Laser welding plastics

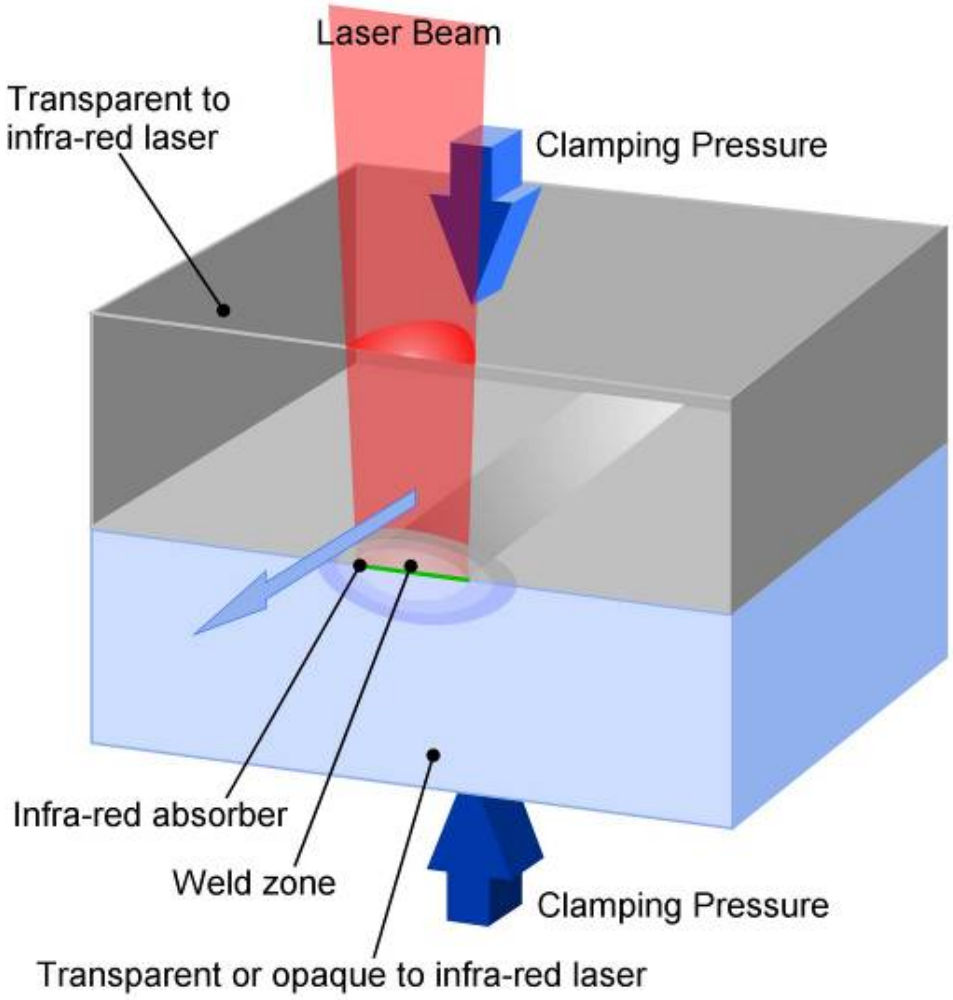
Ian Jones
Laser Section, Joining Group, TWI Ltd.

Materials Joining and Engineering Technologies

Content

- Transmission laser welding
- Direct laser welding
- Process and equipment variations
- Application studies
- Micro and Sub-micron welds

Transmission laser welding (TLW)

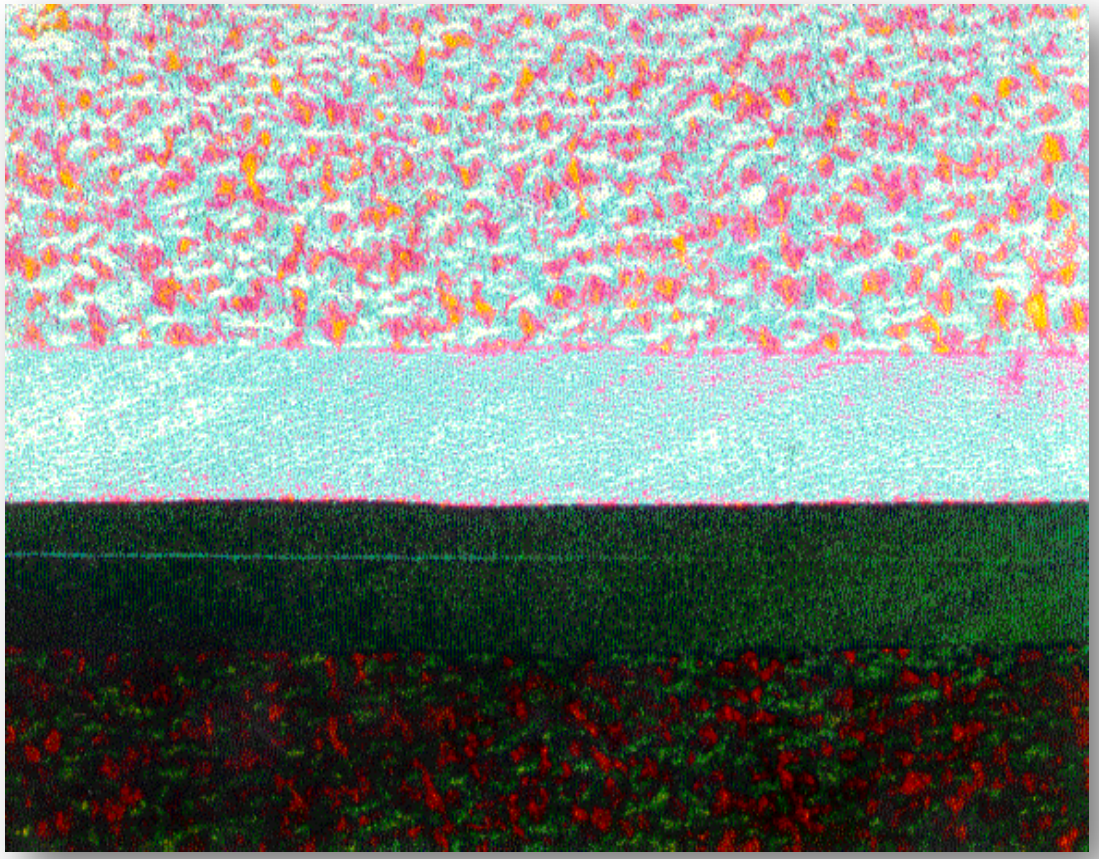


- Most applications in laser welding use this technique
- Materials modified for the process
- Wide range of laser types and equipment available
- Joints designed for different product types
- Heat is applied only where it is needed
- Fast, energy efficient, low distortion, low heat input

