro-precision

introduction

Miniaturization is no longer a wish, it is a fact. And we see it spreading across all kinds of industries.

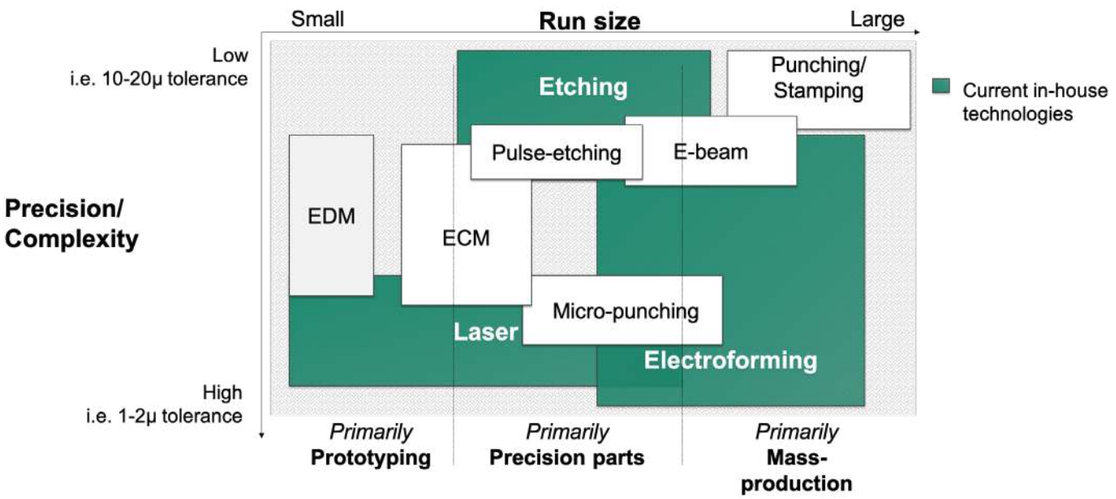
The trend in many industries is towards smaller, more complex, and more reliable devices with higher levels of performance, shorter design cycles, and lower costs. This development has increased the demand for a more precise and flexible process for manufacturing in different markets.

As the world-leading specialist in precision engineering with integrated in-house capabilities of Electroforming, Chemical Etching, and Laser Material Processing, Veco has been working together with leading companies from various industries in innovative research and development. Our highly customized precision engineering solutions not only put our customers in more competitive positions in the market but also enable latest breakthroughs for many industries.

Once you've discovered the benefits of Electroforming, a whole new world of opportunities opens up. What if you could produce, atom by atom, stress- and burr-free precision metal parts with micron-scale accuracy? It would give you the opportunity to raise the bar on precision, tolerance, cost-effectiveness, and high volume production.

Electroforming in Micro Manufacturing

Electroforming is an additive manufacturing process specialized for the production of micro-precision metal parts. Its uniqueness is that you can grow metal parts atom by atom, providing extreme accuracy and high aspect ratios.



This whitepaper on Electroforming aims to give you a good understanding of the technology and its applications. It covers an introduction of the technology, a detailed explanation of the process, technical capabilities, comparison with other micro-manufacturing processes, markets served and applications, etc.

electroforming

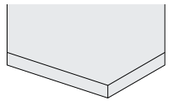
an additive manufacturing process

Electroforming is an additive manufacturing process specialized for the production of high precision metal parts. Its uniqueness is that you can grow metal parts atom by atom, providing extreme accuracy and high aspect ratios. While known as a highly accurate additive manufacturing process, Electroforming is also an electro-deposition process.

Electroforming Process

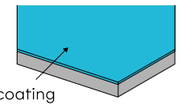
The Electroforming process can be concluded in a series of steps including Cleaning, Coating, Exposing, Developing, Deposition, and Harvesting.

Cleaning



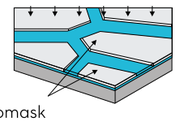
The metal substrate will first be cleaned and degreased.

Coating



The cleaned metal 'blank' is then coated with a light-sensitive coating/photoresist.

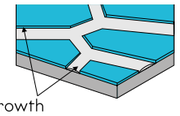
Exposing



The metal sheet is then exposed to ultra-violet light, which hardens the photoresist.

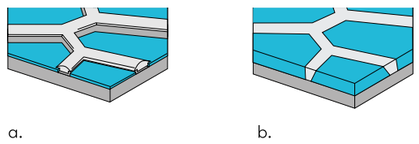
We use the LDI (Laser Direct Imaging) technology which is highly accurate. Also, with an LDI, photomasks become redundant, which significantly reduces costs and decreases lead time.

Developing



After the image is transferred by UV exposure the substrate is developed, rinsed and dried.

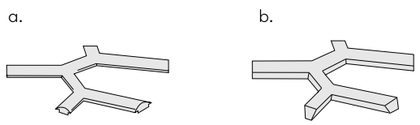
Deposition



An electrolytic bath is used to deposit metal onto the patterned surface.

The electro-deposition process involves an electrolytic solution, two electrodes, and a DC current. The DC of electricity is passed through the solution, transferring metal ions onto the cathodic surface through a continuous deposit. (Therefore, the material can be built up on microscale accuracy: atom by atom.)

Harvesting

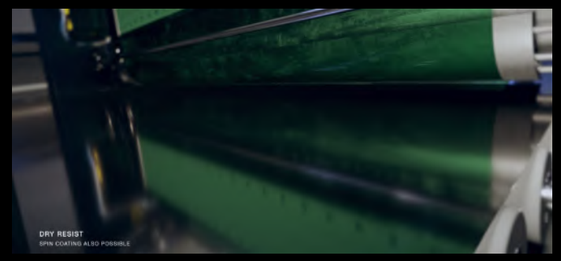


The electroformed part can be harvested from the mandrel, once the material is plated in the desired thickness.

Electroforming: a visual tour through the process

The images below give a visual representation of the Electroforming process from preparation to harvest. These stills are from the animation video which can be found on YouTube under the name of 'Electroforming: A Visual Tour Through The Process', or by clicking the link below.

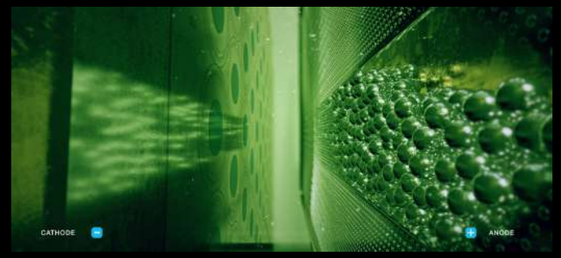
Substrate preparation



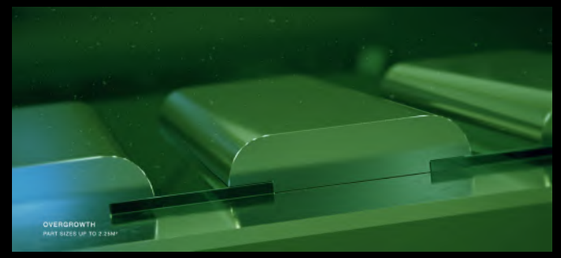
Photoresist type

Photoresist exposure method (LDI)

Photoresist development



Electroforming



Electroforming: overgrowth

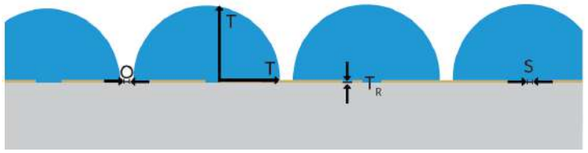
Product harvest

To understand the process in greater detail, **watch our latest Electroforming animation** in full length.

