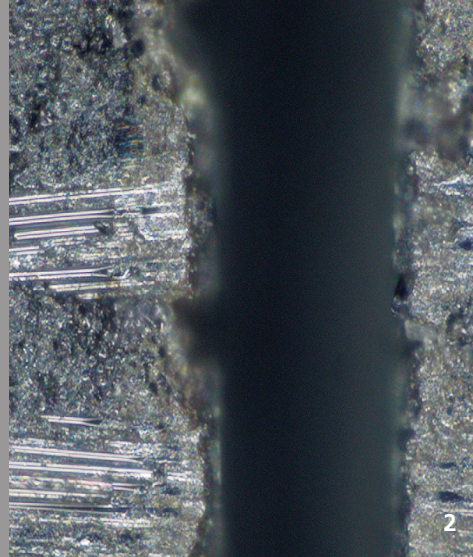




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CUTTING CERAMIC MATRIX COMPOSITES (CMC)

Task

Ceramic matrix composites (CMC) form a young group of materials in which ceramic fibers are embedded in a ceramic matrix, thereby increasing the ductility and crack resistance compared to conventional technical ceramics. The high-temperature and abrasion-resistant CMC materials are used in aerospace and turbine construction, among others. Since the mechanical properties of CMCs make machining them extremely difficult, laser cutting provides manufacturing advantages over conventional processes such as milling or drilling thanks to its wear- and force-free operation.

Method

For the CMC materials Al_2O_3/Al_2O_3 and SiC/SiC, Fraunhofer ILT has investigated cutting methods with cw fiber lasers. It has examined both remote cutting with a scanner in multi-pass ablation as well as gas-assisted cutting with conventional focusing optics and direct formation of a continuous kerf on a 3–4 mm thick sample material. Using laser powers of up to 5 kW, the institute developed a parameter field that leads to economical processing times.

Results

With both cutting methods, the materials can be separated without cracks and at cutting speeds in the range of several meters per minute. Clean cut edges are achieved primarily with cutting gas support, which minimizes the re-deposition of ablated products on the cut surface. Only a thin, non-continuous recast zone is formed with SiC/SiC.

Applications

Due to its high material costs, CMC is mostly used for high-tech applications in aerospace and plant construction. As cost-effective and reliable laser-based processes become available, however, this technologically promising group of materials can be used by a wider range of industrial sectors.

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1 Bore hole with \varnothing 10 mm in Al_2O_3/Al_2O_3 .

2 Cross section of the kerf (detail).