Blueacre TECHNOLOGY

Laser Micromachining Small Holes

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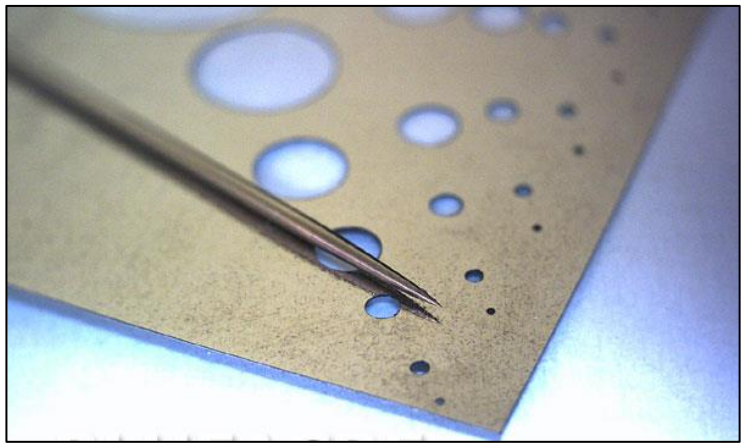
David Gillen, Blueacre Technology



Advances in industrial technology require ever-smaller holes in electronic, medical and related devices. Laser drilling achieves strict size and tolerance requirements in an economically viable process.

Numerous methods of hole production exist, with mechanical drilling, chemical etching and laser machining among the more widely used.

However, as the dimension of the hole decreases, the choice of process is more limited and the interaction of the material with the hole-forming process becomes more critical.

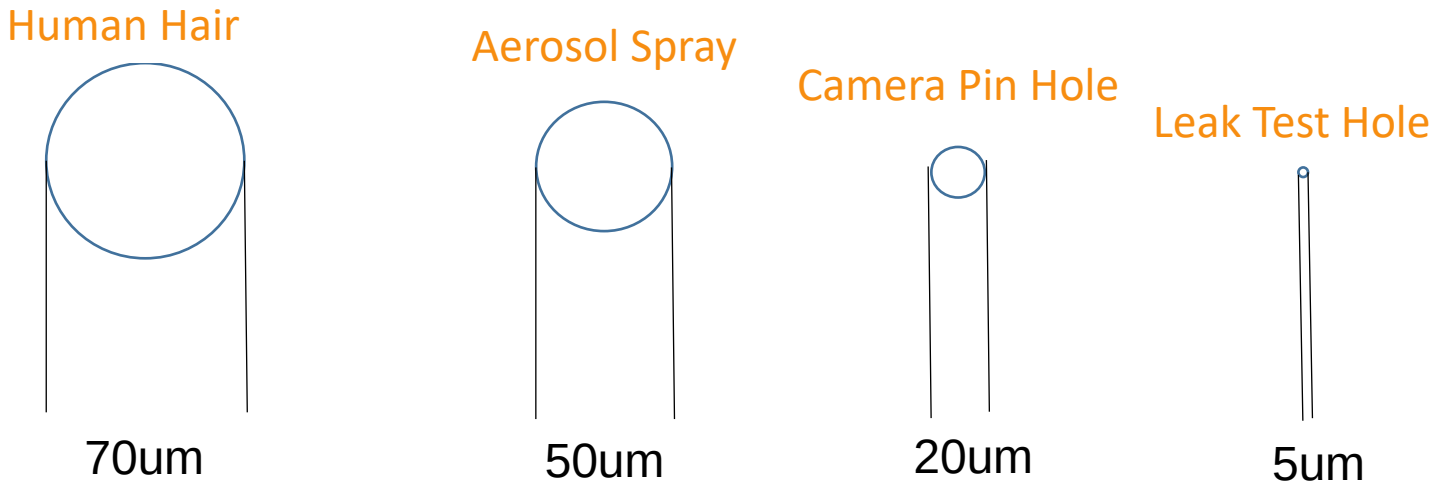
This white paper looks at various hole-drilling methods, examining the use of laser drilling techniques to make holes in diameters smaller than 10 µm.