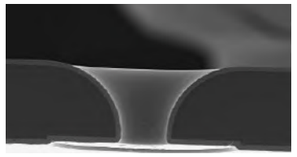
Types of electroforming

Plating Defined Electroforming: the Overgrowth Method

Plating defined electroforming is also referred to as an overgrowth method. It uses a thin photoresist pattern to shield parts of the conductive substrate. A light-sensitive coating is applied to the conductive surface, and it will polymerize where it is exposed to UV light. Metal grows over the photoresist and the thickness of the product (T) exceeds the thickness of the photoresist (TR), hence the process is also known as overgrowth. The process is mainly used to make sheets with small conical orifices for filtration and jetting. Note that outer corners will round off during growth, while inner corners will be sharp.



Schematical cross section of an overgrowth product (in blue) on a thin photoresist pattern (in orange)



Cross section of an overgrowth product

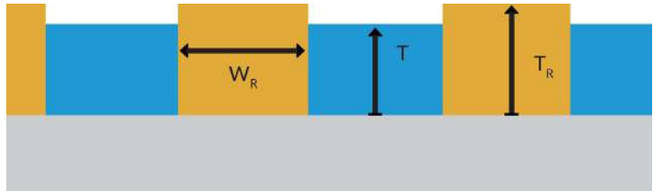
Diameter of the orifices (O)	Down to 2 µm
Thickness of the product (T)	Few tens to hundreds µm
Minimum pitch size (P)	P=S+O+2T

Size of substrate	From 1 x 1 m	50 x 60 cm	30 x 35 cm
Thickness of photoresist Tp (µm)	6-10	3	2.6
Minimum spacing between photoresist spots (µm) (S)	40	30	10
Production costs per product	Lowest		Highest
Exposure method	Film	Film / Laser direct imaging (LDI)	Glass tooling / LDI

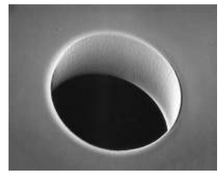
Photo Defined Electroforming: the Thick Resist Method

Photo defined electroforming is also called the thick resist method. In some cases, it is desired to make the product thicker. This is when the thick resist method is applied. A thick pattern of photoresist is used during photo defined growth, such that the thickness of the product (T) does not exceed the thickness of the photoresist (TR).

Aspect ratios (TR/ WR) up to 1 can generally be achieved with ease. The exact limits depend on the size and geometry of the products.



Schematical cross section of a product (in blue) deposited between a thick photoresist pattern (in orange)



Cross section of a thick resist product

319 x 351 mm

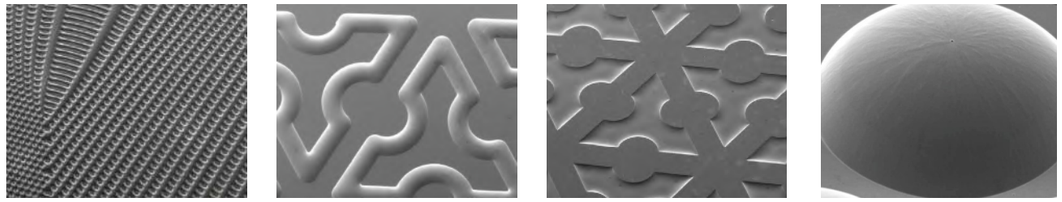
500 x 600 mm

640 x 900 mm

Surface Replication with Electroforming

The electroforming process allows for extremely precise duplication of the mandrel. The high resolution of the conductive patterned substrate allows finer geometries, tighter tolerances, and superior edge definition. This results in perfect process control, high-quality production and very high repeatability.

Electroforming is therefore perfectly suitable for high precision surface replication at low cost and in high volumes.



Examples of Surface Replication by Electroforming

Surface Replication with Electroforming

Positional accuracy is determined by stress in EF material and accuracy of exposure method (For glass tooling and LDI the accuracy is so high that the accuracy in the final product is solely determined by the EF process). Generally, positional accuracy of the LDI/glass tooling is ±0.15‰ and film tooling ±0.25‰.

Feature accuracy of overgrowth is ±2 µm and ±0.75 µm on standard deviation on a 50 µm thick product. Accuracy of features on photo-defined is generally ±5 µm for LDI/glass tooling and ±10µm for film tooling. For mm/cm size features, the accuracy drops by ±0.15‰/±0.25‰.

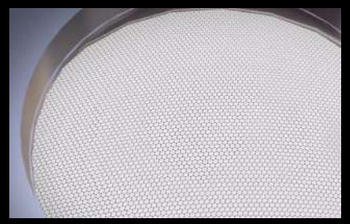
Key benefits of electroforming

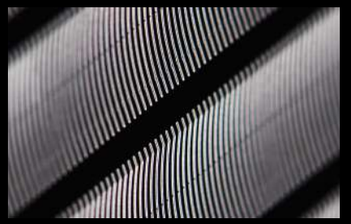
- High precision with extreme accuracy up to ± 2µm.
- Burr-free, stress-free.
- Complex shapes and configurations can be easily achieved.
- No hard tooling costs.
- Very sharp edge definition.
- Great design and redesign flexibility with advanced photo tooling.
- Highly economical.
- From prototyping to high volume industrial production.
- Perfect repeatability enabled by perfect process control, high-quality production, and tight tolerances.
- Not limited to 2D structures, with the possibility to grow additional layers in different directions.

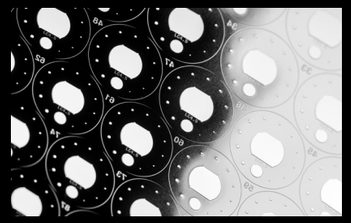
Cost-effective fabrication of micro-precision parts on an industrial scale

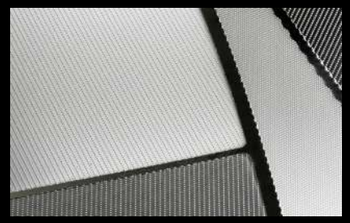
Electroformed products

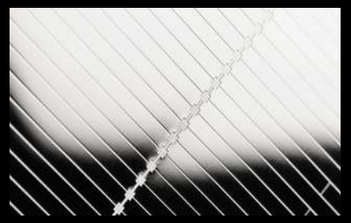

Inkjet Nozzle Plates

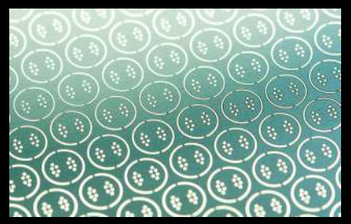

Nebulizer Plates

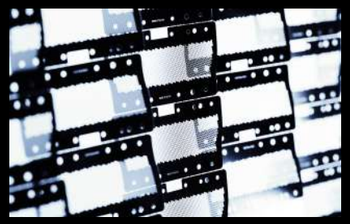

Wafer Probes

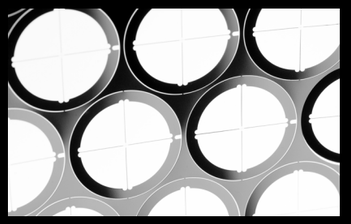

Flow Discs


Filtration

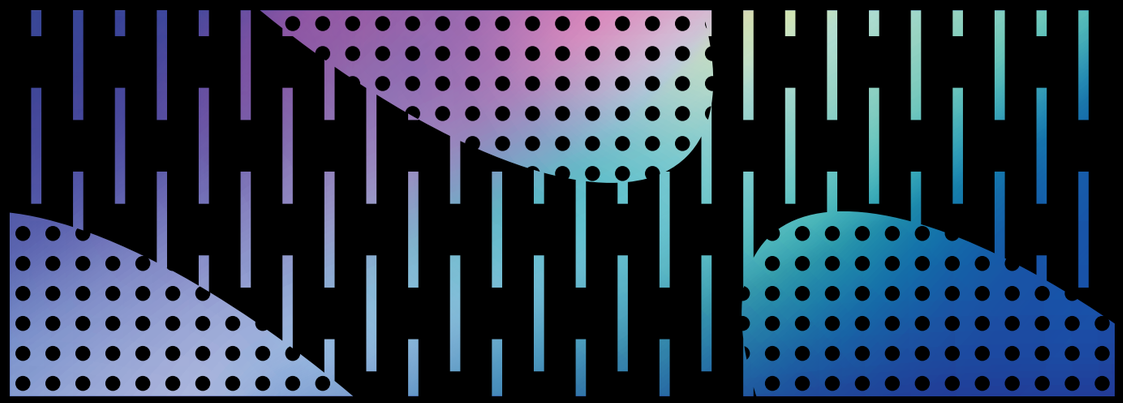

Solar Cell Stencils


Spray Nozzle Plates


Shaver Foils


Reticles

electroforming in a world of micro fabrication



electroforming vs. 3D printing

Electroforming and 3D Printing are both additive manufacturing processes. Whereas Electroforming builds up precision metal parts atom by atom, 3D Printing works by applying materials in droplets through a small diameter nozzle and “print” layer by layer to build up the product.

