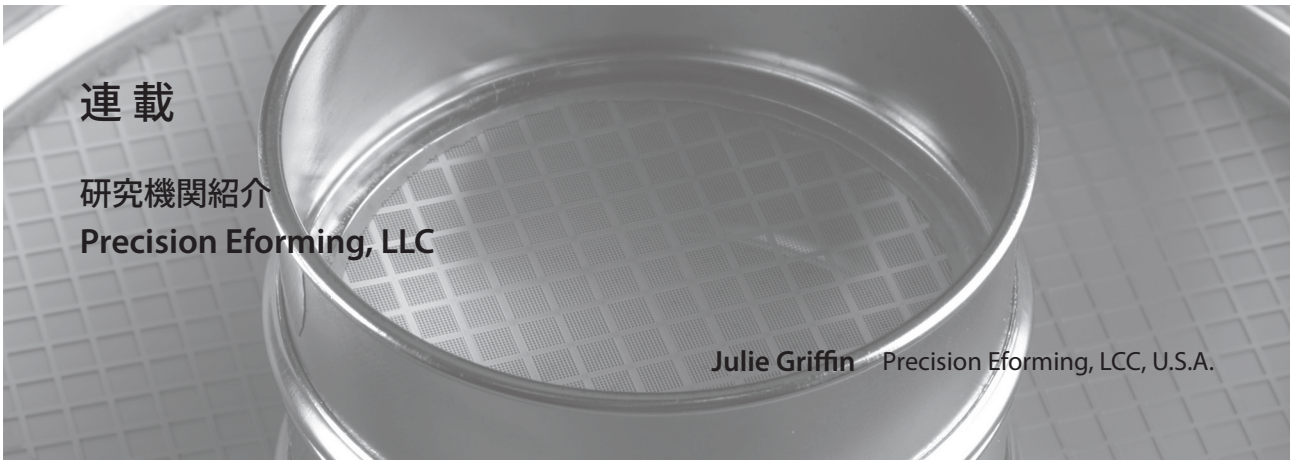

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研究機関紹介

Precision Eforming, LLC

Julie Griffin Precision Eforming, LCC, U.S.A.

History

The roots of our company begin in 1907 with Charles E. Buckbee and Norman T. Mears, when they collaborated to establish Buckbee-Mears Company, a small photoengraving plant in St. Paul, Minnesota. After watching the business grow for many years, Norman's son, Norman B. Mears became involved with developing new metal etching technology. He pushed for the expansion of the business into photochemical reproduction during WWII. When the US Navy needed grids etched on the eyepieces of military equipment, his technology led to the development of the metal reticle. During peacetime, Norman found a way to use this technology to originate processes and equipment for making color television aperture masks. Early in the 1960's, Buckbee-Mears was working with General Electric on a project that required specifications in aperture size and thickness that were difficult to achieve with the photoetching process. To meet these new product requirements, electroforming was introduced.

After many years of developing and improving the electroforming process, the division was relocated to the Buckbee-Mears facilities in Cortland, New York in 2002. The move was part of the company's overall plan to consolidate operations and reduce costs. In late 2003, Buckbee-Mears Company announced that they would be selling the assets of its Cortland, NY location, which was being phased out so Buckbee-Mears could focus on growing its Vision Ease optical lens business. The managers of the electroforming division realized the importance and criticality of the product to their loyal customers and rallied to find a way to save the business. In February 2004, they partnered with a Syracuse NY investment firm, Torridon Companies, to purchase the electroforming division, thus allowing uninterrupted service to the customers of the business. The new company was named Precision Eforming and moved to a new facility in Cortland, NY.

In 2015, Torridon Companies sold Precision Eforming to now President, and long-time employee, Julie Griffin. "Throughout our evolution we have made continuous improvements to our manufacturing process as we strive to produce the highest quality product with shortest lead time for our customers."

