

Precise drilling with electron beams

drilling



Precision drilling for 1. Tofu 2. Aircraft construction 3. Sugar production

The advantages of drilling with an electron beam

Economic technique for all metallic materials when numerous small holes are required.

Productivity

10 to 30,000 holes per second (depending on size)

Precision

Outstanding reproducibility of hole diameter

Bore geometry

Hole shapes ranging from cylindrical to conical, including inclined angles to the surface, with depth/diameter ratios of up to 20:1

Process reliability

All process parameters are monitored and electronically regulated.

Electron beam drilling is especially economical whenever a large number of holes must be drilled. Its strength is particularly noticeable whenever conventional methods reach their limits or become extremely slow. Examples include manufacturing screens with very small hole diameters, a very large number of holes or very deep holes.

Technique ■ With electron beam drilling, in contrast to other procedures (EDM, ECM, laser beam), the work piece and beam can be moved independently of one another during the drilling process. This allows drilling frequencies vastly superior to those of competing techniques. The electron beam works virtually free of inertia, free of wear and at the speed of electronic control systems. In contrast to lasers, the particle beam releases its energy below the surface of the material in a precise manner. This makes it ideal for drilling materials.

Process monitoring ■ The electron beam is controlled totally by electromagnetic parameters. Hence, the drilling process can be exactly monitored, adjusted and reproduced identically any number of times. The shape, density and position of the holes can be defined very precisely by the beam parameters. This makes it possible to produce special hole shapes or complex hole patterns.

Materials ■ All metallic materials can be processed, virtually independent of hardness, reflection behavior, alloy components or heat conductivity. Alloys capable of withstanding high thermal loads can also be drilled economically. Drilling is also possible for some nonmetal materials. This can be checked on request.

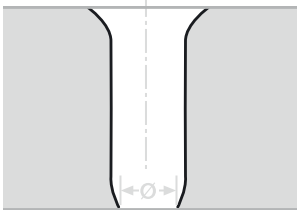
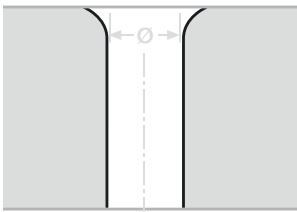
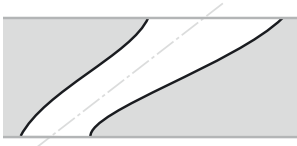
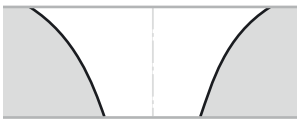


1. Filter for coolants
2. Centrifugal spinners for manufacturing glass fiber
3. Metal filter of a ball mill



Precise results at high drilling frequencies

Borehole geometries



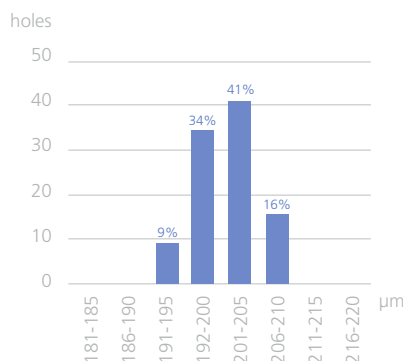
Drilling with an electron beam can create various hole shapes

Drilling with an electron beam utilizes the physical properties of a particle beam when impacting the material. For processing, the work piece is placed in a vacuum chamber. It is then perforated with short, intensely focused, powerful electron pulses.

When used as a drill, a laser beam requires several energy pulses per hole, in order to penetrate deeply into the material. An electron beam, in contrast, produces a hole with each beam pulse. The electrons of the pulse have a very high energy density, melting the work piece at the point of impact to great depths. This deep-welding effect of the electron beam is used to create fine, deep holes.

Due to the different interaction of photons (laser) and particles (electrons) with solid matter, the electron beam penetrates deeply into the material, whereas laser light is adsorbed at the surface. Consequently the electron beam predominantly melts material and the beam's core forms a vapor capillary, similar to the deep welding effect, which permits further propagation of the electrons. By contrast, the laser vaporizes a larger amount of the volume to be removed. In both cases gas pressure is used to blow out the liquid metal from the borehole. With a laser this gas pressure is partly produced by the vaporized material of the work piece itself and partly by an additional gas flow through the laser nozzle. With electron beam drilling there is an additional backing material with a low boiling point and a high vapor pressure which is attached to the back side of the work piece. As soon as the electron beam fully penetrates the work piece and hits the backing material it vaporizes with an instant eruption and blasts the molten metal completely out of the borehole.

This process works only when one single pulse penetrates, which melts and cleans out the hole over its entire depth. The result is a borehole with a sharp edge and burr free beam exit, a slight taper and burr at the beam entrance. The laser, however, needs several pulses to produce deep holes. The inner lining of the hole is formed by a re-solidified layer with several steps. Typically the hole has a taper and burr to both sides.