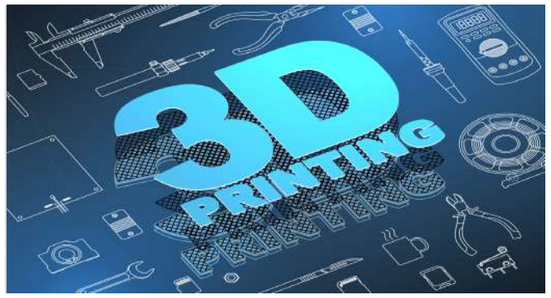
Cost Efficiency
Electroforming and 3D Printing are both additive manufacturing processes. Whereas Electroforming builds up precision metal parts atom by atom, 3D Printing works by applying materials in droplets through a small diameter nozzle and “print” layer by layer to build up the product.

Lead Time
3D Printing of metal parts is still in its infancy. The technique entails printing with minuscule metal powdered parts. After printing, the metal needs to be heated (sintered) in order to suture. In addition to the time-consuming sintering process, the printed layers also need to dry so that they don't sag. These two steps both take a considerable amount of time, which makes 3D Printing a relatively slow procedure for fabricating metal parts. Additionally, 3D Printing can only deal with one part a time Electroforming, on the other hand, is much faster a process, during which you can grow a large number of parts simultaneously (in one electrolytic bath).

Design Flexibility
Electroforming allows for great design flexibility as it requires almost no tooling investment and that it has a very short lead time. With regard to material, however, Electroforming mainly works with nickel and copper. For medical applications, for instance, nickel components can be coated with a layer of a PdNi alloy.
3D Printing also allows for high level of design flexibility and range of material usage are much wider.

Quality/Accuracy
Electroforming allows you to grow material on a micro scale, resulting in absolute accuracy and high aspect ratios. The standard deviation of electroformed parts is less than 1% of the material's thickness. Orifices of just a couple of microns are no exception. 3D Printing can currently achieve 100 micron range of precision at its best. The technique can be 100 times less precise than electroforming.

Compared to 3D Printing, Electroforming has higher accuracy, shorter lead time, and better cost efficiency especially when it's large volume. 3D Printing allows for better design flexibility mainly due to the fact that it works with a wider range of materials.



electroforming vs. chemical etching

Chemical Etching is a subtractive manufacturing process applied in microfabrication of precision metal parts. Similar to Electroforming, it is known as a fast, accurate, and cost-effective manufacturing method to deliver high precision, burr- and stress-free precision metal parts.

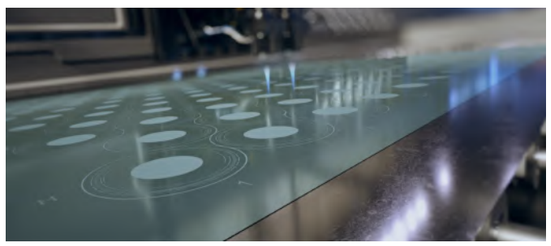
Cost Efficiency
The most common rule of thumb is the higher precision it is, the more expensive it gets. Electroforming is an ultra-precision manufacturing technique, allowing for higher accuracy and tighter tolerances than Chemical Etching. Thus it is commonly assumed that Electroforming is a more expensive process than Chemical Etching. While in some cases that is true, in some others, it is not. Depending on product design and specifications, Electroforming can also be more cost-efficient than Chemical Etching. With electroforming in high volumes the mandrels can be used several times. Sometimes even up to 20 times. Making the EF process very cost effective.

Lead Time
Electroforming is a precision manufacturing process that can harvest a large number of products in every run, which makes it more time-efficient than most other precision fabrication techniques. Chemical Etching goes through a similar process to that of Electroforming and thus also has a short lead time.

Design Flexibility
When it comes to the feature specification, the Chemical Etching process doesn't allow for control of the hole geometry like Electroforming does. With Electroforming, the unique shape resulting from the overgrowth method cannot be realized with Chemical Etching. However Electroforming comes with the limitation on material: mainly nickel and copper can be electroformed, while virtually all metals can be chemically etched with no restriction in hardness of the material.

Quality/Accuracy
With Chemical Etching, a high level of accuracy and precision can be achieved. Electroforming allows you to grow material on a micro scale, providing absolute accuracy and high aspect ratios. The standard deviation of electroformed parts is less than 1% of the material's thickness. Thus compared with Chemical Etching, Electroforming is at an even higher level of precision.

Electroforming is a precision manufacturing process with higher accuracy and shorter/similar lead time compared with Chemical Etching. It allows for better design flexibility when it is about hole geometry; when it is about material choice, Chemical Etching has the advantage. Electroforming can be more cost efficient than Chemical Etching, depending on product specifications.



electroforming vs. laser cutting

Laser Cutting is another subtractive manufacturing process. It works by directing the output of a high-power laser most commonly through optics to cut materials in order to achieve the desired products.

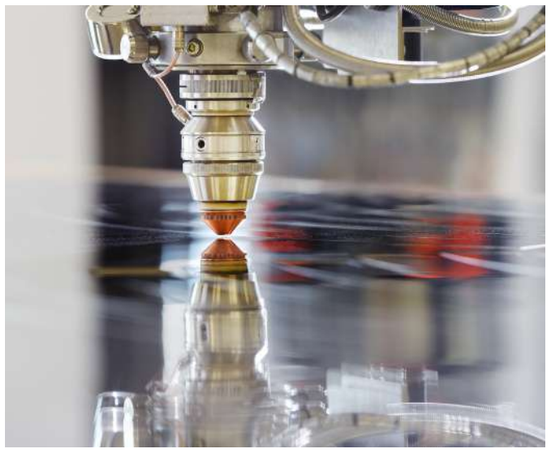
Cost Efficiency
When it's a small volume production or prototyping, Laser Cutting can be more cost-effective than Electroforming. When it's industrial mass production, however, Laser Cutting loses its advantage in costs and Electroforming becomes the favorable option.

Lead Time
With Laser Cutting, you can't produce multiple parts simultaneously, while with Electroforming you can. Compared to Laser Cutting, which can only deal with one component after another, Electroforming is a process that can harvest a large amount of products in every run. When production volume is very low, Laser Cutting might have an advantage in speed over Electroforming. However, when it is industrial production, lead time of Electroforming is shorter.

Design Flexibility
Electroforming and Laser Cutting are both highly flexible regarding design. When the design is very complex, however, Laser Cutting might take much longer time since it can only deal with one part/feature after another while Electroforming works on the complete design simultaneously and can harvest a large amount of product in one run. When it comes to materials, Electroforming has some limitations while Laser Cutting can work with a wider range of materials.

Quality/Accuracy
Electroforming is a high precision manufacturing process that does not change the properties of metals such as hardness, grain structure, or ductility. With Electroforming, you can harvest ultra-precision thin metal parts burr- and stressfree. Laser Cutting, on the other hand, is a thermal process which results in thermal stress, as well as micro burrs.

