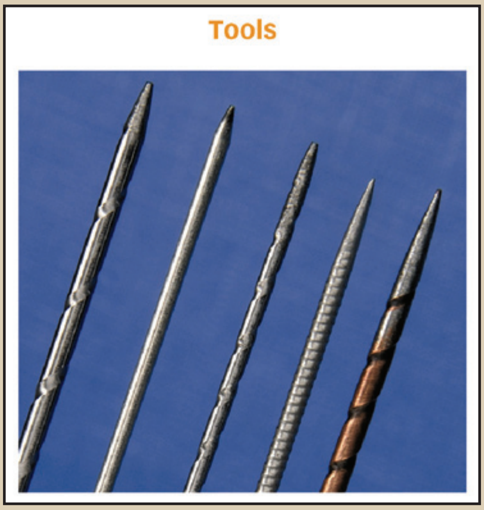
Precise and Easy Processing of the Smallest Bores

RIGHT & FAR RIGHT:
Micro Bore Sizing (MBS) system



Microcut manufactures universal and modular machines, tools, and customised solutions for the processing of small bores with diameters from 0.015 mm up to 4 mm.

The miniaturisation of products continues not only in the electronics, analytical, automotive, telecommunications, and medical sectors, but also in mechanical engineering. The market and the overall economic importance of micro technology is developing dynamically and will clearly continue to grow further in the future.

In order to miniaturise successfully, it is often not sufficient to simply make existing products smaller. Material choice, for example, must be reassessed because in micro technology, the cutting process of ductile material is critical as even the smallest burrs are not tolerable for most applications. This is also why the use of tungsten carbide, ceramics, silicon, and polycrystalline diamond (PCD) has become more and more important.

In addition, conventional manufacturing processes cannot always be down-scaled into the micrometer range, so a system change is often required.

Small Bores

In the area of micro technology, the processing of a bore represents a special challenge. Difficult accessibility of the working surface and frequently large aspect ratios (bore length to diameter) are the key challenges.

Not many manufacturing processes exist for small bore machining that give the required tolerances (form, position, measure, etc.) as well as a surface quality in the sub-micrometer range. While bore hole technologies exist (EDM, laser, ultrasonic etc.), the processes for finishing remain scarce. Often, therefore, to reach the quality demanded, bore holes require a finishing procedure.

Conventional procedures — such as internal cylindrical grinding or honing — reach their economic and technical limits for bore diameters below 1.2 mm. Reliable measuring of the bores also represents a challenge in itself in such diameter ranges.

Micro Bore Sizing

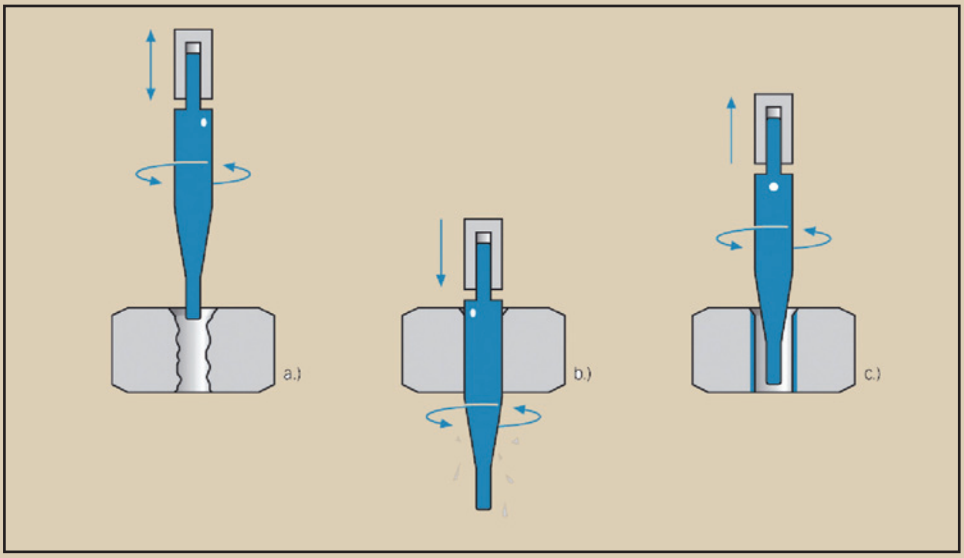
With the Micro Bore Sizing (MBS) machine range, Microcut has addressed this challenge and offers specialised and economical solutions for the processing of bores especially in hard materials, starting from a diameter of 0.015 mm.

The Microcut technology exhibits some key advantages, such as easy handling to bring geometry (diameter, roundness, cylindricity) into close tolerance fields, and high quality surface roughness. The company offers customer-friendly solutions consisting of machines, tools, and services.

The machining takes place via an abrasive moulding of an exact tool in the work piece. With the conical part of the tool the raw bore is enlarged and with the cylindrical part a consistent diameter range is achieved. Together with the working movements of the power-sensitive machines, the specifications can be automatically reached. The obtained surfaces and accuracies, as well as the attainable qualities, are comparable to those achieved in lapping technology. By the machine cutting (cold) process, no structure-conditioned material attenuation of the edge zones occurs.

The tools play an important role in the Micro Bore Sizing system, and it is because of their accuracy that the precision of the diameter is reached. Furthermore, it is the choice of the tool that governs the surface roughness and the material removal rate.

