29p-D2-9

Experimental and theoretical investigation of physical mechanism of ultrafast laser glass microwelding

理研 [1]　○呉 思竹 [1]，杉岡 幸次 [1]，緑川 克美 [1]

RIKEN [1], °Sizhu Wu[1], Koji Sugioka[1], Katsumi Midorikawa[1]

E-mail: wusizhu546@163.com; ksugioka@riken.jp

Recently, glass microwelding induced by femtosecond laser has attracted great interest because of its potential applications, such as microelectromechanical systems, precision machinery, healthcare, and small satellites. Several research groups have successfully demonstrated glass microwelding using ultrafast laser pulses [1] realized the welding between two pieces of silica glass without the insertion of an intermediate layer by femtosecond laser pulses. In our previous work, we firstly demonstrated high efficiency microwelding of photostructurable glass by double femtosecond laser pulses. The bonding strength by double pulse irradiation was approximately 22% greater than that of a sample prepared by conventional single pulse irradiation[2]. Here, we experimentally and theoretically investigated the underlying physical mechanism by measuring the transmittance of the laser pulse under different laser power.

An amplified femtosecond Er-fiber laser system (IMRA America, FCPA μJewel D-400) generated 360-fs pulses with a wavelength of 1045 nm at a repetition rate of 200 kHz was used in our experiment. The delay time was controlled by adjusting the optical path in the optical delay circuit using a high precision stage and it was confirmed by cross-correlation. The first and second pulses had a equal pulse energy of 0.75uJ. The substrates used were a commercially available photosensitive glass (Foturan; Schott Glass Corp.) that consists of lithium aluminosilicate doped with trace amounts of silver, cerium, sodium, and antimony. Figure 1(a) showed the dependence relationship between the transmittance and the probe energy. We can find that the transmittance decreased from 66.2% to 23.6% as the probe energy became big at the delay time of 15 ps. The variation at different probe energy is believed as the combined actions of femtosecond laser-induced one, three and four photon absorption according to the theoretical simulation [Fig. 1(b)].

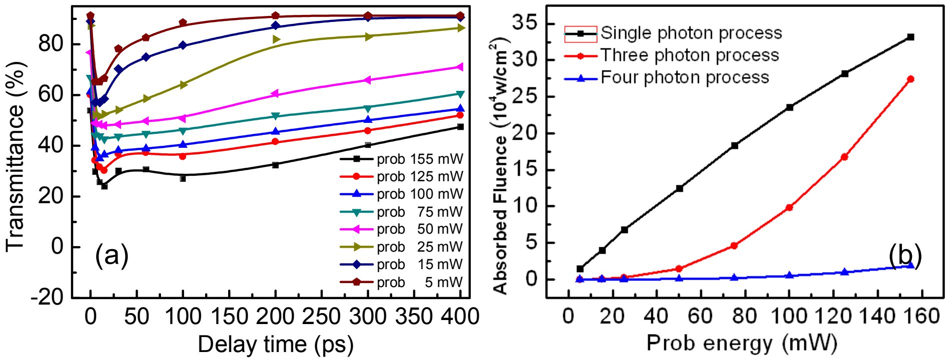

Figure 1. (a)The laser transmittance under different probe energy. (b) The theoretical simulation of the absorption

[1]T. Tamaki, et al., *Jpn. J. Appl. Phys.* **44**, L687 (2005). [2]K. Sugioka, et al., *Opt. Lett.* **36**, 2734 (2011).