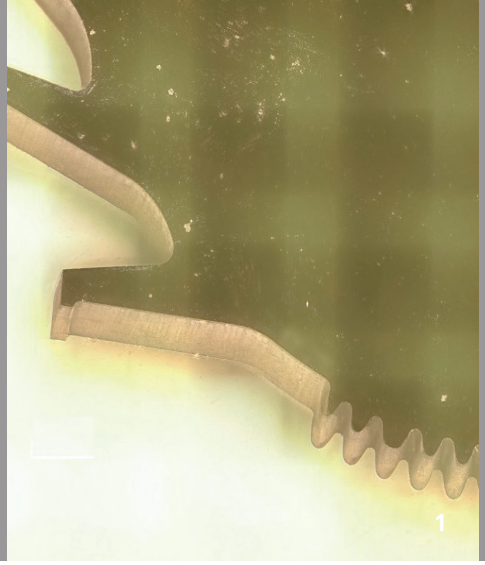

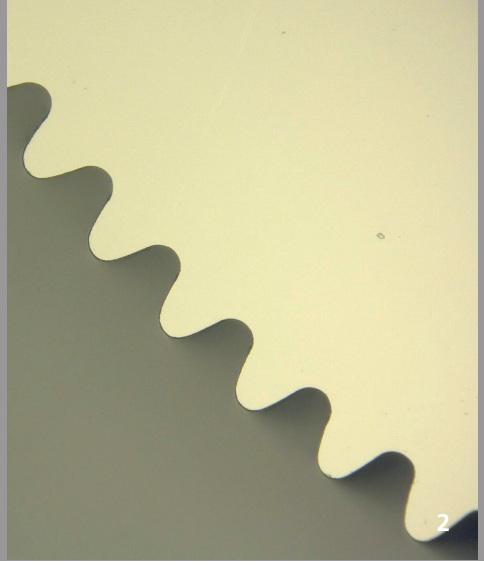

PRECISION HELICAL CUTTING OF DIELECTRIC MATERIALS WITH LASER RADIATION

Task

Manufacturing technology is faced with special challenges when it has to precisely separate dielectric materials such as glass, ceramics, sapphire, etc., due to their material properties like extreme high hardness and brittleness. The cut edge quality (depth of striation, rectangularity and burring) is critical to how well precision mechanical components function. Laser cutting, especially with ultrashort pulse lasers in the femtosecond and picosecond range, makes it possible to process these materials flexibly and with high quality.

Method

Compared with the classical laser cutting process, a new process – helical cutting – was used to cut the dielectrics. Here, the laser beam is placed in circular oscillation and, thus, not only takes over the cutting process, but also an evaporation-based reworking of the cut edge. With helical optics mounted on a rotating Dove prism and a frequency-doubled ps laser, precision cuts can be generated in different thicknesses of ceramics, silicon and sapphire.

Fundamental parameters such as feed rate, gas pressure, power and oscillation can be tuned depending on the material thickness. The width of the cutting kerf can be adjusted in the range of about 30 µm to 200 µm by varying the angle of incidence and of the helical diameter of the laser beam in the drilling optic. Laser scanning microscopy is used to analyze the cut edge.

Result

The new helical cutting method can be deployed to make edge-defined and rectangular precision cuts in 0.5 mm thick silicon with minimal furrow and burrs. Thanks to ultra-short pulse lasers and optimization of the laser parameters, the ablated material evaporates, so no recast layers and melt deposits can be detected. The roughness Ra of the kerf is < 0.8 µm.

Applications

Precision helical cutting can be applied mainly in areas where a high cut-edge quality is required. In particular, the process can close the gap between etching and mechanical production in terms of quality and productivity both in the watch industry and in the production of micro-mechanical components.

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1 Precision cutting of 0.5 mm silicon.

2 Overview of the cut edge.

3 Cross-sections of 0.5 mm ceramic.

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