Defining Small

Traditional methods such as mechanical hole drilling allow for the creation of features on the order of 50 to 100µm, which is roughly the diameter of a human hair.

By modern standards, these holes can no longer be described as small. Refined, repeatable, high-speed laser processes can machine holes as small as 1 µm in diameter with specialised configurations, and can easily drill below the 10µm diameter mark in a variety of materials.

To get an idea of how small a laser hole can drill, the images below illustrate the relative size of laser drilled holes against some day objects such as a human hair and a droplet from an aerosol spray.



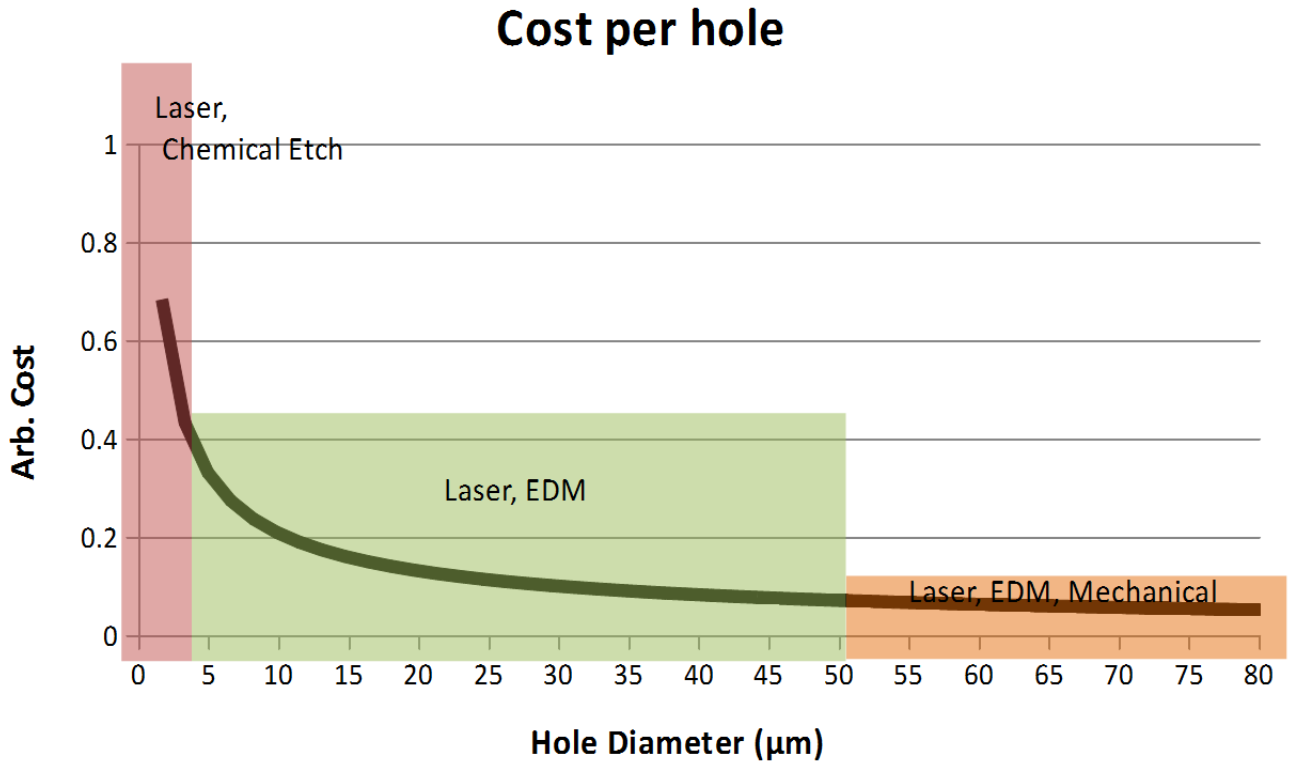
Small-hole Production Methods

There are a number of methods of producing holes in the sub 100um range. The table below outlines some of the key characteristics.