Figure 1: Photograph of the company roots

What is electroforming

Electroforming is a process of forming parts through electroplating on a model known as a mandrel. Conductive (metallic) mandrels are pre-treated chemically to allow subsequent separation of the finished electroform. The outer surface of the mandrel forms the inner surface of the form, and a thick layer of electroplating is applied until the plate itself is strong enough to be self-supporting. Usually, the mandrel is separated intact or dissolved away after forming. The finished plated form can either be the finished part, or used in a subsequent process to produce a positive of the original mandrel shape.

Recently, due to its ability to replicate a mandrel surface precisely and with practically no loss of fidelity, electroforming has become important in the fabrication of micro and nano-scale metallic devices.

Electroforming–building mesh atom by atom

Electroforming is a method of precision metal making and is key in the fabrication of micro scale metal pieces. Ours is a specialized additive process where we grow high precision mesh products by electro deposition onto a conductive mandrel surface and then remove it.

Using pure nickel, copper or gold we chemically deposit thin layers of metal, atom by atom, building each custom piece to your exact specifications.

This proprietary process enables Precision Eforming to manufacture the most consistent and accurate materials with exceptional surface finish properties and dimensional stability.

Electroforming vs. other metal making processes

Compared to other basic metal forming processes (casting, forging, stamping, deep drawing, machining and fabricating) electroforming is very effective when requirements call for extreme precision, tight tolerances, or complexity in design. The resolution subsequent from the photographically produced conductive patterned substrate, allows finer geometries to be produced to tighter tolerances while maintaining superior edge definition with a near optical finish. Electroformed metal is extremely pure, with superior properties over wrought metal due to its refined crystal structure. Multiple layers of electroformed metal can be molecularly bonded together.

Advantages of electroforming include:

- Superior Edge Acuity–Virtually within .1 micron variation and burr free.
- Ultra Precise Apertures–Precision down to the single micron increments.
- Unparalleled Tolerances–Tolerances of +/-1um are typical and unobtainable with other manufacturing methods.
- Consistent Repeatability–Complex designs can be reproduced with near exactness.
- Pure Metal Materials–Nickel, gold and copper materials available with purity levels of 99.8+ %

Sieve applications

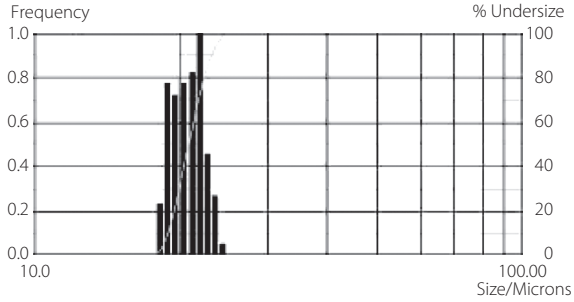
Sieving is a reliable technique for determining particle size and shape, important factors in the quality of many products in a number of industries including diamond powder / abrasives. Precision Eforming produces electroformed sieves for use in sorting, sifting, screening and classifying a variety of materials. Our sieves are precise instruments and are widely used in manufacturing applications, as well as laboratory environments.

Electroformed sieves offer a number of advantages. The largest advantage is the achievable hole sizes. We currently produce sieves ranging from 3 to 2000 microns, with a +/- 2 micron tolerance. They are not subject to the limitations of woven wire sieves such as clogging, particle entrapment and imprecise tolerances. In addition, their flat, smooth surface simplifies cleaning. Our standard apertures are square, round

Figure 2: Photograph of sieves

Whitehouse Image Analysis:
Size Distribution (number, raw data)
Sample: 20 µm, Wire Sieve

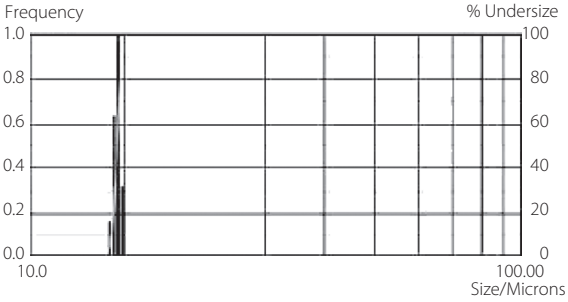
% Undersize	1.0	5.0	10.0	25.0	50.0	75.0	90.0	95.0	99.0
Max Size/µm	18.4	19.1	19.1	19.0	21.3	22.0	22.7	23.4	24.1



