IMPROVED SEAM STRENGTH IN ULTRASHORT PULSED LASER WELDING OF GLASSES VIA INTERFACE PRE-ROUGHENING

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Laser-based glass welding is a joining technique that enables the formation of strong, hermetic joints by inducing highly localized melting in transparent materials through controlled laser-matter interactions, making it suitable for high-precision and long-term reliable applications [1]. The non-optical contact glass welding technique enables welding of glasses with interface gaps of up to several micrometres [2]. In addition, the use of relatively loose focusing can be employed, allowing the use of fast galvanometer scanners [2]. However, loose focusing shifts the welding process towards higher pulse energies and average power levels, often exceeding several watts [3]. These elevated power levels can lead to increased heat accumulation, resulting in higher residual stresses, more pronounced chipping and cracking, weakening the seam strength. Fortunately, glass surface pre-roughening has been shown to enhance laser absorption [4], potentially enabling lower welding power levels at non-optical contact welding conditions.

This study investigates non-optical-contact multi-scan welding of two 1 mm thick soda-lime glass plates using an ultrashort pulsed laser operating in burst mode at a wavelength of 1030 nm. Both the glass pre-roughening and welding processes were realized using the same laser source. Transition between the two regimes was achieved by adjusting the incident laser power and laser beam scanning strategies. After welding, longitudinal tensile tests were performed to determine the weld strength, while optical microscopy was used to evaluate the weld morphology.

The results (see Figure 1) demonstrate that glass interface pre-roughening improved weld strength compared to standard welding without the roughening step. Moreover, pre-roughening reduced the optimal laser power levels, increasing welding process efficiency.

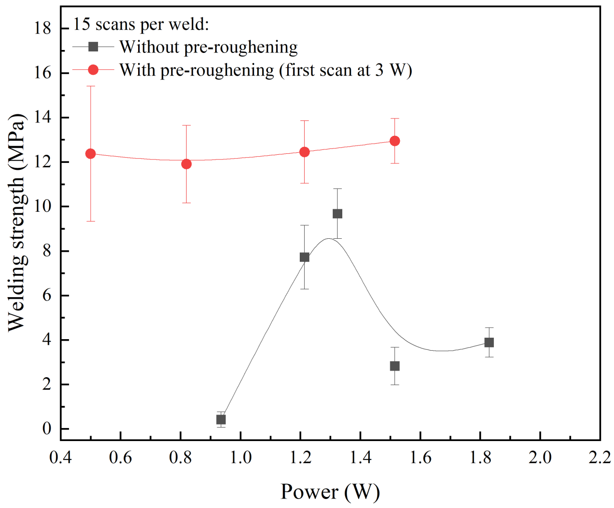

Fig. 1. *Welding strength dependence on incident laser power for samples processed with and without interface pre-roughening. Laser pulse duration 176 fs and 23 sub-pulses per burst. Dots are connected to guide the eye.*

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