

## Improvement of Two-photon Polymerization Resolution of SU-8 by GHz Burst Mode Femtosecond Laser

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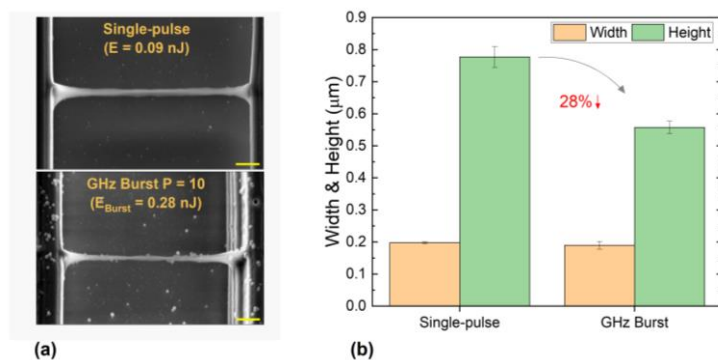
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In recent years, many research efforts have focused on fabricating high-resolution polymerized three-dimensional structures using two-photon polymerization (TPP) of SU-8 photoresist for constructing functional microdevices [1]. The resolution of TPP is greatly influenced by laser parameters and localized photoexcitation in the laser focal spot [2]. Over the past decade, laser processing with GHz burst pulses of femtosecond (fs) pulses has attracted great attention for improving performance of laser-induced microfabrication due to the ability of efficient laser-material interaction with multiple fs pulses at GHz repetition rates in burst pulses [3].

This study investigates the TPP of SU-8 using a green-wavelength (515 nm) GHz burst mode fs laser. We show superiority of the GHz burst mode over the conventional single-pulse mode for improving the fabrication resolution when fabricating SU-8 suspended polymerized lines. As Figure 1(a) shows, for the GHz burst mode laser processing with an intra-pulse number of  $P = 10$  (10 pulses in a burst pulse), the polymerization threshold energy of intra-pulses is  $\sim 69\%$  smaller than that of the single-pulse mode. The experimental results reveal that for the polymerized lines with a length of  $\sim 10 \mu\text{m}$ , the TPP resolution along the beam axis is improved by  $\sim 28\%$  using the GHz burst pulses (Figure 1(b)).



**Figure 1.** (a) SEM images ( $30^\circ$  tilted view, scale bar:  $1 \mu\text{m}$ ) and (b) comparison of width and height of the SU-8 polymerized lines fabricated by single-pulse mode and GHz burst mode ( $P = 10$ ) laser processing at the polymerization threshold energies of 0.09 and 0.28 nJ, respectively.

[1] P. Golvari, and S. M. Kuebler, *Micromachines*, 12, 472 (2021).

[2] E. Skliutas, et al., *Nanophotonics*, 10, 1211-1242 (2021).

[3] K. Sugioka, K. Obata, and S. Kawabata, *Laser-based Micro- and Nanoprocessing XVII*. SPIE (2023)