Melt region magnification

Nd:YAG laser
4mm PP
100W
1.6m/min

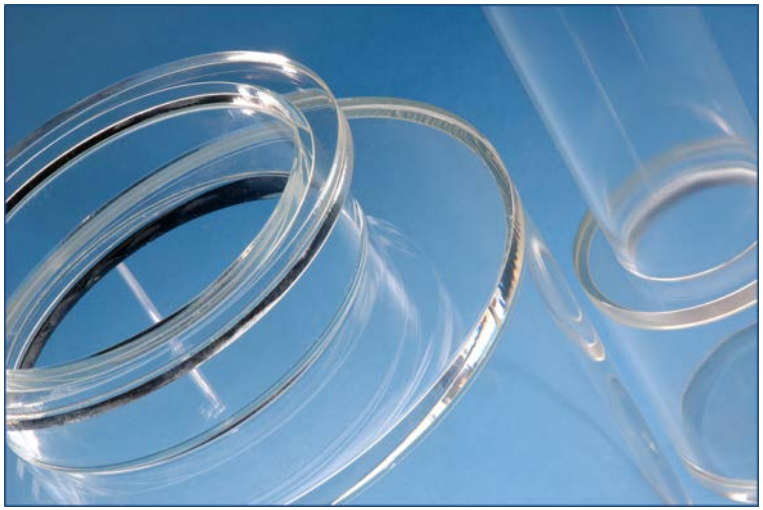
Melt zone
0.36mm thick



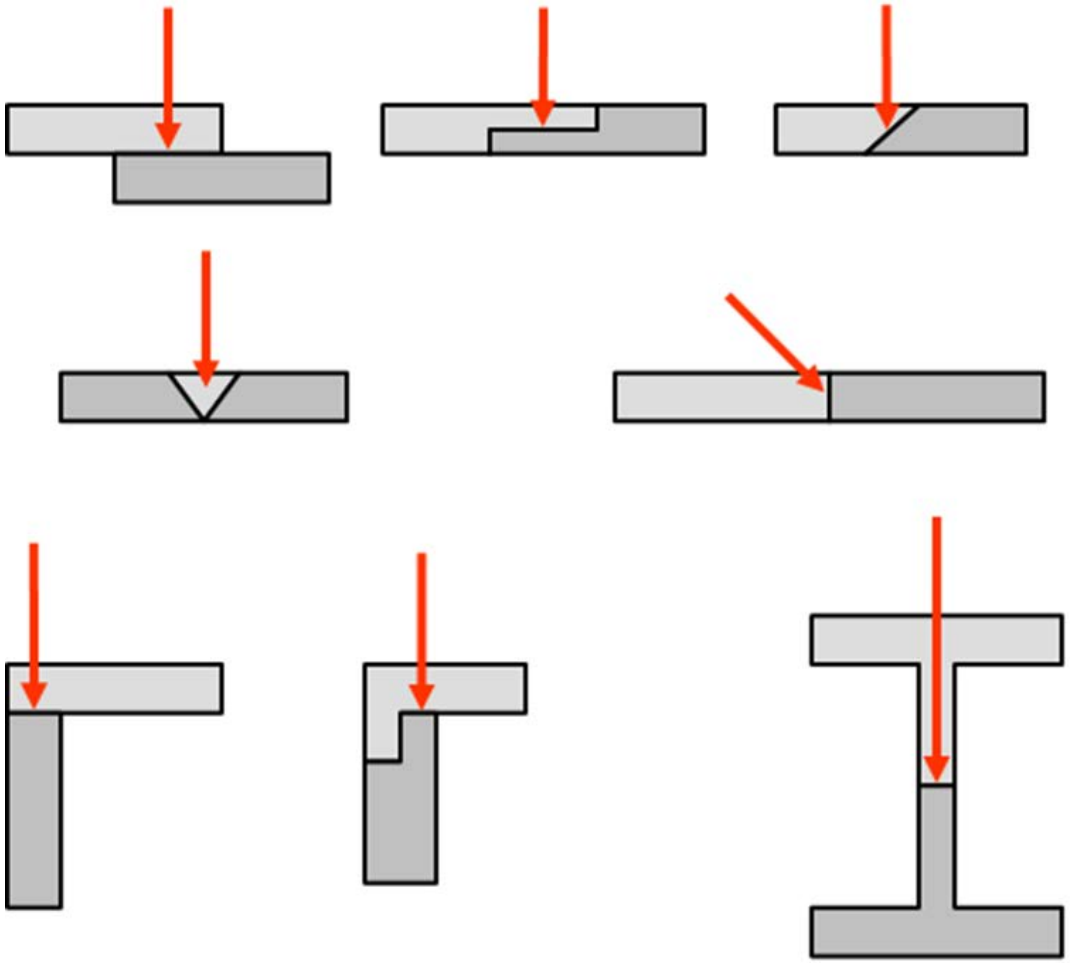
Clearweld™

A method invented at TWI, that uses infrared absorbing dye to allow transmission laser welding of plastics without one part being coloured black to absorb the laser beam

- Brings flexibility in choice of colours when welding plastics.
- Enables colourless to colourless and white to white welding.
- Applied as coatings, films or resin additives.
- Allows multi-layer welding and ‘welding in a box’.
- Can be used in coatings for laser or infra-red curing.

