Cutting soda lime silicate glass using ultra-short-pulsed laser filamentation: phenomenological description of the cleaving process.

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Abstract

Utilizing ultra-short-pulse laser filamentation of glass is one of the latest developed techniques to cut glass. In comparison with other techniques the superior benefits are a small heat-affected zone, a quasi-non-gap cut, and the possibility to free from cut.
However, despite the large interest in the laser/glass interaction for various laser sources and pulse durations, the process of cleaving and the underlying mechanisms are fairly undescribed. In this study, we utilized a Nd:YAG laser with an average power of 100 W, a center wavelength of 1,064 nm, and a pulse duration of 12 ps via a specially designed optic to generate laser filamentation in soda-lime- and borosilicate glass with varying Pitch and Burst parameters. The filaments and cut edge are analyzed with scanning electron- and laser scanning microscopy to study the topological phenomena and roughness.
Photoelastic measurements were done to assess the stress distribution within the glass and show cumulative interactions at the filament extremity. From the observations made, phenomenological models are proposed to describe the initial micro crack formation considering the shock wave and thermal influence caused by the laser pulses. Two types of micro cracks are identified, with radial cracks passing through the filament and bypass cracks that form around the laser-affected zone. Models are elaborated for both glass types to evaluate the influence of a parameter change on the micro crack formation and the cleaving guidance. The different behavior between soda-lime- and borosilicate glass, with their distinct physical properties, helps to interpret the influence of laser parameters on the micro crack formation and the cleaving guidance.

Keywords: pulse laser, glass cutting, cleaving process

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