Mechanical Drilling **Tool must match hole size** **Tool small and prone to breakage** **Requires high speed spindle**	**Punching** **Punch and die matching hole size required** **Highly repeatable / scalable** **Hole diameter > thickness**	**Chemical Etching** **Requires mask / exposure/ etch** **Fine control enabled** **Can produce 1um holes** **Isotropic etch so holes have taper**
Electron Beam **Produces small holes with fine tolerances** **Limited to metals and some ceramics** **Requires vacuum**	**EDM** **Conductive materials only** **Produces holes down to 5um** **Produces fine sidewall surface** **Lower processing speed**	**Laser** **Can produce sub 5um holes** **High aspect ratio >50:1** **Higher capital investment** **High Speed – High Repeatability** **Taper can be controlled**

Cost of Production

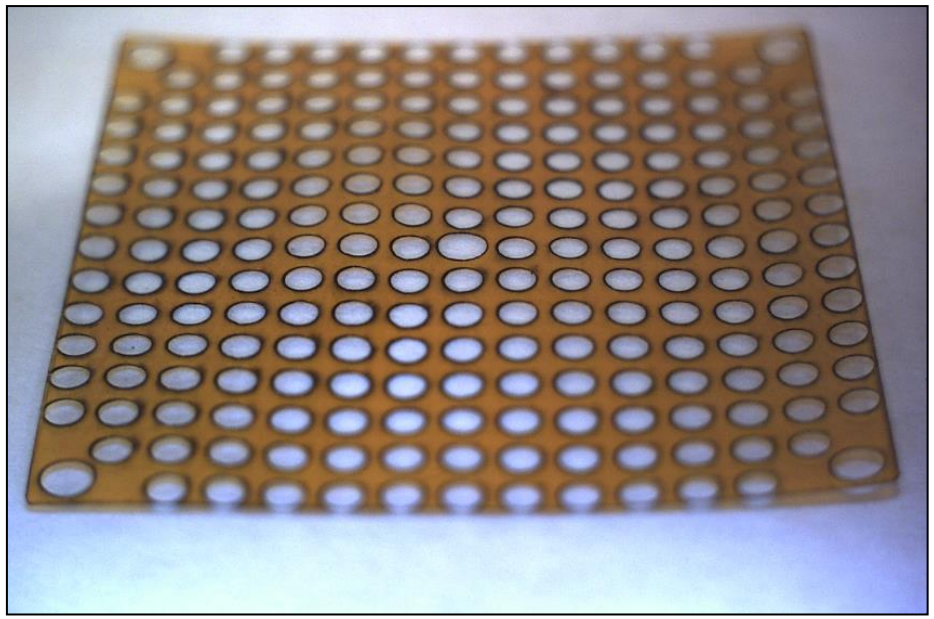
The comparative cost of different drilling methods is shown below. In general, the cost of producing a small hole rises exponentially as the hole diameter decreases. Laser is the one process that can be used to cover a broad range of diameters



Laser Drilling Advantages

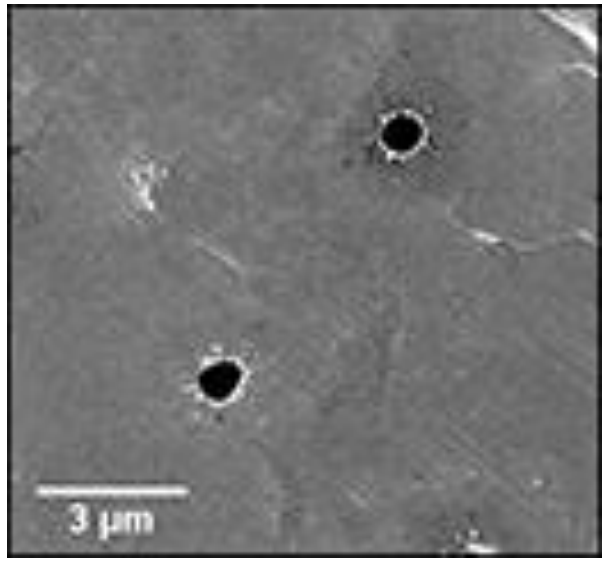
Using lasers to drill small holes has many advantages. Not only can lasers create repeatable, high-aspect-ratio holes in diameters as small as 1 µm, the noncontact process does not require additional coolants or lubricants during drilling.

