Scanning pattern optimisation techniques in ultrashort pulse laser welding of borosilicate glass to Silicon for residual stress management in optical applications.

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Ultrashort pulsed laser welding of dissimilar materials is becoming an attractive alternative technique to currently used adhesive bonding for metal-glass components in the manufacture of optical and laser systems. This laser welding process relies on the very high peak intensity from a laser beam that is tightly focused through the top of the transmissive optical component (glass) to provide a focal spot in the vicinity of the metal-glass interface. Non-linear multi-photon absorption results in the generation of free electrons in a highly localised focal volume, leading to plasma formation. For a successful weld, the laser pulse repetition rate must be sufficiently high to also provide thermal accumulation, resulting in a localised melt volume (heat affected zone (HAZ) surrounding the small plasma. The size of this HAZ depends on the laser parameters used and can be controlled to be a few 10s of microns. As the laser spot translates across the material, this highly localized melt zone solidifies behind the beam and forms a strong bond (micro weld) between the two surfaces. Different scanning strategies have been tested in order to provide robust welding whilst controlling the post welding stress.

In this presentation we present our recent findings on the influence of these laser scanning strategies on the residual stress in the glass optical component after welding. This includes measurement of optical birefringence using a polariscope setup, together with in-process thermal measurements. Results from the shear strength tests and accelerated lifetime test of the ultrashort pulse laser welded components will also be presented.