INVESTIGATION OF THE LASER SCRIBING CAUSED DAMAGE TO THE METAL COATING OF THE TRANSPARENT MEDIA

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In recent decades laser has proven to be a versatile tool for cutting, drilling, ablating and micro-processing a variety of engineering materials [1]. Pulsed lasers provide submicrometre precision due to reduced heat diffusion related to fast laser–matter interaction, thus it is great for cutting transparent substrates with coated thin layers on them [2].

In this work we present, to our knowledge, previously little studied phenomena of laser beam causing damage to the back-side coating layer of the transparent media at the large distances from the scribe line (comparing to the laser beam spot-size). While laser scribing 1 mm thick fused silica glass with 30 nm-thick gold layer, ablated area in gold approximately 0.9 mm away and parallel to the laser beam was observed (Fig. 1).

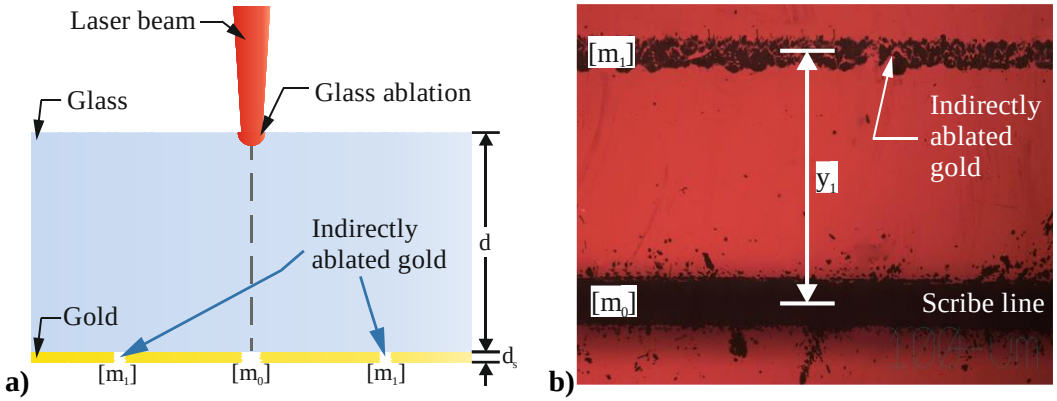

Fig. 1. (a) – Scheme of laser cutting of glass with gold thin film, deposited on the back-side, and ablated areas alongside the scribe line, (b) optical microscope image of the damage alongside the scribe line, y_1 – distance from directly and indirectly ablated lines.

In order to further investigate this phenomena picosecond pulsed laser (λ_{IH} = 1064 nm, λ_{IIH} = 532 nm) with galvanometer scanner were used. Experiments varying glass thickness, gold film thickness, laser wavelength, laser polarization and beam angle of incidence were performed (Fig. 2).

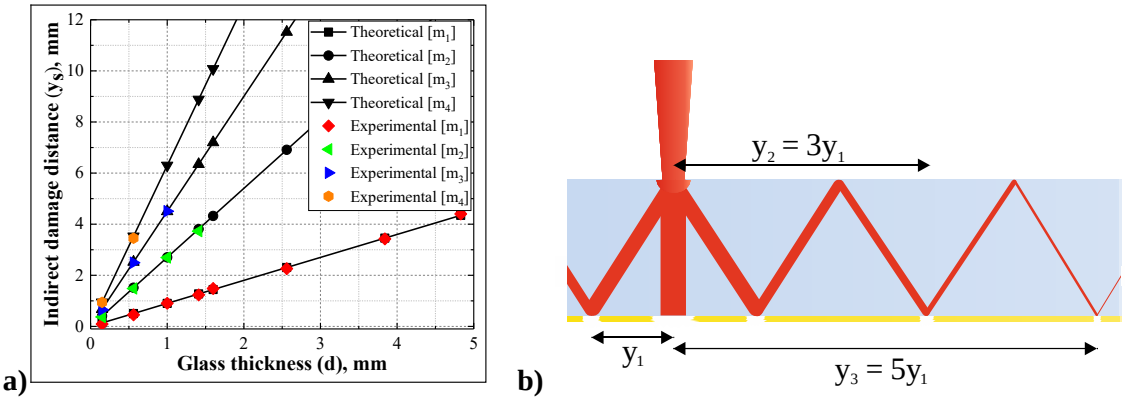

Fig. 2. (a) – Relationship between the Indirect damage distance from the center of the scribe line and glass thickness; several lines of indirect damages were seen when using glass thinner than 2 mm, (b) illustrates how these lines may be formed by diffraction and reflection.

Theoretical calculations of Fraunhofer diffraction were performed and compared with the experimental data. It was concluded, that indirect ablation of thin gold layer is due to the laser beam diffraction from the glass ablation area, where laser beam interaction with the medium reduces its transparency.

[1] G. Račiukaitis et al., Use of high repetition rate and high power lasers in microfabrication: How to keep the efficiency high?, *Journal of Laser Micro Nanoengineering* **4**(3) (2009): 186–191, doi:10.2961/jlmn.2009.03.0008.

[2] J. Hermann et al., Comparative investigation of solar cell thin film processing using nanosecond and femtosecond lasers, *J. Phys. D: Appl. Phys***39** (2006): 453–460, doi:10.1088/0022-3727/39/3/005.