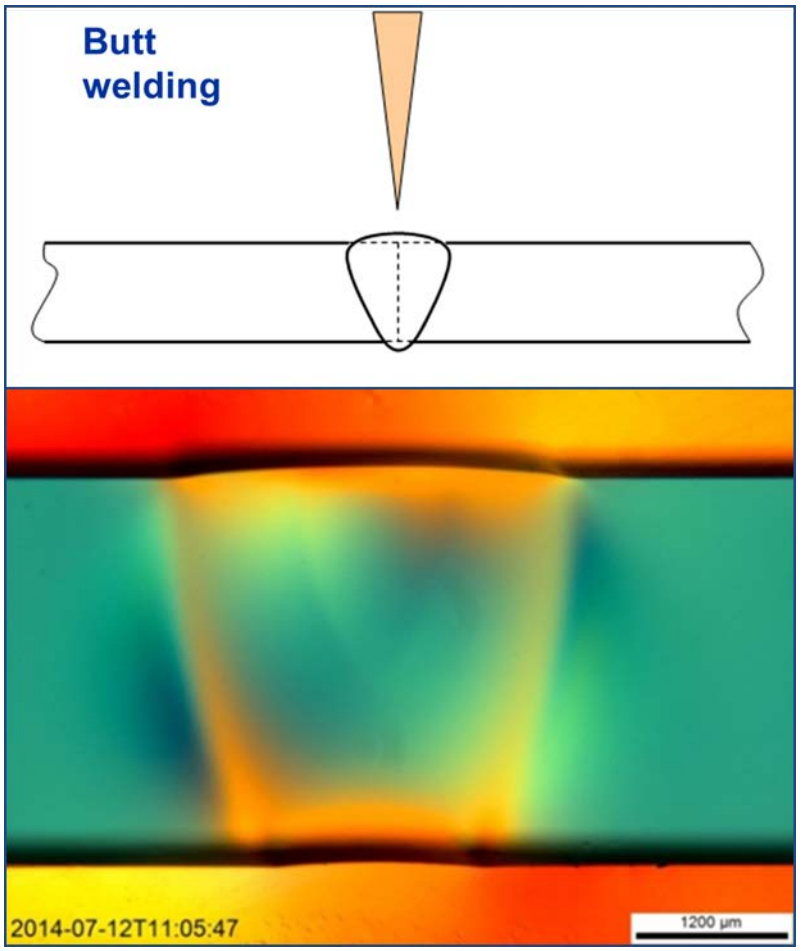


Joints for transmission laser welding

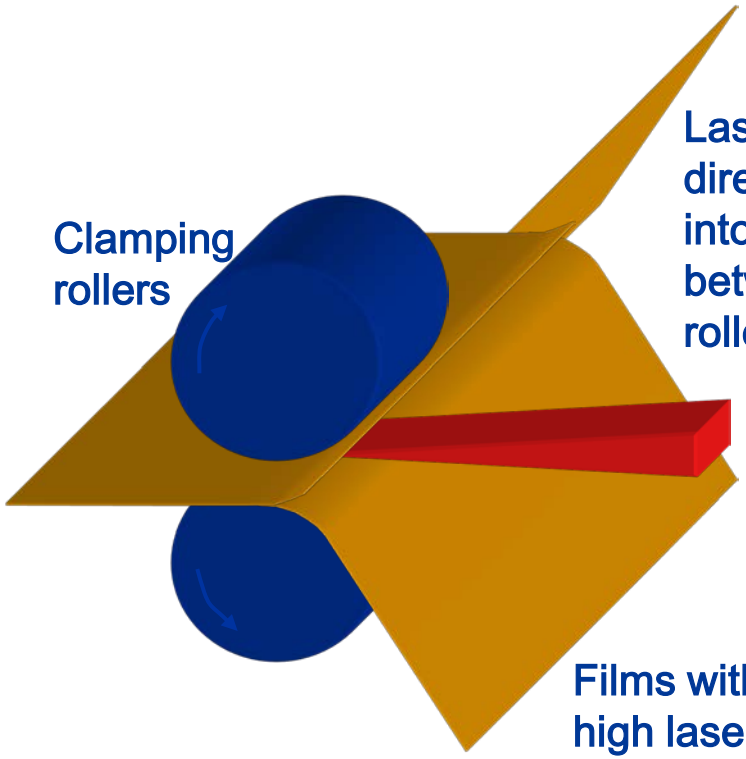


Direct laser welding (DLW)

- 2-3µm and 10µm wavelength laser sources are used for direct welding.
- No additional absorber additive is required in natural plastics.
- However, the process is sensitive to the presence of fillers.
- Process tends to be slower than TLW.
- Suitable for 1-5mm thickness range.
- Suitable for butt welding and partial penetration stake welding

