Picosecond laser microwelding of ultra-thin flexible glass for hermetic encapsulation of OLEDs.

Paulina Morawska¹, R.M. Carter¹, M.J.D. Esser¹, Y.F. Chan², P. Melgari², R. Douglas², D. Karnakis³, D.P. Hand¹

¹ School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, EH14 4AS, UK
² Centre for Process Innovation Ltd – National Printable Electronics Centre, The Neville Hamlin Building, Thomas Wright Way, NETPark, Sedgefield, Stockton-on-Tees, UK
³ Oxford Lasers Ltd, Unit 8, Moorbrook Park, Didcot, OX11 7HP, UK

OLEDs are of significant interest in both displays and lighting due to their flexibility and efficiency, however they are highly sensitive to both oxygen and moisture and so must be placed inside a hermetic package. A solution is to encapsulate the OLED between two sheets of thin flex glass, providing both flexibility and hermeticity; however hermeticity can be compromised by the material used (typically a polymer) to bond the glass sheets. A direct weld would be the best solution, hence we have developed a laser process, driven by non-linear absorption within a normally transparent glass, to provide reliable and repeatable welding of thin glass to thin glass.

The glass-glass welding process relies on the very high peak intensity from an ultra-short pulsed (picoseconds or less) laser beam that is tightly focused through the top sheet of glass to provide a focal spot in the vicinity of the glass-glass interface. Non-linear absorption results in the generation of free electrons in a highly localised focal volume, leading to plasma formation [1]. For a successful weld, the laser pulse repetition rate has to be sufficiently high to also provide thermal accumulation, resulting in a localised melt volume surrounding the small plasma. The size of this volume depends on the laser parameters used and can be modified to be smaller than 100 µm. As the laser spot translates across the material, this highly localized melt zone solidifies behind the beam and forms a strong bond (microweld) between the two surfaces.

We report laser microwelding of two 100 µm thick flexible glass sheets using a picosecond laser system (5.9 ps, 400 kHz at 1030 nm). We investigate both hermeticity and strength of the welding seam.

Finally we provide details of a prototype commercial laser welding machine developed for this process and for other optical material welding applications (e.g. glass to metal; Nd:YAG to metal).

References

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Figure 1. Optical microscope images of the weld features in two 100 µm thick flexible glass components obtained by ultrafast laser microwelding (a) Top view of a series of welds; (b) cross section of the weld seam