

# COMPACT LASER CUTTING HEAD WITH HIGH-POWER OPTICS MADE OF SYNTHETIC MONOCRYSTALINE CVD DIAMONDS

## Task

Highly dynamic cutting applications require compact machining heads for medium laser power in the kW range. Conventional optical materials such as quartz or optical glass have only limited suitability for these applications. Compared to established materials, monocrystalline synthetic CVD diamond has a variety of outstanding properties, such as high hardness, thermal conductivity and a high refractive index. Since diamond has such advantageous thermal properties, the optics can be efficiently cooled even at very large power densities. Moreover, the high refractive index makes it possible to build optical systems with significantly fewer lenses. Compared to polycrystalline diamond, monocrystalline synthetic diamond is better suited for the low-loss shaping of laser radiation at a wavelength of 1 µm.

## Method

The research presented here focused on reducing the size and weight of the cutting head by optimizing its mechanical and optical design. So that the installation space could be minimized, the fiber end is imaged onto the workpiece with an optical group instead of a conventional arrangement consisting of collimator and focusing unit. The diamond lenses have an anti-reflective coating, and the lens mount is water-cooled, allowing reliable lens operation even at high power densities.

## Results

This cutting head is more than 90 percent lighter than conventional compact cutting heads. In the first application trials, a stainless steel sheet with a thickness of 1.5 mm was cut with diamond optics and a single-mode 1 kW fiber laser.

## Applications

In addition to the demonstrated application of diamond optics in the field of laser-beam cutting, this optical system can be used in all applications in which compact machining systems are advantageous with high laser power in the multi-kW range. These include additive manufacturing processes such as laser material deposition.

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*1 Synthetic monocrystalline diamond lens.*

*2 Laser cutting test with the machining head.*



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DQS certified by DIN EN ISO 9001, Reg.-No.: DE-69572-01