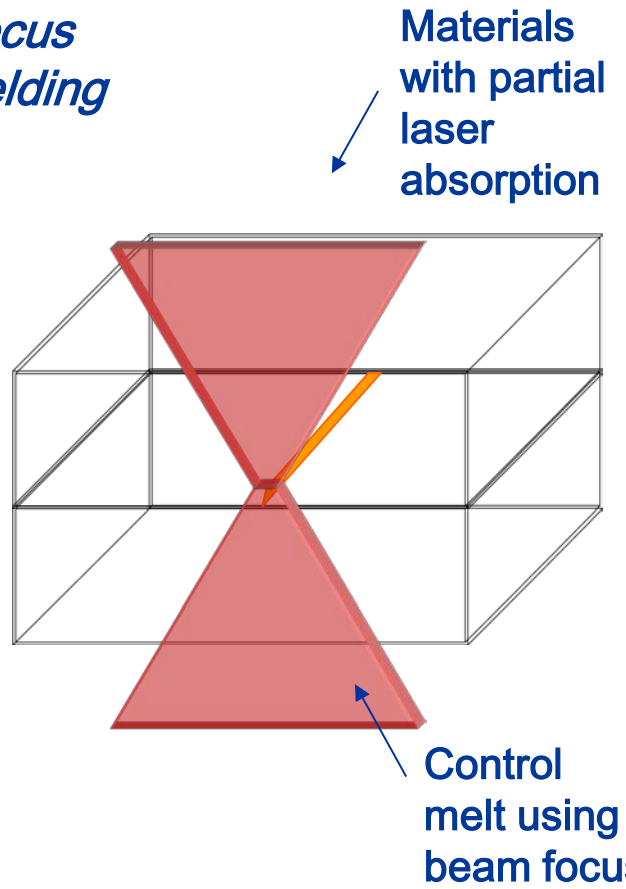


Direct laser welding (variations)