Compared to Laser Cutting, Electroforming is the more optimal choice when it is large volume production of precision thin metal parts, especially when the design is complex and quality/accuracy demand is high. When it is about material choice, Laser Cutting has the advantage over Electroforming.



electroforming vs. stamping

Stamping, also known as pressing, is a manufacturing process that place flat sheet metal into a stamping press, where a tool and die surface forms the metal into the desired shape. The trend of miniaturization has driven the industry to the micro level, which is referred to as Micro Stamping.

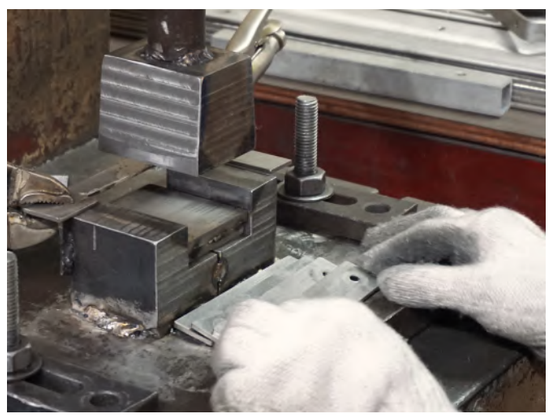
Cost Efficiency
Unlike Electroforming which features no tooling cost, Stamping always requires substantial investment in tooling and installation: both monetary-wise and time-wise. One stamping die can easily cost thousands of dollars, not to mention
the extra costs for setting up and maintenance costs over time.

Lead Time
With Stamping, the lead time can be 6-8 weeks only for preparing the tooling. Even after the stamping tool is completed, extra time (and costs) will incur for setting up the tooling in the stamping press. With Electroforming, lead time is a matter of days. Compared to those who still stamp their precision metal components, you can receive your ultra-precision electroformed parts even before their stamping tool is ready!

Design Flexibility
Electroforming allows for more design flexibility as it requires no hard tooling and that it has a very short lead time, while with Stamping modifying a design means making a completely new die and investing on tooling and setting up all over again. This also means that Electroforming is perfect for small amount prototyping as well as industrial production. When it comes to material choice, however, Stamping allows for more flexibility than Electroforming.

Quality/Accuracy
Electroforming is an ultra-precision micro-manufacturing technology. With Electroforming, a higher level of accuracy and precision can be achieved. Moreover, electroformed parts are completely burr- and stress-free while stamped parts feature partial burrs and stress at cutting edge. Although minor burr or stress can be acceptable for some applications, it might be a stumbling block for your next breakthrough.

Compared to Stamping, or Micro Stamping, Electroforming has shorter lead time, lower costs, better quality, and more design flexibility (when the material is not an issue).



electroforming vs. EDM

Electrical Discharge Machining (EDM), also known as spark machining, burning, die sinking, wire burning, or wire erosion, is a manufacturing process whereby a desired shape is obtained by removing materials with electrical discharges (sparks).

Cost Efficiency
When production volume is small or it is only for prototyping, there's no significant difference regarding cost-efficiency between Electroforming and EDM; when it is industrial-scale production, however, Electroforming is far more cost-efficient.

Lead Time
Lead time of Electroforming and that of EDM are at a similar level. For large volume production, Electroforming gains an advantage over EDM.

Design Flexibility
With electroforming, the unique cross section resulting from the overgrowth method cannot be realized with EDM, thus allows for more design flexibility. However, Electroforming has its limitations on choices of materials, and so does EDM. EDM can only work with electrically conductive metals and alloys since the process is dependent on electrical current.

Quality/Accuracy
Compared to Electroforming which has no effect on material properties, EDM can cause heat distortion because of its use of high-temperature electrical current. Besides, micro burring, tempering, and structural changes may also occur, which makes it a less accurate process.

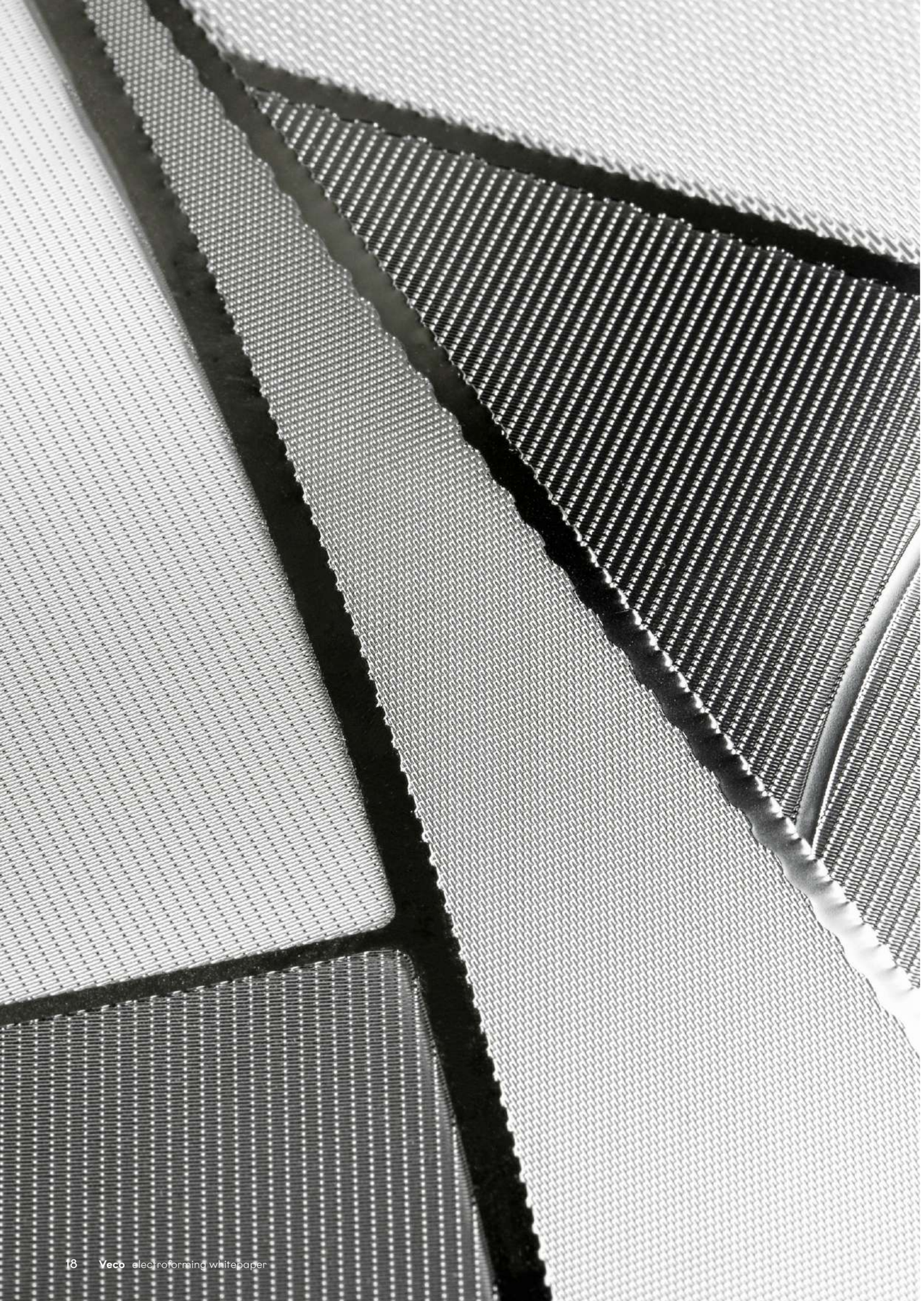
Electroforming and EDM are at a similar level on lead time and cost efficiency. When it is about quality, accuracy, or design flexibility, Electroforming becomes the obvious winner.