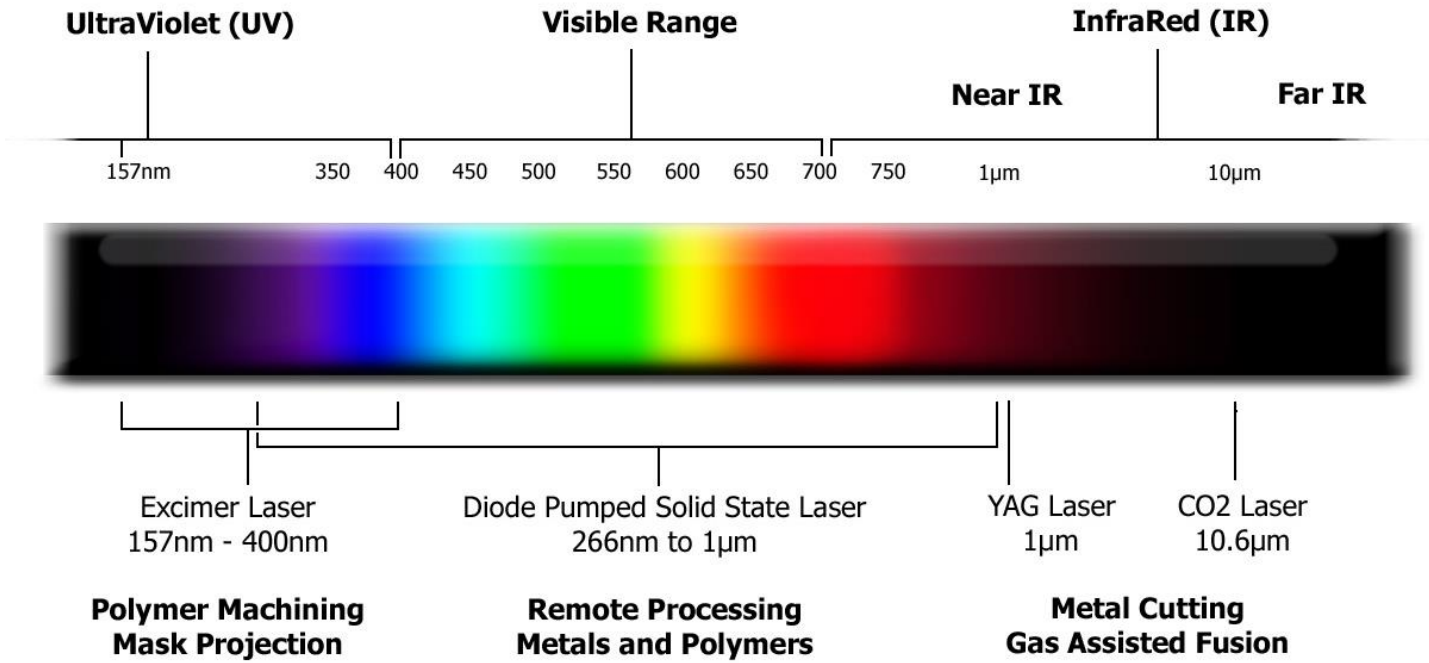
The noncontact nature of laser processing is especially advantageous when machining very thin materials that are too flexible or fragile to undergo a contact machining process.



Considerations in laser drilling small holes

One of the main advantages of using lasers for materials processing is the possibility to choose a laser source that will achieve optimal results.