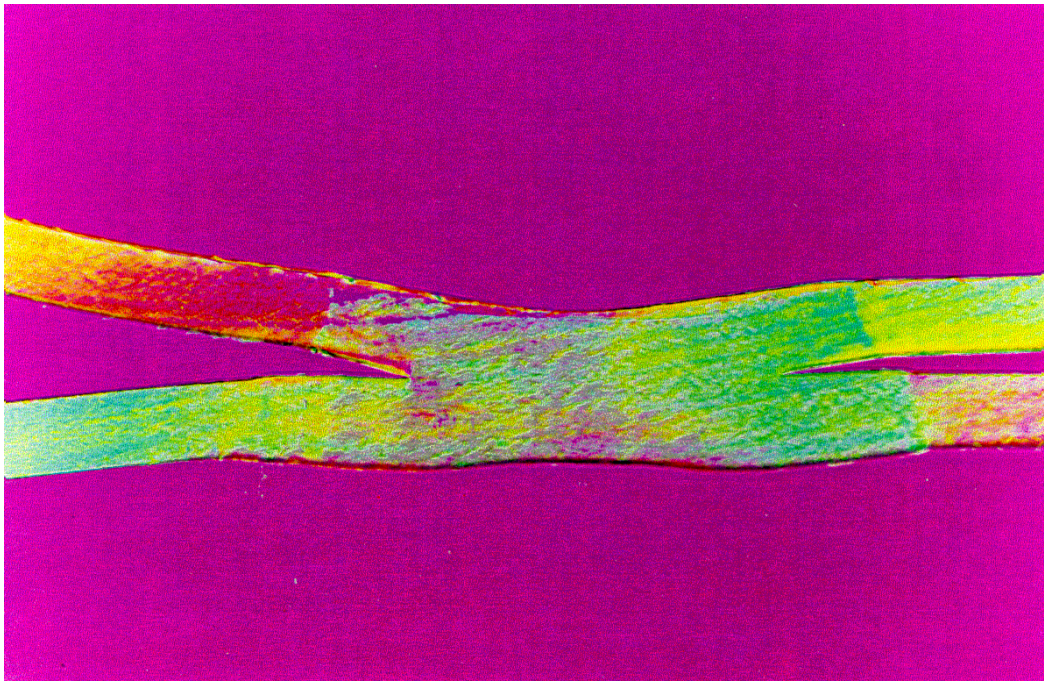
Film or fabric welding

Focus welding

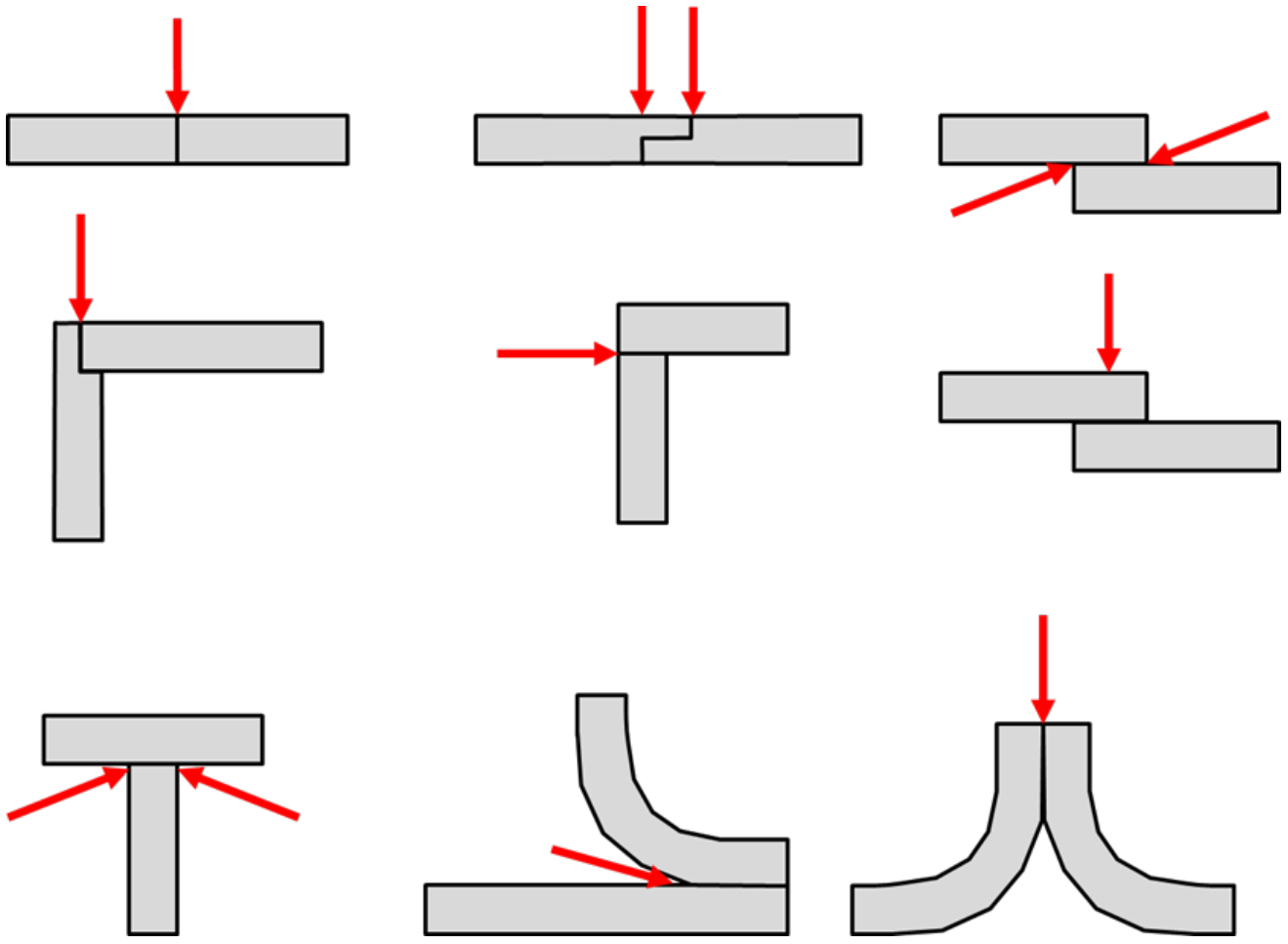


Using lasers with a 10µm wavelength

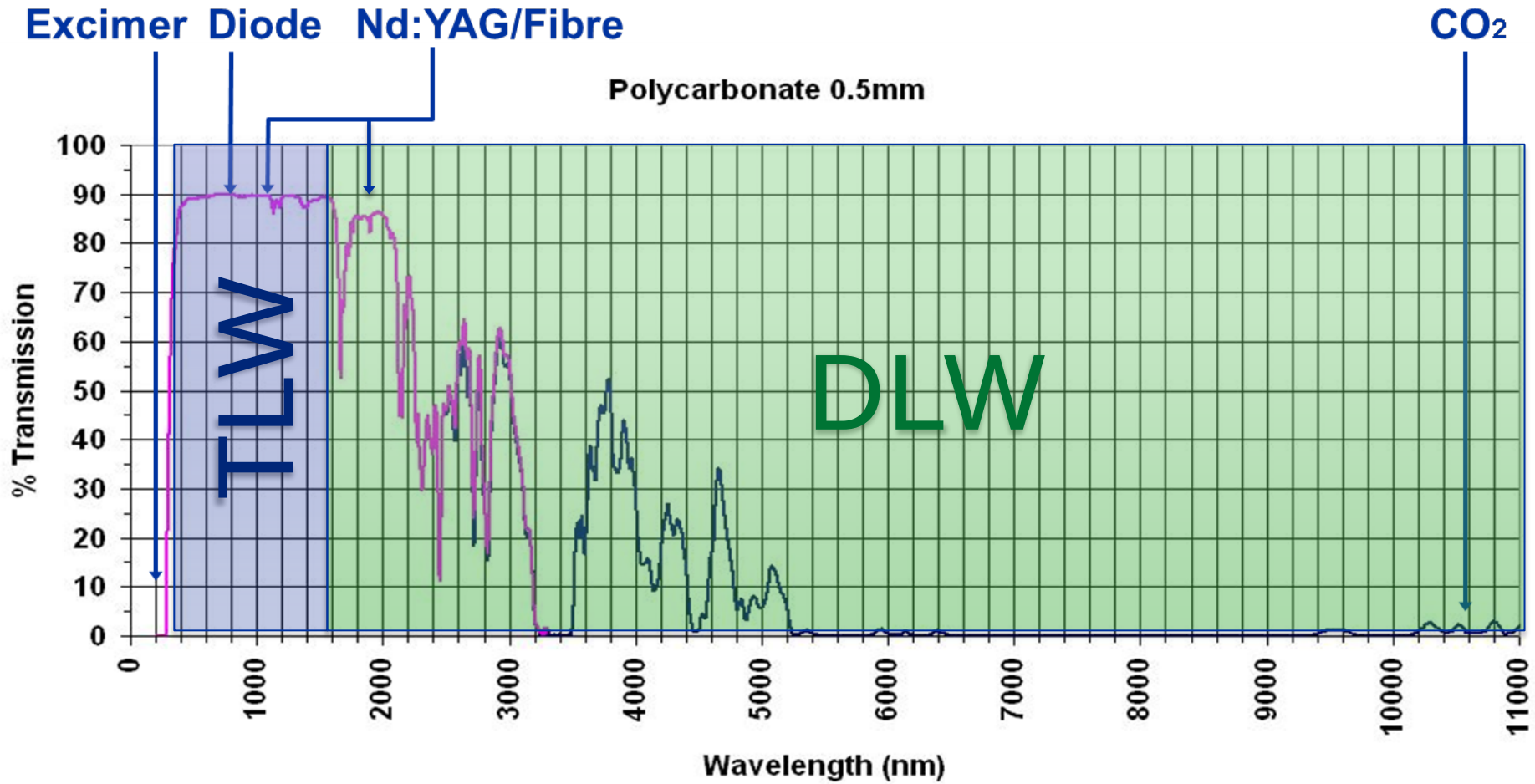
- High speed welding of film
- 2 x 0.1mm PE
- 100m/min, 900W
- 10.6µm wavelength with high absorption
- Wavelength limits thickness that can be welded