Comparison of Electroforming and Other Precision Engineering Technologies:

	Runtime		Precision µm	Tooling and setting up	Stress and burrs
	Prototype	Production			
Electroforming	Very short	Very short	2	No hard tooling needed, very quick and cost effective	Stress free, burr free
Chemical Etching	Very Short	Very short	30-40	Quick, easy, cost-effective	Stress- and burr-free
Stamping	Extremely long	Very short	50-100	Expensive and time-consuming	Stress at cutting edge, partial burrs
Laser Cutting	Extremely short	Extremely long	c.a. 50	Quick, easy, cost-effective	Thermal stress, micro burrs
Electro Discharge Machining (EDM	Very short	Short	c.a. 50	Quick, easy, cost-effective	Deformation, tempering, structural changes
3D Printing	Very short	Extremely long	100	Easy setup and cost effective (only for prototype)	Thermal stress, micro burrs

applications of electroforming

filtration | digital printing | electronics & semiconductor | medical



filtration

filtration is everhywhere

Filtration is a complicated industry with applications ranging from liquid / solid, solid / gas filtration, light filtration, sound filtration, to separation within the water, chemical, algae, petrochemical, oil, gas, pharmaceutical, food and a wide range of other process industries.

Filtration media varies across applications/industries and has a significant influence on the efficiency of the production process and quality of final products.

Engineers strive to search for the right solutions for different projects/demands.

What Electroforming can Bring to the Filtration Industry

Electroforming enables rigid, homogeneous structures with excellent separation characteristics. Holes can be down to 2 microns whilst maintaining high throughput and easy cleaning – even in-process cleaning. The perforations can be made in many different shapes. Filters made by the electroforming process are always absolute filters. By applying a “cake” they can also be used as a depth filter.

Solutions and related products:

- Sieves used in Aerospace and Defense.
- Sieves used in food process (coffee filters, continous centrifugal screens, sugar sieves, starch screens, leaf filters, MSG filtration screens, etc.).
- Sieves used in water treatment.
- Sieves used in pharmaceutical filtration.
- Sieves used in research such as test sieves.
- Sieves used for oil refinery.
- Sieves used for pigment filtration in paint industry.

digital printing

way to pioneer the digital printing world

For printing industry, staying competitive has never been harder: higher printing speed, finer image quality, better reliability, shorter development cycle, and lower costs. What's more, the inkjet printing technology has advanced so much in the last couple of years. It's critical but hard to keep track of them all.

Opportunities for the next-gen printing tech lie in miniaturization. To stay competitive on the market, it is essential to find the future-proof solution.

Filtration media varies across applications/industries and has a significant influence on the efficiency of the production process and quality of final products.

Engineers strive to search for the right solutions for different projects/demands.

What Electroforming can Bring to the Digital Printing Industry

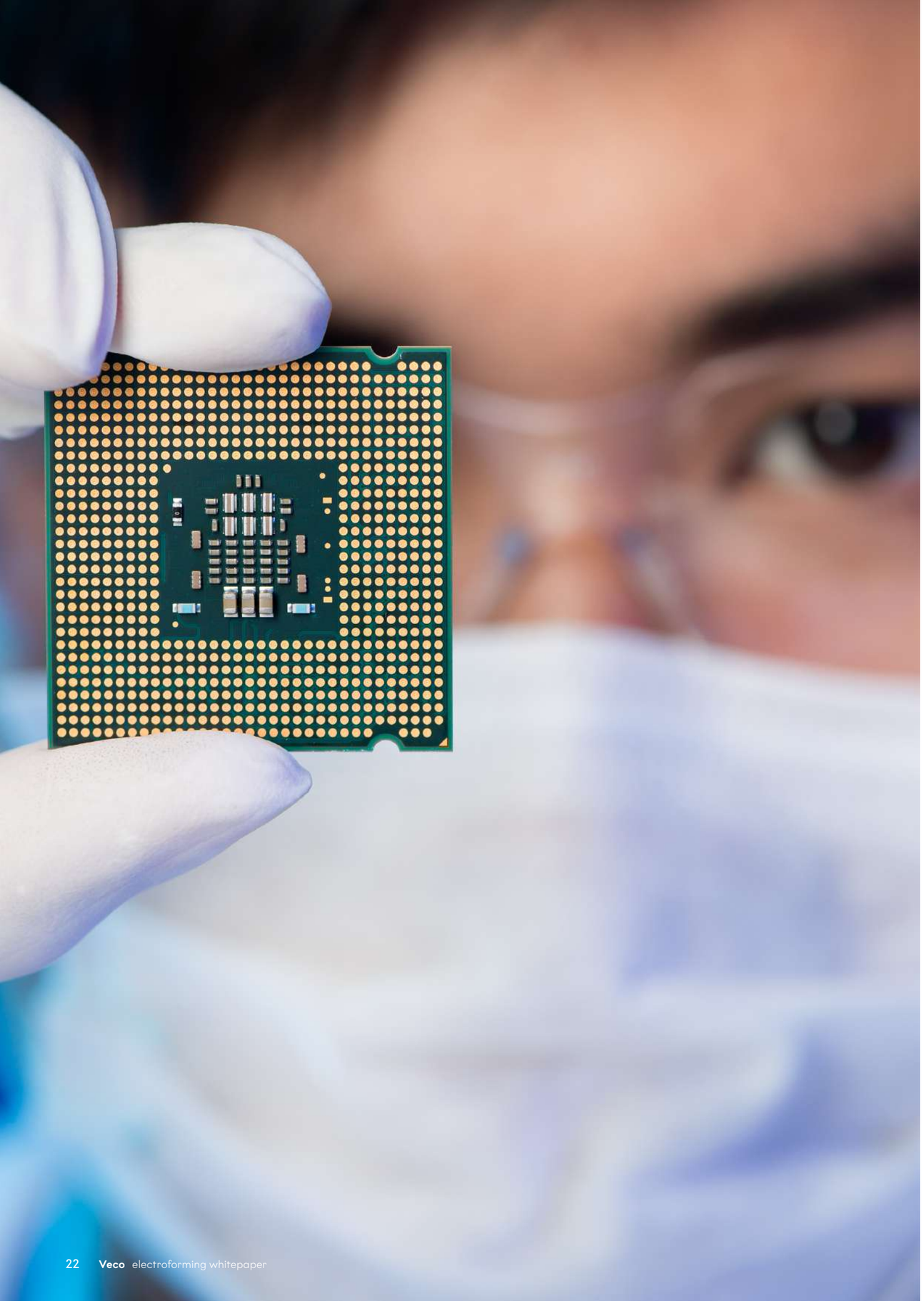
Electroforming is an ultra-precise additive manufacturing technology, which enables next level of micro-precision features for key printing components — while maintaining top-notch and consistent printing quality.

With Electroforming, not only micron-sized holes but also the highest and most accurate aspect ratios and cost-effective prototyping can be achieved.

Solutions and related products

As the industry leading specialist in electroforming, Veco offers the industry customized top quality inkjet printer parts, meeting every specific need regarding nozzle shape, hole geometry, chemical/mechanical stability, and traceability of parts by laser marking, and multi-layer alignment.

- Inkjet nozzle plates.
- Inkjet nozzle guard.



electronics / semiconductor

staying competitive in a landscape of innovation

Semiconductor manufacturers have faced the pressure to make components increasingly smaller, durable, and powerful — while maintaining cost-efficient and sustainable production. And all has to happen at a fast pace: short lead time is essential to bring latest innovations to the market first — a crucial aspect if you want to become or remain a market leader.

