Ultrashort Laser Welding of Optical-Structural Materials

R.M. Carter[1], P.O. Morawska[1], S. Hann[1], O.P. Ciuca[2], P.B. Prangnell[2], M.J.D. Esser[1], D.P. Hand[1]

1- Institute of Photonics and Quantum Sciences, School of EPS, Heriot-Watt University, Edinburgh, EH14 4AS, UK

2- School of Materials, University of Manchester, Manchester, M13 9PL, UK

Corresponding author: r.m.carter@hw.ac.uk

Modern manufacturing processes often require the direct joining of optical (e.g. glass, crystal etc.) to structural components (e.g. metals). However the capacity to do so in a reliable long term manner is often limited due to the requirement for an interlayer (glue, solder, frit etc.). Interlayer processes are often not highly repeatable producing uncertainty in the final part position. Furthermore, the interlayer materials used often age badly, and a particularly severe issue is outgassing of organics into controlled environments. There is therefore a clear requirement for a joining technique without the need for interlayers.

Ultrashort pulsed laser microwelding can solve this problem. The laser is focused through the optical material onto the surface of the metal, or other structural material. Through a combination of linear absorption on the metal surface and non-linear absorption within the optical material it is possible to stimulate absorption, and the formation of a plasma, in both simultaneously, but confined to the interface region. Over multiple pulses thermal accumulation results in a melt region surrounding the plasma but maintaining a total heat affected zone (HAZ) of only a few hundred micrometers around the laser focus. As the molten material mixes and cools it forms a highly localised fusion weld between the materials. The combination of simultaneous melting while maintaining a strictly limited HAZ allows for fusion welding of materials with significantly different thermal properties, e.g. glass and aluminium.

Research into this process over the last five years in CIM-laser has moved from early proof of principle demonstrations through to a process that is now being industrialised via a follow-on grant from Innovate UK. In this talk we will present an overview of the work carried out within CIM-Laser, commenting on both the strengths and the weaknesses of the process as a reliable industrial process. Finally we will present our most recent work and our next steps in transferring this novel process to industry.