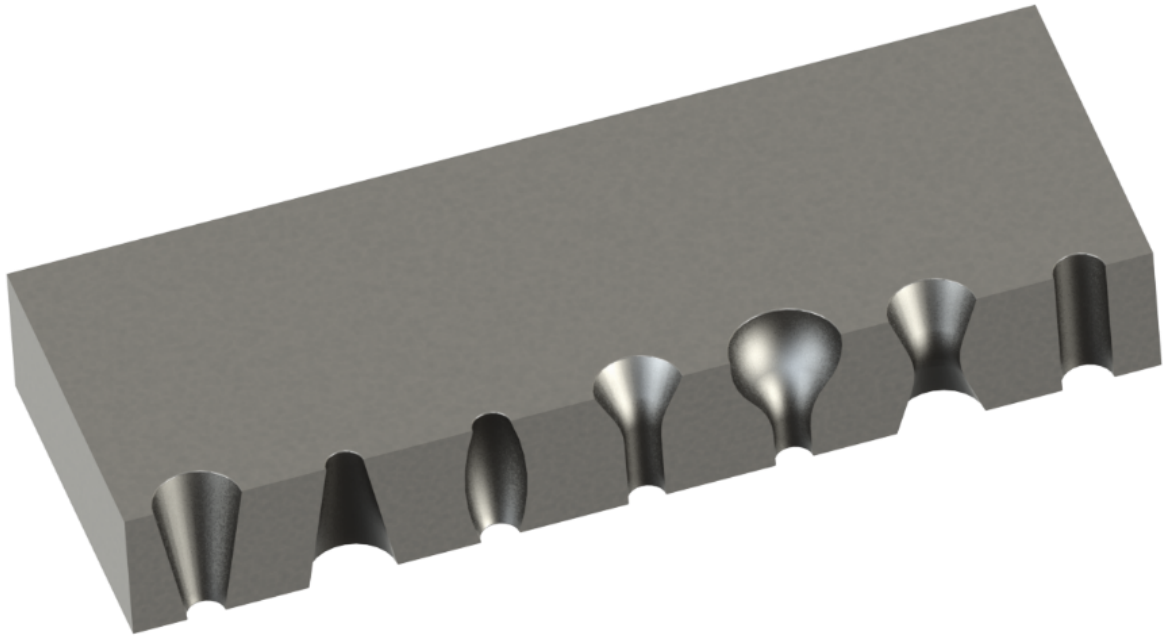


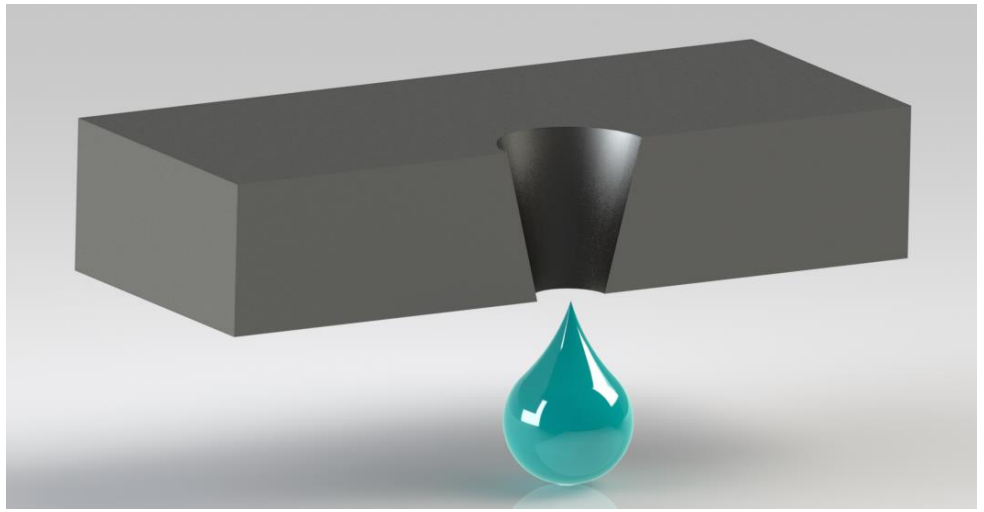


Materials absorb different wavelengths of light in different proportions, and various applications require lasers that operate in different modes, such as pulsed or continuous wave. For very fine applications, short-pulsed lasers in the nanosecond range and below tend to provide optimal results, because heat buildup during the machining process is minimised.

Shaped Holes

Another key benefit of a laser, is the ability to change the shape of the via by changing the optics. By controlling how the laser beam is delivered it is possible to provide a range of hole shapes.