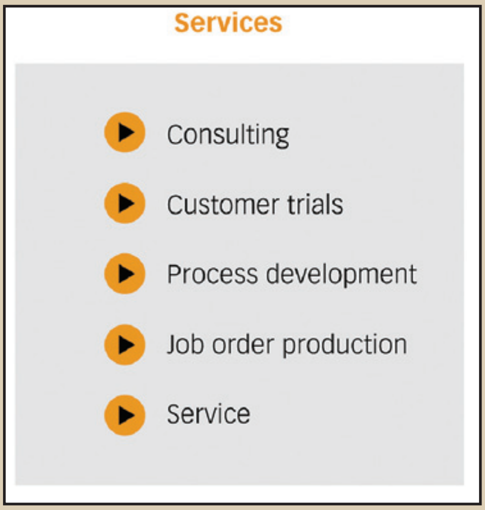
Two different processes can be undertaken using different tools on the UniBore 800.

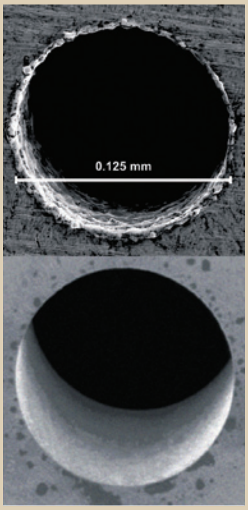


Process of Micro Bore Sizing (MBS)

RIGHT:
Part of the Micro Bore Sizing (MBS) system

FAR RIGHT:
Raw bore by fine EDM, finished bore by MBS





First, machining with a lapping process using loose grit. The tool consists of a carrier rod, carrier liquid, and an abrasive (typically micro diamond). The carrier rods are conical on one side and cylindrical on the other, and can be supplied either at standard or customised accuracy.

Second, a honing process with bonded grits. The rod is shaped the same as in the lapping process, the differences being in the grit size and in the fact that the grits are fixed to the rod.

In general, the honing process is favoured for softer materials such as steel. The lapping process is suitable for brittle-rigid materials and achieves good surface roughness.

Criteria During the Machining Process

It is well known that dimension, form, and surface are all linked.

Form. The dimensional accuracy is determined by the tool and then improved by overlaying movements (rotation and translation), so that the roundness of the finished bore typically turns out more exact than those of the tool. For example, a roundness of << 0.5 μm can be achieved for ferrules (key components in a fibre optic connector). The nozzle bore in the figure below left was made by conventional machining with a twist drill and exhibits a roundness of 5 μm. With the finishing process using the MBS method, a roundness of 0.65 μm can be reached.

Diameter and accuracy. Using the MBS method, the finishing from the starting diameter to the desired final diameter is achieved and then after this, a closer tolerance field is reached. For the ferrules, the requirement concerning diameter and hole length of approximately 10 mm is given as Diamater = 125 μm +1/-0 μm. The diameter tolerance of the steel nozzle in shown below could be improved from +/- 5 μm to +/- 1 μm.

Surface roughness. The figure above right shows the surface difference of an eroded bore in steel with a roughness value Rz of 2 μm (fine-EDM), and an optimised surface by means of MBS of 0.2 μm. The surface quality obtained using the MBS technology can be adjusted through the choice of process and the diamond grit size. In theory, the finest possible surfaces can be achieved using hard materials. For example, a surface quality of 0.12 μm with a relatively high stock removal rate can be achieved for a tungsten carbide stencil.

Material and Work Pieces

Typical products that can benefit from the MBS process are nozzles, tubes, and bushes. With the UniBore 800, small bores can now also be machined in large non-rotationally symmetrical work pieces as are typically used in the die cutting and injection moulding tool construction industry. Electrical conductivity is not relevant, so non-conducting materials can be machined. MBS is most suited to hard materials such as ceramic(s) or tungsten carbide, but the machining of softer materials like steel or glass is possible. The areas of application extend from the tool construction, fibre optics, medical, and semiconductor industry to the automotive industry.

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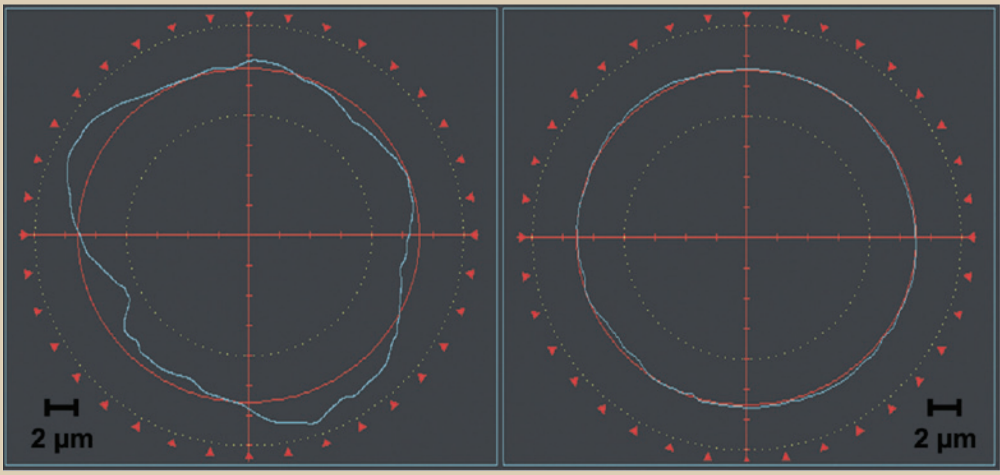

Roundness of the bore of a nozzle before and after MBS