# Surface structuring of ceramics using laser-profiled grinding wheels with assist of embedded metrology

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**Abstract**

Structured surfaces play an increasingly important role in optics and electronics, biomedicine, and the energy field due to their novel properties such as super-hydrophobic, optical tuning, antifouling and drag reduction. Grinding with laser-profiled wheels is a creative manner to generate microstructures on brittle materials. To generate deterministic microstructures on glass-ceramic, an optimized laser processing strategy is proposed for shaping the diamond grinding wheel with high form accuracy and an embedded metrology system is integrated into the grinding environment to assist the toolsetting and compensation machining. Besides, major geometric errors of the XZC type ultra-precision machine tool is identified using Monte Carlo simulation considering the characterization of the on-machine sampling path and measured by the self-developed measuring platform. The shape transferability of the grinding wheel, in terms of the minimum groove width, spacing, and grinding performance, are investigated through a series of grinding tests with the assistance of embedded metrology. Results indicate that the proposed laser texturing strategy can effectively overcome the thermal deviation and optical path error of the laser marking head and ensure the high form accuracy of the laser profiled grinding wheels. The minimum groove width and spacing that can be accurately shaped by the nanosecond laser are 150 µm and 160 µm, respectively. With the assistance of the integrated on-machine surface measurement system, micro grooves and pillar arrays with varying spacing (180 µm to 230 µm) and heights (20 µm to 100 µm) are deterministically fabricated on the ceramic sample, and the maximum aspect ratio of 3.8 is achieved. The proposed method enriches the toolbox for the surface structuring of brittle materials.