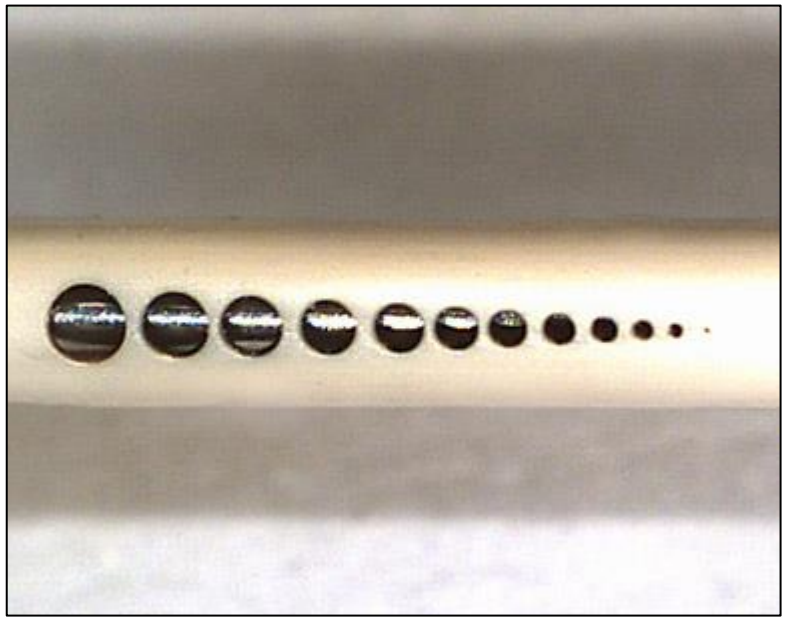


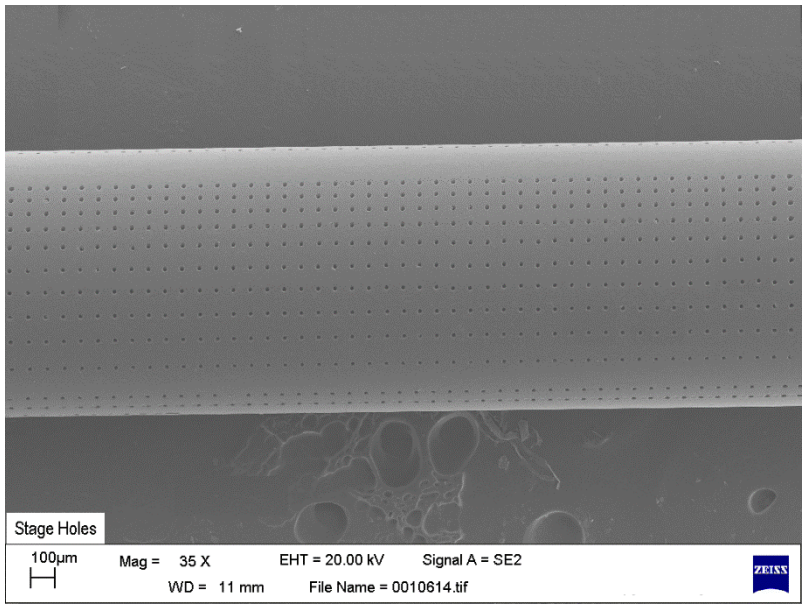


Although this can add to the cost per hole, it is a key method when using the hole to deliver fluids or vapour as the shape of the hole can control the size of the droplet formed.

Medical Applications

The ability to drill small holes in polymer and metal materials is important in medical device design. These holes can be used for collecting fluids from the body or delivering localised medicine into the blood stream