Joints for Direct Laser Welding



Transmission of light in polymers



Fluid tanks

Alternative to manual hot gas welding with filler rod

Initial trials demonstrated satisfactory properties

- High strength
- Leak tight

Scale-up to full-size prototype tanks

- 500W diode laser
- 6-axis robot

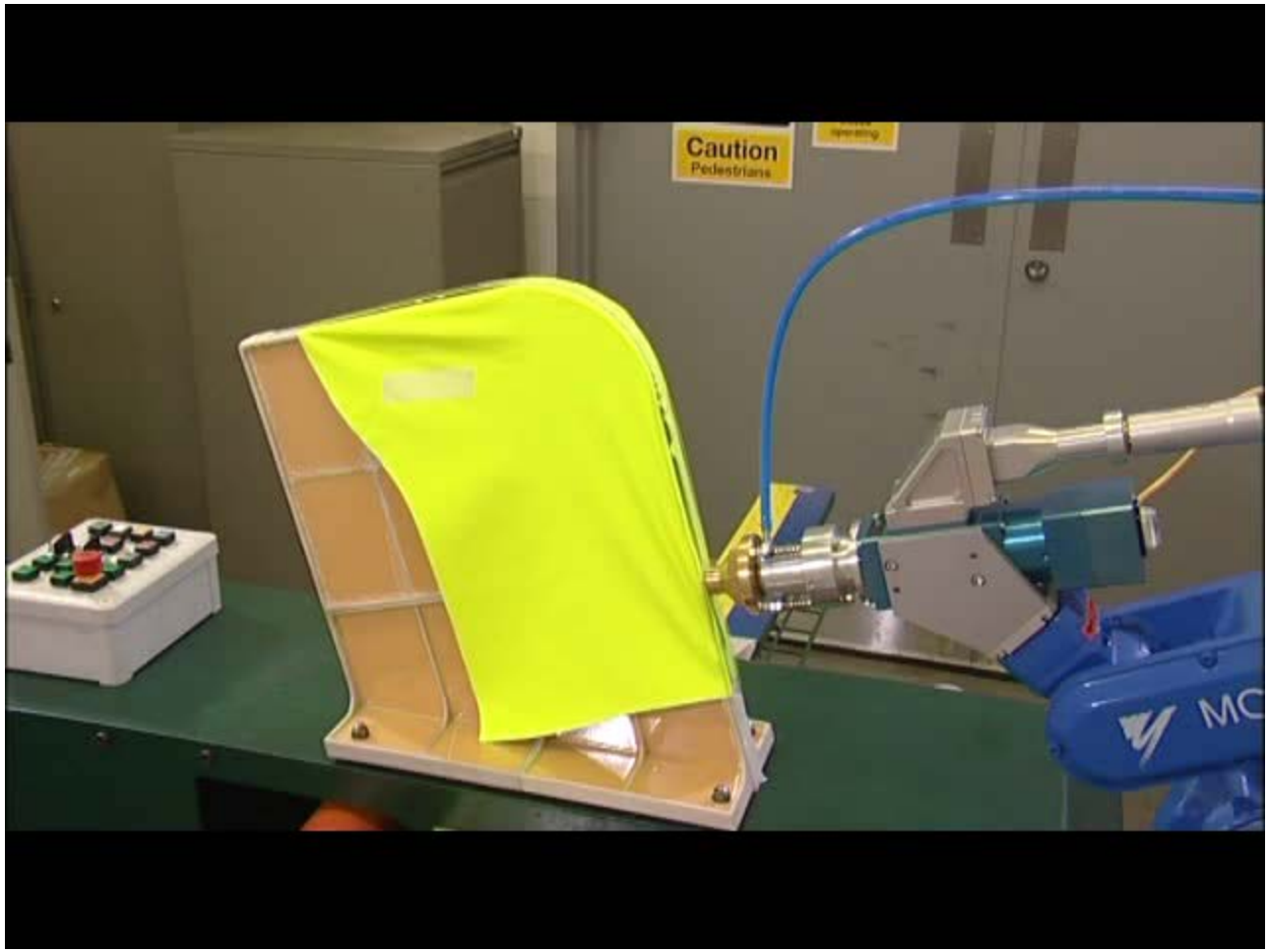
Backlit number plate

- Conventional joining method: Bonding
- Laser Process: Contour welding
- Material: PC

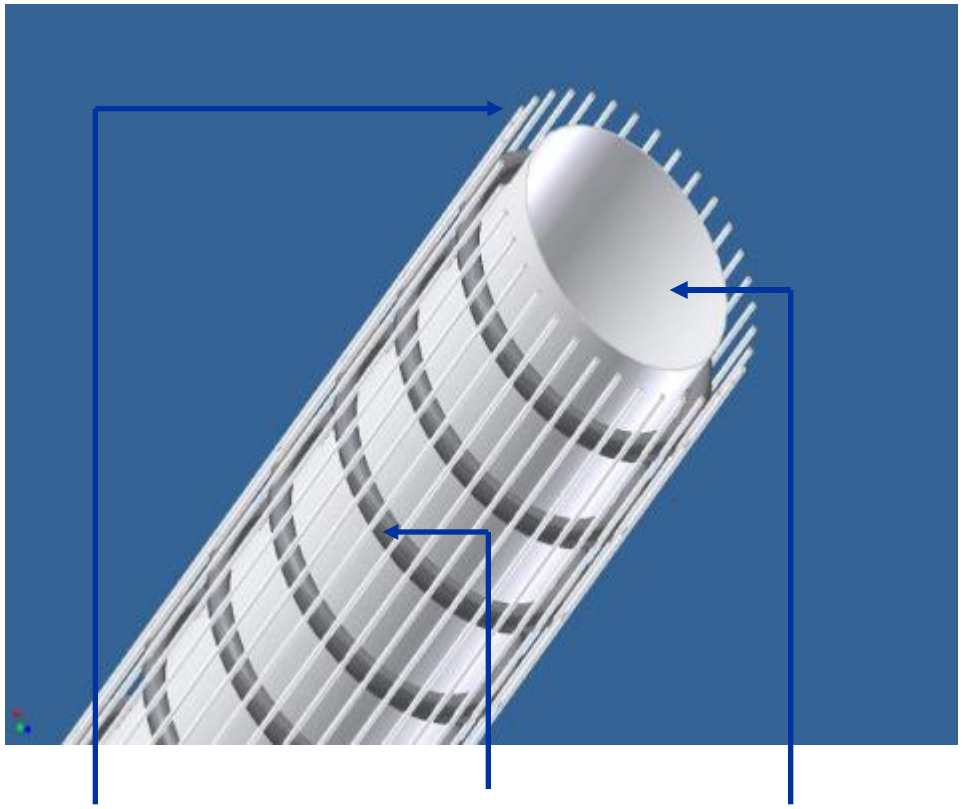
Laser advantages:

