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Glass processing with different techniques

Juozas Dudutis[a], Jokūbas Pipiras[a], Paulius Gečys[a,*]

[a]*Center for physical sciences and technology, savanoriu Ave. 231, LT-02300, Vilnius, Lithuania*

Abstract

Precision, speed and quality makes laser glass processing a very attractive technique for industry. However, other conventional technologies such as mechanical dicing (score and brake method), diamond saw and water jet cutting are widely used in industry. For this, we conducted a comprehensive investigation to validate the laser based technology processing in respect to conventional technologies. Two laser glass processing techniques were investigated – rear side glass processing with tightly focused nanosecond laser pulses and sub-nanosecond laser dicing with Bessel beam. Furthermore, three conventional glass processing technologies were also considered – diamond saw cutting, mechanical dicing and water jet cutting. Sample processing speed, quality and component resistance to the mechanical load was investigated. In this work, in-depth investigation of these effects will be introduced.

Keywords: Glass; laser processing; Bessel beam; mechanical processing; water jet processing;

1. Introduction

The laser based transparent material processing has emerged as a very attractive tool for industrial applications. Rear-side glass processing and Bessel beam dicing techniques have already demonstrated their potential in precise processing applications (Dudutis et al., 2019, 2018, 2016; Gečys et al., 2015; Rapp et al., 2017; Stoian et al., 2018; Tomkus et al., 2019, 2018). Precise and confined laser energy deposition into the transparent material can ensure high resolution processing together with low damage of the surrounding material. Thus, the laser based technology can provide processes, which are not possible to perform with

* Corresponding author. Tel.: +370 5 2644868; fax: +370 5 260231.
E-mail address: p.gecys@ftmc.lt.

conventional techniques. With evolution of modern industrial lasers, the laser based glass processing techniques can ensure high throughput together with optimal processing quality. However, no comprehensive studies were carried out to compare laser based processing versus conventional. Therefore, this paper is dedicated to compare laser based glass processing techniques with the most common conventional techniques – diamond sow cutting, mechanical dicing and precision water jet cutting.

2. Experiment

In order to evaluate various glass cutting methods, tests soda-lime glass samples of 1x5x45 mm^3 were processed with investigated technologies. No further post processing steps were performed. More details on laser based processing with Bessel beam and rear-side cutting can be found in (Dudutis et al., 2019) and (Gečys et al., 2015), respectively. In the case of conventional mechanical processing, samples were cut with commercially available technologies (diamond saw cutting, mechanical dicing and precision water jet cutting). Samples were characterized in terms of surface chipping and part resistance to the mechanical load. The optical microscope images of surface chipping after glass cutting process is presented Fig. 1.

Laser technology		Conventional technology		
Bessel beam dicing	Rear-side cutting	Mechanical dicing	Diamond saw cutting	Waterjet cutting

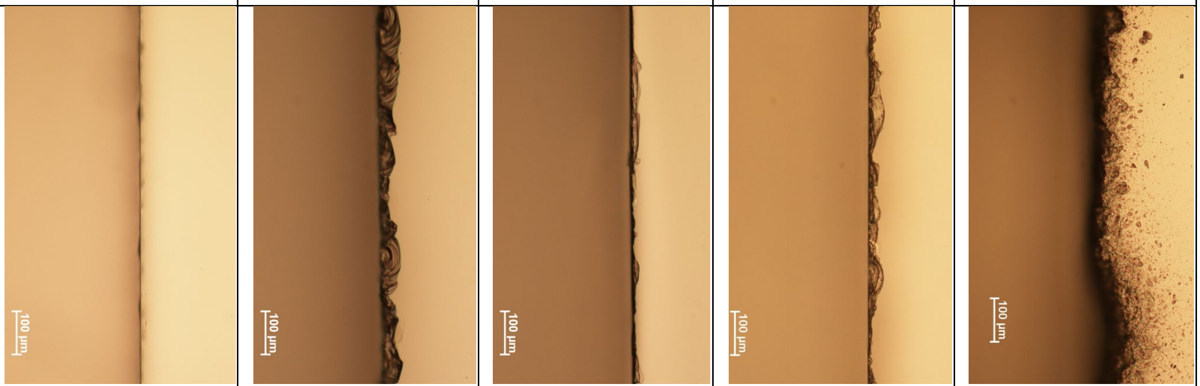

Fig. 1. Optical microscope images of glass samples cut with different technologies.

The best processing quality was observed for the Bessel beam dicing technique. This technology provided the lowest surface chipping with average crack size of <35 µm. However, such technology is attractive for straight of low-curvature cutting applications. The rear-side laser cutting technology is much more flexible, cutting and milling of complex shape structures is possible with high resolution. However, the surface chipping is increased up to 130 µm compared to Bessel beam processing. Both laser technologies ensured taper-less cutting with perpendicular side-walls to the glass surface. In the case of conventional technologies, the mechanical dicing showed the best quality. The surface chipping was up to 110 µm. However, the side wall waviness was much higher compared to laser based processing. The Diamond saw dicing provided average surface chipping of 110 µm. The lowest processing quality was observed for water-jet cutting. Burr formation with deviations from the cutting trajectory was observed in particular case. The average surface chipping was in the range of 160 µm.

The sample bending tests were performed for the rear-side laser cutting and mechanical dicing techniques. The test showed, that the laser cut samples flexural strength was 80 MPa in average, while mechanically diced samples showed flexural strength of 140 MPa in average. Unfortunately, bending tests for other technologies are still on-going and cannot be presented in this conference proceeding.

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