Variance of hole diameters for 200-µm holes typically within $\pm 10 \mu\text{m}$

Ultra-fine microholes for Japanese households

Centrifuge screens for producing sugar



Tofu is made from soya beans pressed through a fine screen. In Japan, it is considered to be a real delicacy. Special sieves, with small, identical holes, are required. Gourmets even maintain that the difference in hole sizes can be tasted. Stainless-steel screens are easy to clean and very durable. However, durable materials are usually difficult to drill. Here, the electron beam technique resolves an apparently unsolvable conflict.

Quality that can be tasted

pro-beam uses electron beams to drill screens. More than 12 million tiny holes per square meter are drilled in stainless-steel metal sheets, which are 0.5 millimeters thick. Each hole has a diameter of 0.12 millimeters. Electron beam drilling can be reproduced exactly, ensuring uniform shape and quality of the holes. Considering the large number of holes required, the economy of the electron beam process is so advantageous that Japanese manufacturers of household appliances import perforated metal sheets from Germany.

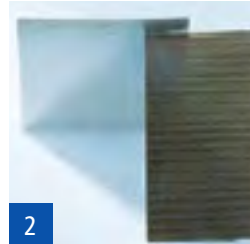
pro-beam developed a laser-beam punching technique as an alternative to the galvanoplastic manufacture of nickel sheets. Similar to electron beam drilling, punching makes it possible to use food-standard materials in the production of foodstuffs and pharmaceuticals. The manufacturers of crystal sugar use laser-punched centrifuge screens to separate refined sugar from the molasses. Until now, the sugar industry has used centrifuge screens made of nickel which are manufactured by a galvanic procedure. They are then chrome-plated to increase the useful life of the soft material.

Allergy hazard eliminated

However, the chrome plating wears off or often chips. The soft nickel is exposed, causing dangerous nickel contamination in foodstuffs and dreaded nickel allergies. Laser-punched screens made of stainless steel eliminate these problems. Although relatively expensive, they are in common use especially in South American countries, due to their long useful life.



1



2

1. Tofu screens
2. Centrifuge screens for producing sugar

Perforate with an electron beam or with laser?



Higher product quality and opportunities for optimizing manufacturing – pro-beam has perforation solutions that make good business sense

Asking one of our perforation experts for advice might be a wise step. Often, an innovative technique can solve seemingly irreconcilable conflicts. Producing fine yet extremely durable screens is not necessarily a contradiction. With pro-beam, small holes are less expensive than big ones!

pro-beam masters a number of different economic techniques for perforating sheet metal, films and other, mostly cylindrical work pieces. We have specialists for laser beam techniques for cutting, punching and drilling, in addition to our experts for electron beam drilling. We can help you develop the one solution which best fits your objectives and specifications. In particular, we discuss suitable techniques and thoroughly investigate the requirements of your task. The ultimate outcome is a solution which is both innovative and economical.

Various lines of business profit from innovative perforation solutions, such as aeronautics and space exploration as well as the textile, paper and food industries



The right holes for every filter

pro-beam electron beam drilling

Work pieces thickness:
up to 6 mm

Hole diameter:
60 µm – 1.1 mm

Typical tolerances:
90% for +/-10 µm,
98% for +/-20 µm

Aspect ratio: 1:2 – 1:20

Open areas up to 22%
(with an aspect ratio of up to 1:10)

Drilling frequencies, currently up
to 3,000 Hz, in the future up to
30,000 Hz

Incident angle hole to surface:
25° – 90°



With regard to filtration, every industry has its own, special requirements. Examples are processing tomato paste or mustard, sorting granulates, sieving laundry detergent or separating shredded plastics from metal product residue for recycling of plastics.

Due to its great flexibility, an electron beam is the ideal tool for producing various kinds of screens. This technique meets requirements which cannot be fulfilled economically with other perforation methods. It is clearly superior when a large number of holes must be drilled in thick material, with the required geometry.

For the paper industry, pro-beam produces screens for filtering cellulose fibers. The task consists of drilling many small, conically shaped holes (diameter: 0.15 to 0.20 millimeters, conically opening to around 0.4 to 0.45 millimeters), in acid-resistant material. The processed materials are up to 3 millimeters thick, because the sieves must withstand high mechanical forces during centrifuging. The small diameter of the holes ensures that very few fibers are lost. The holes open conically toward the outside, allowing the ejected liquid to run off well rather than blocking the holes.

pro-beam operates four of its own systems, with various sizes. One of them is the world's largest electron beam drilling system. Work pieces up to 1 m long and 1.20 m in diameter can be processed. With a wide range of moving and rotating jigs, in combination with CNC control any desired hole pattern can be drilled in virtually any rotation-symmetrical work piece.

Headquarters
pro-beam AG & Co. KG aA
Behringstraße 6
D-82152 Planegg bei München

Tel. +49 89 899 233-0
Fax +49 89 899 233-11
info@pro-beam.de
www.pro-beam.de