Polarization controlled crack propagation in Bessel beam processing of soda-lime glass

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The control of laser-induced transverse crack propagation direction in the volume of material is essential for Bessel beam glass scribing processes. By controlling the laser induced crack direction in the way, that the transverse cracks align in parallel to the glass dicing direction it is possible to reduce the side wall surface roughness, increase the scribing speed and reduce the glass workpiece separation force [1]. The most common way to induce controlled transverse cracks is to control the generated Bessel beam asymmetry by shaping the beam with various phase or amplitude based optical elements [1–3] or take advantage of imperfect axicon geometries [4].

In this paper, we demonstrate the possibility to generate polarization controlled directional transverse cracks which is more appealing for industrial applications. The experiments were performed with FemtoLux 30 femtosecond laser from Ekspla operating at 1030 nm wavelength with pulse burst option. The Gaussian beam was converted to Bessel beam via commercially available axicon. The half-wave plate was introduced at the laser beam path before the axicon to control the beam polarization.

We will show that the linear polarization angle corresponded to the crack angle when scribing of a 1 mm-thick glass sample. This allowed us to control the transverse crack direction during laser scribing. We will also present results on scribing with linear polarization orientated in parallel and perpendicular to scribing direction, compare the results with circular polarization for Bessel beam scribing. We will conclude that polarization controlled transverse cracks allowed us to increase the dicing speed and reduce the glass workpiece separation force. Finally, we will demonstrate 4.8 mm glass workpiece dicing with 80 mm/s throughput at single pass regime.

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