Median: 21.3 µm Mode: 22.0 µm Mean: 20.9 µm SD: +/– 6.4 %

Whitehouse Image Analysis:
Size Distribution (number, raw data)
Sample: 20 µm, Buckbee-Mears Sieve

% Undersize	1.0	5.0	10.0	25.0	50.0	75.0	90.0	95.0	99.0
Max Size/µm	18.4	19.1	19.2	19.2	19.4	19.6	19.7	19.7	19.9



Median: 19.4 µm Mode: 19.6 µm Mean: 19.4 µm SD: +/– 1.2 %

Figure 3: Comparison of aperture hole size of 20 um wire (left) and electroformed sieves (right)
Note: Taken from "Absolute Precision in Particle Size Analysis"; Dr. G Rideal; Whitehouse.

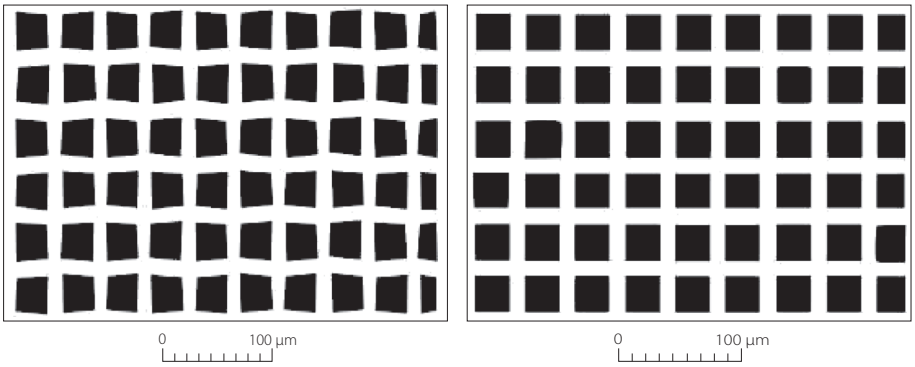


Figure 4: Comparison of Woven Wire Materials vs Electroformed Materials

Note: A microscope comparison of 20 um wire (left) and electroformed sieves (right). Taken from "Absolute Precision in Particle Size Analysis"; Dr. G Rideal; Whitehouse.

and slotted, and hexagonal, and we also have the ability to produce custom geometries.

Our sieves are currently used in a variety of applications and industries including: chemicals, textiles, pharmaceuticals, powder metals, diamond powder, abrasive, cement and nuclear fuel production.

Precision electroformed mesh

Precision Eforming's production process was the first established process for manufacturing precision electroformed mesh in the world. Mesh produced from this process was used to establish all current standards including ASTM, ANSI, and ISO. Our products include:

- Nickel, Copper, Gold, Black Nickel and Gold Flashed Meshes
- Range from 5 LPI to 2000 LPI independently in each axis
- Range from 3 % to 95 % open area (Transmission)
- Range in thickness from 3 microns to 250 microns
- Mesh from any designable geometry

Our mesh can be used in filtration applications such as:

- Wet or dry
- In hot or cold environments
- For imaging transmission control
- For precise electrical signal control
- For sound (sonic) control
- For air (or dispersion)
- For gas
- For particles

Electroformed mesh advantages

Electroforming is a specialized additive process for building high precision mesh products by electro deposition in a plating bath over metal mandrel and then removing it.

Electroforming is ideal for the applications where stamping, photochemical etching and laser cutting simply cannot achieve tight tolerances or complex / specific hole shapes.