- Contact free process
- Optical even weld seams
- No flash

3D contour welding



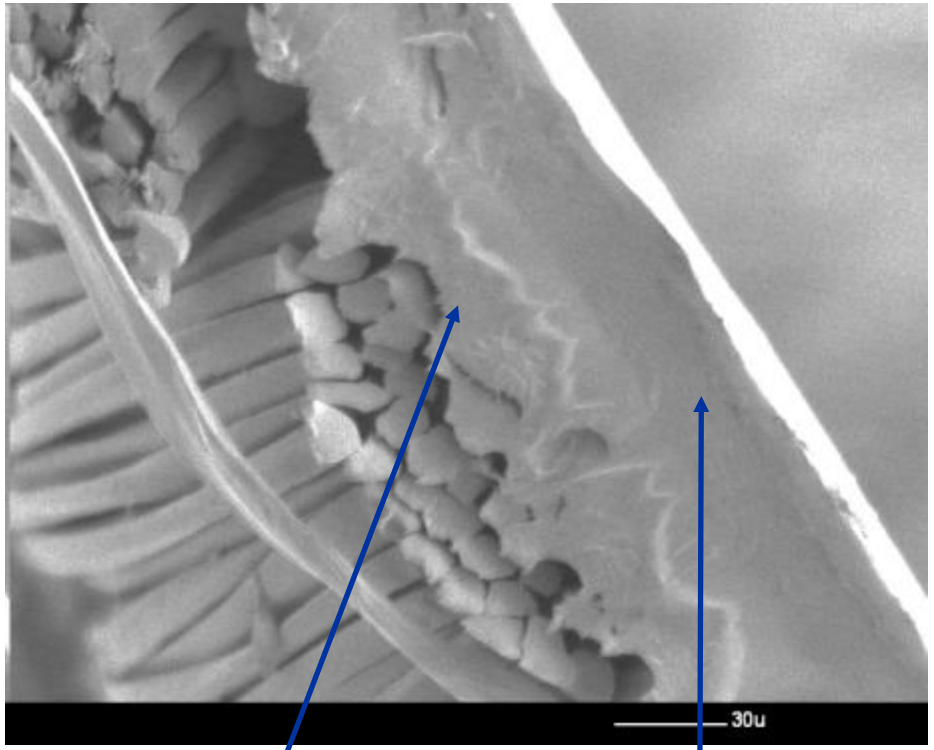
Medical Implant – textile vascular graft
Attachment of nitinol rings to stent



