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Citation for published version:
Hann, S, Macleod, N, Morawska, P, Carter, R, Elder, I, Lamb, RA, Esser, MJD & Hand, DP 2021, 'Stress Induced Birefringence of Glass-to-Metal Ultrashort Pulse Welded Components', 7th Industrial Laser Applications Symposium 2021, 24/03/21 - 25/03/21.

Stress Induced Birefringence of Glass-to-Metal Ultrashort Pulse Welded Components

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Ultrashort pulse laser welding of dissimilar materials is an attractive alternative to the currently-used adhesive bonding of glass-to-metal components e.g. in the fabrication of lasers and optical systems. Adhesive bonding can suffer from performance and reliability issues such as outgassing, creep and degradation with age. The bonding process can also be labour intensive to ensure consistent deposition and curing of the adhesive.

Although interest in ultrashort pulse laser welding as a viable bonding method has been gaining momentum [1,2], it is important to quantify the impact of any stress induced by the bonding process on the optical performance of the component being bonded. We therefore developed a polariscope for stress field analysis of 10 mm BK7 glass cubes bonded to 15 mm x 15 mm x 5 mm aluminium coupons using the Patterson and Wang 6-step method [3] to calculate the stress induced retardation present in the samples. We have applied this measurement system and analysis technique both to laser-bonded samples, and to samples adhesively bonded with a standard approach used in industry. The results of this analysis will be presented in terms of ISO Standard for stress birefringence in optics [4]. It was observed that ultrashort pulse laser welding results in a low level of stress induced birefringence within an 85% optical aperture of the 10 mm cube. These levels are suitable for use in photography and microscopy applications as defined by the relevant ISO standard for permissible stress induced birefringence limits in optics. The welds were compared to adhesively bonded and hydroxide catalysis bonded samples.

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