What Electroforming can Bring to the Electronics and Semiconductor Industry

Electroforming is the future-proof solution for the Electronics and Semiconductor industry. By its ability to produce very fine curved shapes it surpasses conventional technologies like stamping and punching. Radii as small as 30 microns can be made in relatively thick (30-100 micron) material. With Electroforming, it is possible to make very slim designs with high aspect ratios. This means that very small products can be made without compromising on reliability. Aspect ratios achieved with electroforming are up to 3 times higher than with conventional stamping or punching.

Solutions and related products:

As the industry leader in Electroforming, Veco has been working with industry leaders in Electronics and Semiconductor industry around the world, co-developing the next generation solutions.

- Testing contactors, cantilevers, test probes.
- Lead frames.
- SMT stencils.
- Shadow masks, evaporation masks.

medical

precision engineering with electroforming

With constant development of medical science, the medical and health care industry sees tremendous growth opportunities as well as more challenges. The demand for precision and quality is getting even more critical.

With the trend of miniaturization, medical components are not only extremely small in size, but also demanding more complex geometries, tight tolerances, and superior mechanical properties. Traditional manufacturing processes such as stamping, EDM, Water Jetting, and CNC Milling can no longer meet the demanding requirements the industry faces nowadays.

What Electroforming can Bring to the Medical Industry

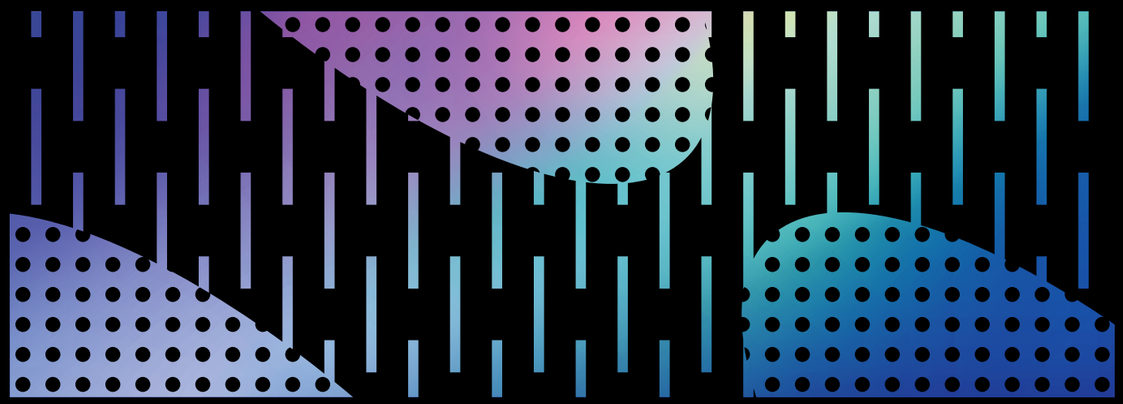
Electroforming as an additive manufacturing process is highly suitable to create thin, strong, and/or ultra-precise components in complex shapes. Miniaturized components can be produced with holes down to 2-micron and tolerance within ± 1 micron. This precision has enabled various breakthroughs in medical industry and can be of great benefit for next-gen medical device design.

Solutions and related products:

Veco has been working together with leading companies in the medical industry, delivering high quality precision parts and co-developing next generation breakthroughs.

- Precision metal sieves, meshes, such as nebulizer plates.
- Various optical parts such as spectrometer slots and apertures.
- Electrical parts in various medical devices, such as hearing aid parts.
- Medical flow regulation parts.
- Co-development service for next-gen innovation development and prototyping.

additional services



Metal Finishing and Electroplating

For many hi-tech and hi-spec applications, Metal Finishing is essential for corrosion and wear resistance, or specific functional reasons. Proper Metal finishing not only helps to increase product lifetime but also allows for more flexibility regarding choice of base materials and improves product functional performance.

Veco is a recognized leader in Electroplating processes with a wide range of material capabilities. With our own on-site world class plating facility, we can provide a full plating and metal finishing service: Gold plating, PdNi plating, Nickel plating, Electroless Nickel, Tin (Bright or Matt) plating, Anodising, and Blackening are a few of the services we provide.

In-house Forming and Assembly Service

With forming, assembly and plating capabilities, the post-production engineering services can shorten the total component production process drastically. Working collaboratively with our customers allows us to provide cost-effective solutions to complex engineering requirements.

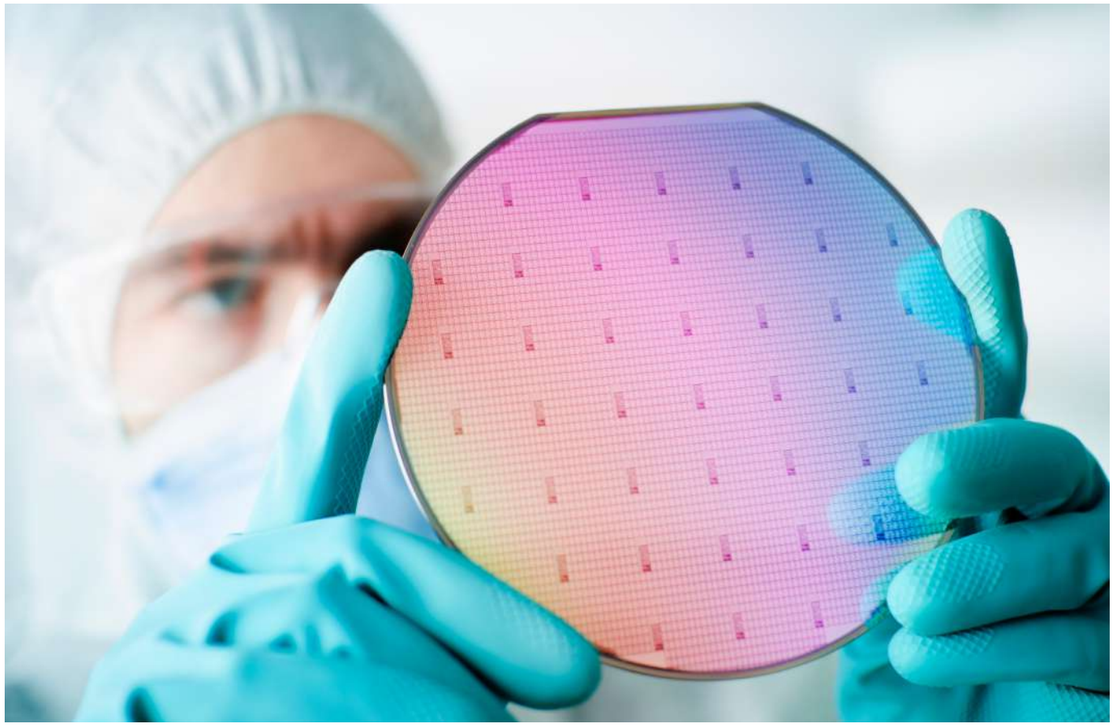
Current examples of our services include the requirement to provide a micro-precision domed nebulizer plate in large quantities at a competitive price in a demanding environment. Veco's 'know-how' means we are the partner of choice for your business.

co-development process

Creating innovations that help your company become the frontrunner in its industry — that's what you do as an engineer. But setting the industry standard is challenging, especially when limited tech possibilities compromise your freedom of design, and you don't have a sparring partner.

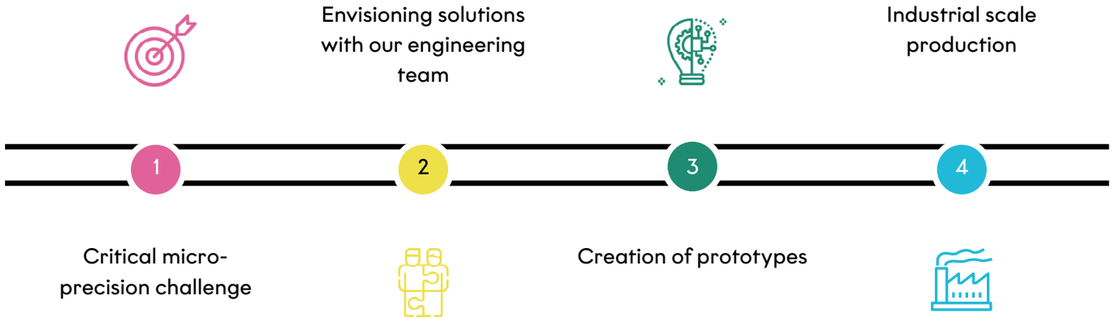
What if you had a partner to co-develop the best possible solutions for your critical components with? A partner that's with you from the very start, so that you can design, prototype, and go to industrial scale production together. Don't ever feel limited or on your own again.