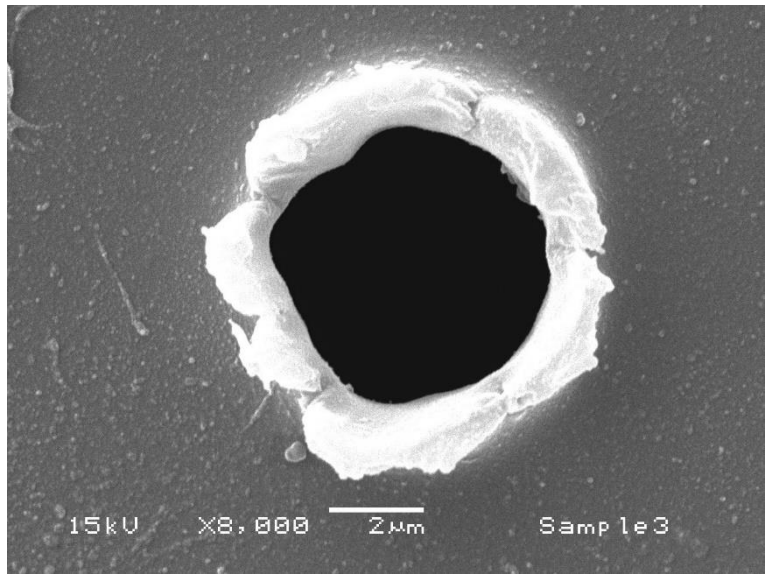




As the laser is a highly repeatable process, it is ideally suited to medical device applications, where process control is key to ensuring patient safety.

Leak Testing

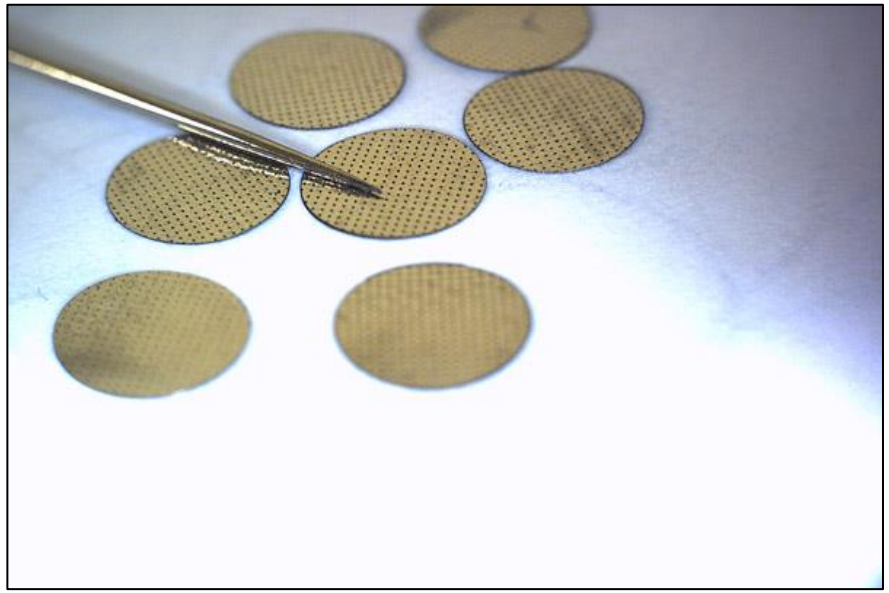
In safety critical industries, such as pharmaceutical, it is necessary to ensure the integrity of the packaging that contains the medication. The manufacturers of the packs, known as Blisters, need to ensure that their in-house test systems can pick up leaks.



To do this Blueacre Technology laser drills holes as small as 5um into the packs to simulate the tiniest of defects. Detecting these small holes gives the manufacturers confidence in their products integrity.

Filters

The laser process can be used to machine fast and repeatable arrays of micro holes in a range of materials from metal through to ceramics and polymers. These can then be used a filters in a process critical applications such as oil and gas, automotive and aerospace.



Chemically resistant polymers such as PEEK and Polyimide, which can withstand both high temperatures and chemical attack are routinely machined by Blueacre Technology.

Conclusion

Current manufacturing trends are driving the need to drill smaller holes with increased repeatability and process yield.

While there are several suitable drilling methods, such as EDM and mechanical techniques, lasers outperform them in many applications.

Because it is a noncontact process, there is less need to post processing of the drilled parts, and there is no mechanical tooling wear to consider.

Lasers afford the user the possibility to drill holes smaller than can be achieved using other techniques (1 µm) while maintaining high throughput and economic viability.

Blueacre Technology can work with you to develop laser micro hole drilling solution to meet your needs.

Contact info@blueacretechnology.com or Tel + 353 42 938 622