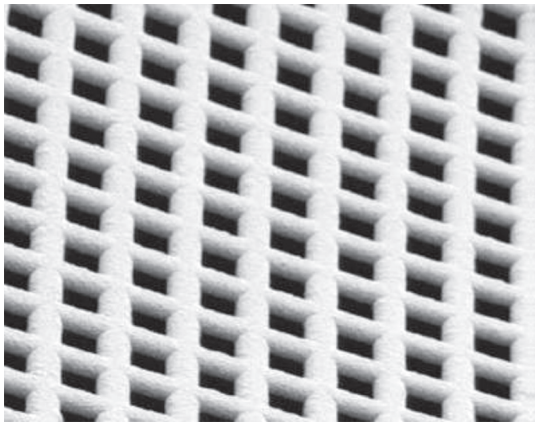


Figure 5: Photograph of mesh

Some of the advantages of electroformed mesh products are:

- Ultra Precision
- Flat Materials, burr free
- Sharp edge definition
- Excellent repeatability

Electroformed nickel mesh

Nickel is extracted from ores by conventional roasting and reduction processes that yield a metal of greater than 75 % purity. Purification of nickel oxides to obtain the purest metal is performed via the Mond process, which increases the nickel concentrate to greater than 99.99 % purity. Based on geophysical evidence, most of the nickel on Earth is postulated to be concentrated in the Earth's outer and inner cores.

The major use of nickel is mainly characterized by strength, ductility, and resistance to corrosion and heat.

Electroformed copper mesh

Pure copper is soft and malleable. The softness of copper partly explains its high electrical conductivity and high thermal conductivity, which proves to be the second highest among pure metals at room temperature. This is because the resistivity to electron transport in metals at room temperature mostly originates from scattering of electrons on thermal vibrations of the lattice, which are relatively weak for a soft metal. Copper is widely used as a conductor of heat and electricity.

Electroformed gold mesh

The superior qualities that are natural to elemental gold are also inherent in our gold mesh products. Our gold mesh is made with the same precision as our nickel and copper mesh, with attributes such as:

- Ultra tight tolerances
- Low surface tension
- Consistency in shape and smoothness of aperture walls
- Excellent edge acuity
- Precision repeatability of aperture dimensions

3D printing and powdered metal

3D printing is a progressive manufacturing method growing quickly in popularity, especially in the 'micro manufacturing' industry. While 3D printing greatly expands the range of producible products, in some applications the mechanical strength of 3D printed objects is not sufficient. It is widely understood that mechanical strength is directly related to the porosity of the 3D printed metal. As well, the porosity is directly influenced by the raw materials used in its manufacturing, such as powdered metals.

By using electroformed sieves, particles can be filtered to a specific desired size for an even distribution. It has been proven that an optimized arrangement of fractions with large and small particles can provide 3D printed products with enhanced mechanical strength due to a higher packing density. An increase of mechanical strength can possibly expand the application area of 3D printed metal products into industries not currently served.

One historical way of separating powders into range sizes are with woven wire sieves. Traditional wire woven sieves are available at pre-selected opening sizes and carry a tolerance at up to +/-20 % of the opening. More accurately, electroformed sieves are available at the single micron increment starting at 3 microns, allowing a further customization of powdered materials. They are built atom by atom, resulting in a singular piece or non-woven material. Due to the media being non-woven, electroformed sieves also experience significantly less clogging and particle entrapment.

Benefits

- Ultimate Accuracy – Filter by specific particle size with narrow tolerances as low as one or two microns.
- Wider Range of Separation – Electroformed sieves are available at every micron size between 2 and 2,000 allowing a wider, more accurate separation.
- Reduced Powder Distribution – Electroformed sieves ensure that your powder is consistent in size right down to the micron level allowing your powdered metal to compact even tighter.
- Increase Strength – Uniformed micron sizes increase strength in your products density. Tightly packed powders lead to denser, stronger end products.
- Reduced Particle Entrapment – non woven sieving media results in decreased clogging, easier cleaning.

Conclusion

We appreciate the opportunity to earn your business. Precision Eforming embraces the inherent qualities specific of metals and builds mesh filtration, separation and particle sizing products, atom by atom. As new challenges and needs develop, we are here to find a solution. Our experience and customer service make us the leader in our industry. Each Precision Electroformed product is custom built, by the hands of our highly skilled professionals, and then meticulously inspected by microscopy for any imperfections. Made with Pride. Made in the USA. Made for You.

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