Work with our specialized Application Engineering and R&D teams to create your next-generation product.



Enable continuous innovation for your business through co-development

How you and our R&D team work together: the co-development process



1 - Critical micro-precision challenge

To create a next-generation product, you require micro-precision components. In the first phase of the co-development process, we look at your project parameters and demands together so that we can design the best possible solution in phase 2.

2 - Envision solutions with our engineering team

How can we co-develop your next innovation as efficiently and cost-effectively as possible, while ensuring a consistent quality of your product? Together, we draw up the path to product development We select the most suitable manufacturing technique, define which key features to measure to ensure further optimisation during iterations, and determine the parameters for final quality inspection.

3 - Creation of prototypes

As the world leader in micro-precision parts, we are the first in the industry to use Laser Direct Imaging technology. It not only shortens lead time and cuts cost, but also allows for more design flexibility, which will be highly beneficial for sampling.

4 - Industrial scale production

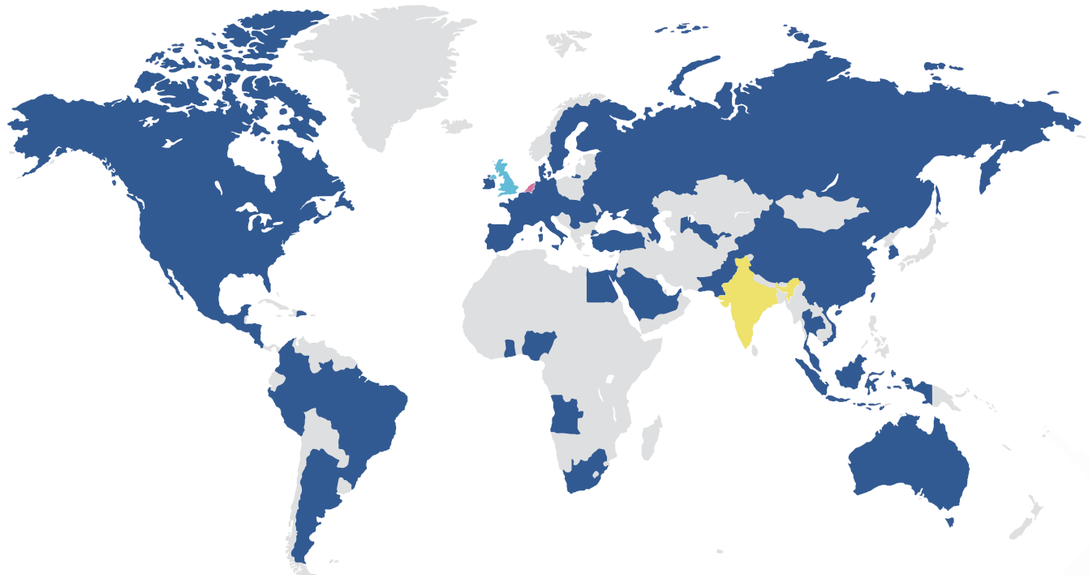
After the sample is created, tested and inspected, it's time to move to industrial scale production. And we can move to industrial scale production fast because the majority of the production parameters are already in place from when we created your sample. Our philosophy is to use as much of the pre-existing production processes for the series production of your parts — something you'll notice in terms of delivery times and quality.

about Muon group

world leader in micro-precision

As micro-precision components are becoming the key factor for companies when developing their competitive edge, Muon believes that offering successful small-scale answers to complex questions requires acting on a bigger, professional and global scale.

Working together enables the Muon Group of companies to push boundaries and create game and life-changing innovations. The wider joint network, greater investment power, and accumulated confidence in the potential of micro-precision empowers them to co-create smarter and more imaginative micro-scale components that are mission critical to industrial evolution and product performance.



Muon B.V.
Karel van Gelreweg 22
6961 LB Eerbeek
the Netherlands
T +31 313 672911

www.muongroup.com
info@muongroup.com

meet the Muon family

The Muon Group consists of Centres of Excellence in the fields of Electroforming, Chemical Etching and Laser Material Processing.

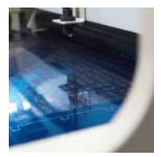
Veco B.V.
Located in Eerbeek, the Netherlands, Veco is a world-leading manufacturer of micro-precision parts. With Electroforming as its main technology, Veco serves the world's most innovative high-tech companies in industries that demand high quality and precision.

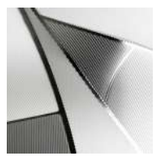
Millux B.V.
Located in Wijchen, the Netherlands, Millux, formerly known as Reith laser, is a specialist in Laser Material Processing for the high-tech industry. Millux serves the industry with worldclass laser micro machining capabilities.

LouwersHanique B.V.
Located in Hapert, the Netherlands, LouwersHanique provides advanced precision technologies such as mechanical processing, laser machining, joining technology and thermal processing in the world of technical glass and ceramics.

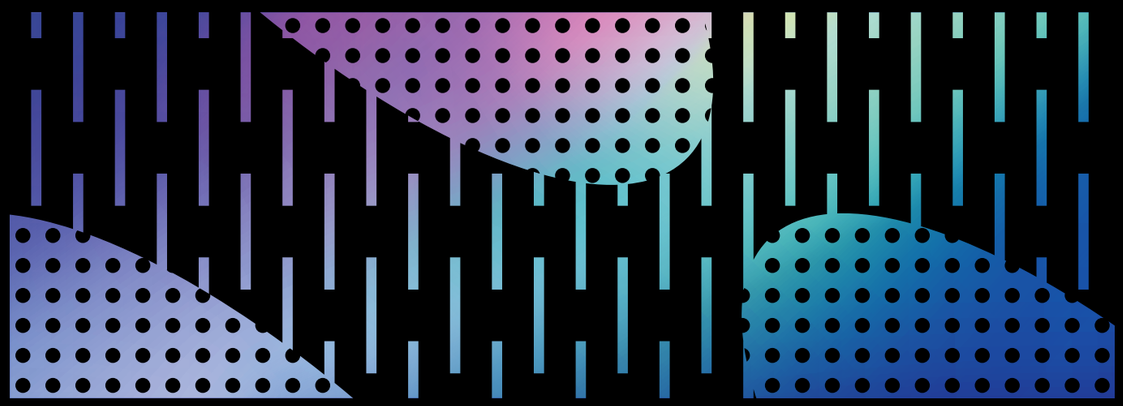
Tecan Ltd.
Located in Dorset in the UK, Tecan is a leading manufacturer of customised micro-precision parts. Using Photo Chemical Etching, Tecan quickly attracted a wide range of work from companies that recognise the advantages of etching over more conventional manufacturing methods.

Atul Sugar Screens Pvt. Ltd.
Based in Pune, India, Atul is the largest exporter of nickel screens in Asia and is the industry leader in the Indian market. Today, its state-of-the-art facility with the largest independent manufacturing and testing capacity under one roof in Asia, serves thousands of customers across 5 continents.




get in touch with us



contact information

Whatever your needs, we are here to help. If you have any questions about our products or services, please do not hesitate to contact us.

Located in Eerbeek, the Netherlands, Veco is a world-leading manufacturer of micro-precision parts. With Electroforming as its main technology, Veco serves the world's most innovative high-tech companies in industries that demand high quality and precision.

