FORM CUTTING OF BRITTLE CARBON MATERIALS

Task

When conventional manufacturing methods, such as mechanical cutting or grinding, are used to process hard and brittle materials, such as diamonds or other forms of carbon or ceramic materials, uncontrolled ruptures often result due to mechanical stresses introduced into the component. The resulting microcracks lead to unwanted ruptures and corresponding contour deviations. Depending on the processing method, contour cuts can only be done to a limited extent. The use of ultra-short pulsed lasers often provides the desired cutting results, but is very slow or cannot be used for materials having a thickness in the range of several millimeters. To reduce the process time, the suitability of fiber lasers in multi-kilowatt power range shall be investigated.

Method

So that the thermal influence is kept low, the laser beam of a fiber laser (up to 4 kW power laser) is guided at high speed (3 - 5 m/s) over the workpiece. Galvanometer scanners were used for a stationary workpiece and a 2D handling system with fixed optics for a moving workpiece. The process strategy used was to pass over the component multiple times while resetting the focal position and varying the trace offset.

Result

The process generates high-quality cut edges while only causing minimal damage to the material thanks to short interaction times. This way, 4 mm thick cylindrical specimens of graphite were cut out of a layered graphite body at an effective rate of 15 mm/s, while preserving the material and preventing flakes from forming. In addition, the sample surfaces were leveled with the same laser system. Similarly, good results were achieved in the processing of »black diamonds«.

Applications

In addition to working with pure carbon, this flexible laser process can also be used on other difficult, hard and brittle materials, such as ceramic matrix composites (CMC).

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1 Cylindrical sample cut out of a layered graphite body (thickness 4 mm).

2 Laser-cut »black diamond« (Ø ~ 6 mm).

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