Veco B.V.
Karel van Gelreweg 22
6961 LB Eerbeek
The Netherlands
+31 (0)313 672 911

www.vecoprecision.com

appendices

customer case: multitest

pushing boundaries by co-developing with Veco

Multitest is the world's leading manufacturer of test equipment for semiconductor's integrated circuits. It is a trusted partner that the world's most renowned semiconductor manufacturers work with. Veco has been working with Multitest since 2010 and helped them along the way to become the international leader in the industry.

In semiconductor testing equipment, test contactors are of essential importance. They are used to determine the performance of electrical devices like micro-electro-mechanical systems (MEMS), sensors, microcontrollers, and integrated circuits. The challenge of the industry lies in improving testing efficiency and profitability. Sharing Multitest's vision, Veco has been working together with Multitest to co-develop the solution to make a difference, applying an experimental approach. Instead of a traditional supplier/ manufacturer relationship, Multitest and Veco work hand-in-hand every step of the way.

This also guarantees Multitest a tailored solution that is based on their specific demands and requirements. Innovative next generation solutions are achieved, with our Electroforming technology and newly developed HR nickel, which considerably improve the testing efficiency and reliability.

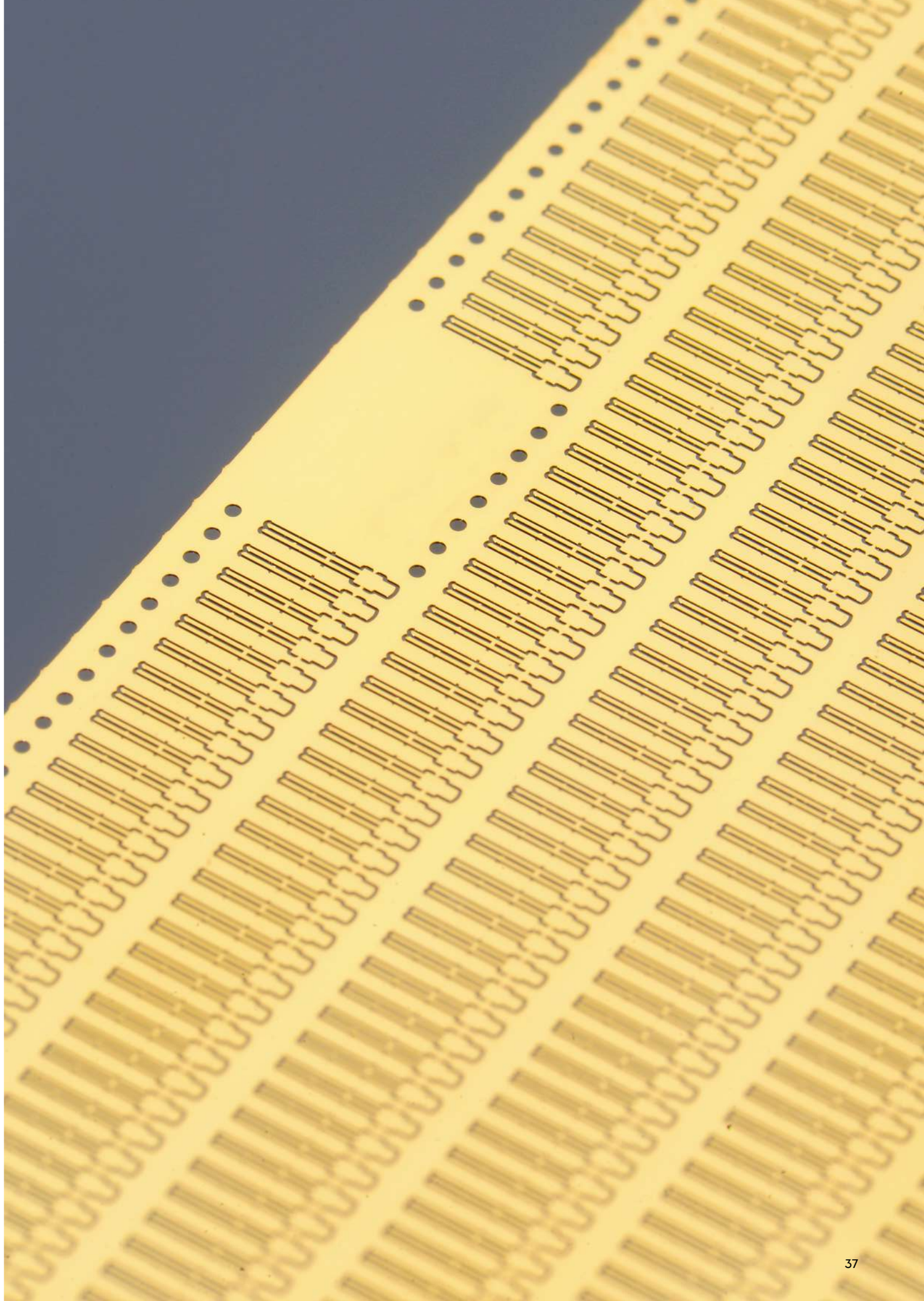
Electroforming enables cost-effective fabrication of micro-precision parts on an industrial scale.
Electroforming differs from other manufacturing techniques in that it allows manufacturers to 'grow' parts atom by atom, which provides excellent accuracy and high aspect ratios. It also allows for exceptionally short lead times both in prototyping and production.

Electroformed components feature extremely clean and smooth surface which is burr- free and stress-free, straight sidewalls, sharp edges, and accurate hole sizes impossible to achieve through other techniques. In practice, Electroforming allows Multitest to achieve near-perfect process control, high repeatability, and top-quality component production – in other words, it's the perfect solution for manufacturers looking to achieve high production volumes at minimal cost.

HR Nickel makes testing more reliable and profitable.
Use of Veco's newly developed HR Nickel not only improved the reliability of Multitest's testing process: it improved the profitability and productivity of the entire business. By using a metal that is better suited to the stresses of semiconductor testing, failure rates are significantly lower, and getting accurate testing results is faster, more reliable, and more affordable, without compromising on quality.

HR nickel makes it possible for Multitest to run several million tests on their components before they show any signs of wear (Up to three times more than conventional components), and are suitable for both testing and production purposes.

multitest
Handler and Interface Product Group of
Cohu



customer case: aerogen

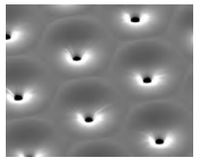
aperture plate releasing millions of micron sized medicine droplets per second

In state of the art aerosol drug delivery system enabled by Vibrating Mesh Technology, Veco's nebulizer aperture plate (mesh) releases millions of micron sized droplets per second through its unique geometry.

The key to the Vibrating Mesh Technology which re-defined respiratory treatment is the aperture plate surrounded by a vibrational element (shown below).

The electroformed aperture plate is just 5 mm in diameter and perforated with 1000 precision formed tapered holes. It vibrates 128,000 times per second, creating a mini pump that produces a fine particle mist of uniform size droplets, each between 1 and 5 microns in diameter, an ideal particle size for deep lung penetration. Clinical study has shown that this results in deposition rates far greater than that can be achieved by conventional nebulization.

Nebulizer aperture plate surrounded by vibrational element



Microscopic photo of the unique geometry of the micro holes on the aperture plate

As the development of drug delivery technologies, the industry sees an increasing demand for nebulizer nozzle plates of higher precision and quality level. Electroforming as an additive manufacturing process highly suitable for miniature structure meets this demand perfectly due to the following features:

- Highly uniform orifice holes can be formed as small as 1 micron.
- Flexible hole geometry, any complex hole pattern or shape possible.
- Ultra-precision and extreme accuracy.
- Capable with bio-compatible materials.
- Flexible and economic tooling and prototyping.

veco