Outer graft film layer

Stent rings

Graft fabric

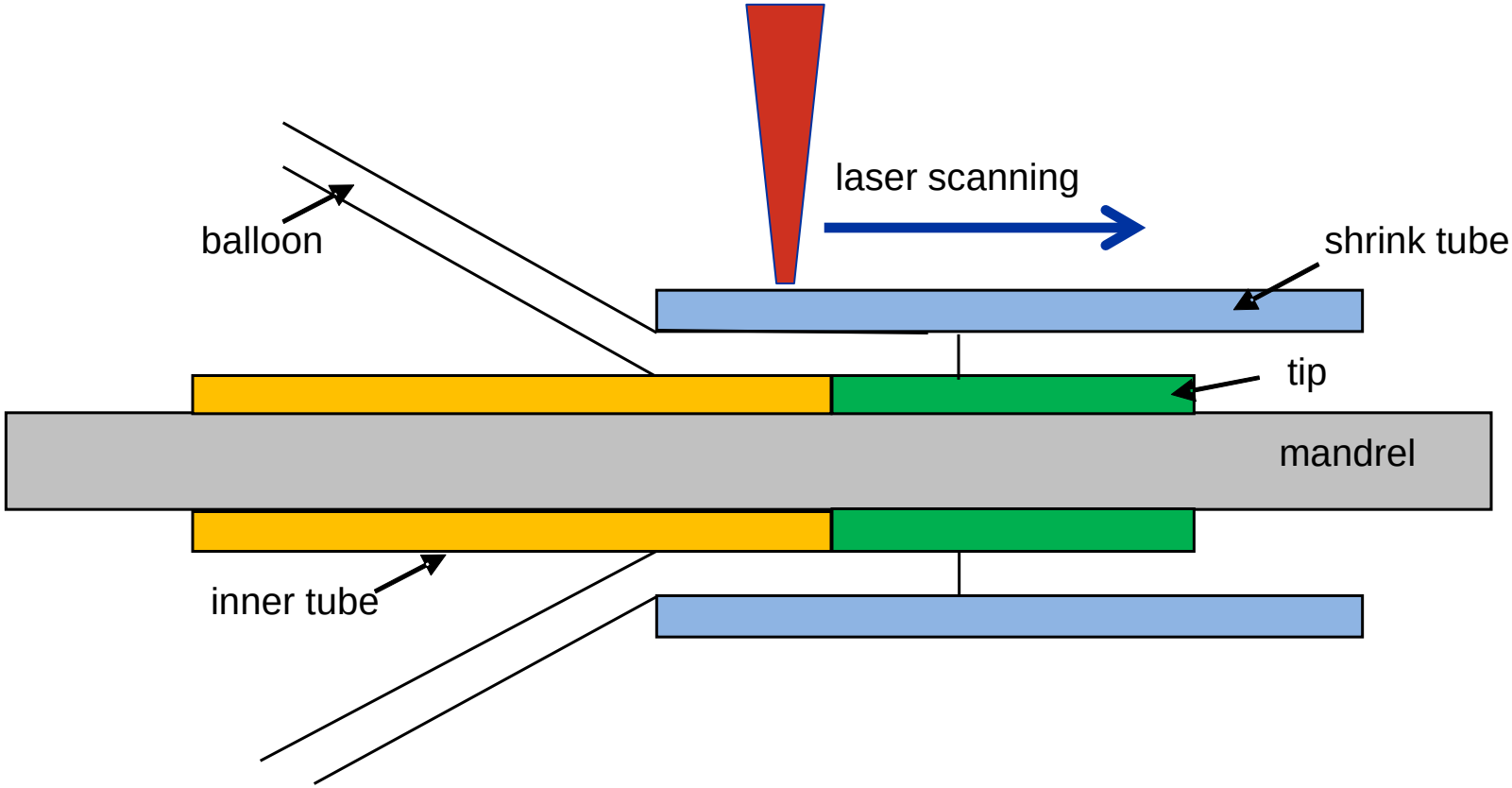


Weld at the fabric/film interface

Outer film undamaged

Laser welding catheters

Clean, fast, controlled heating, potential for new designs and smaller dimensions

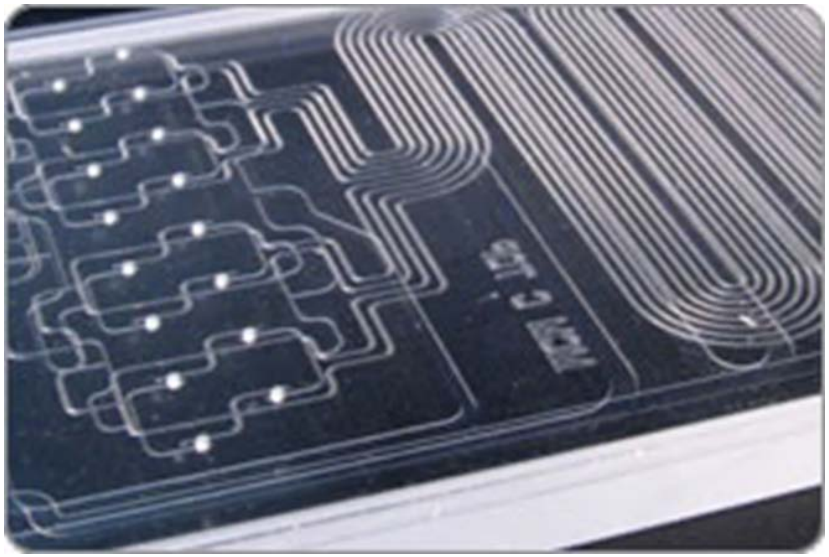


Catheter welding

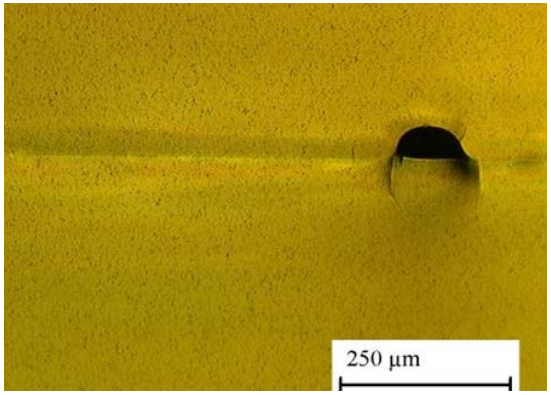
- Catheters from 0.7mm diameter
- Diode or fibre laser
- Less than 10W, power modulated for different points in weld
- Selective application of absorber
- Tip and balloon welded simultaneously
- Melt shaping in addition to welding
- Joint completed in a few seconds

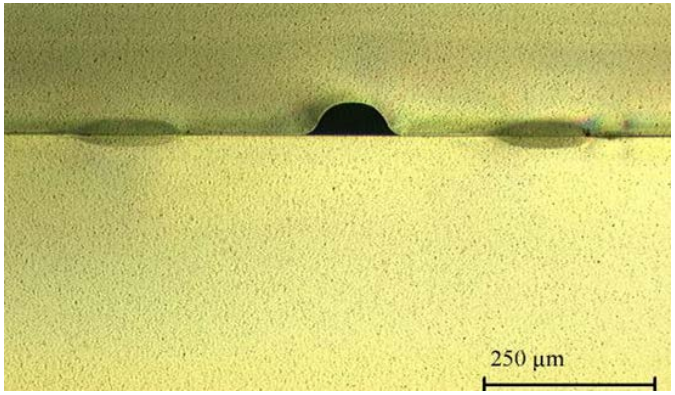
Laser micro/nano welding

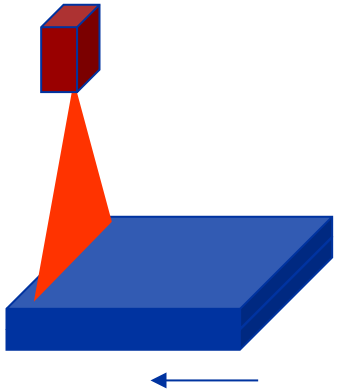
- Current limit is 30µm weld width
- Need for smaller welds for micro chemical reactors and diagnosis units for gases and liquids.
- Potential to use a line beam, a scanned small spot or patterned absorber to control the heating location



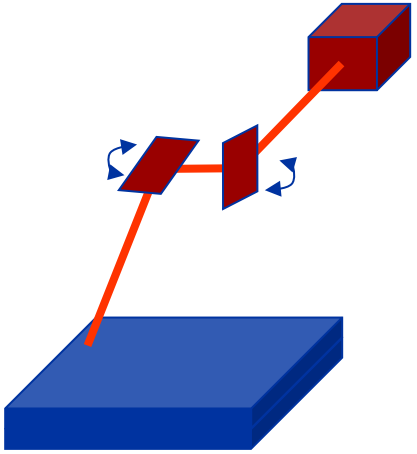
Laser micro-welding methods





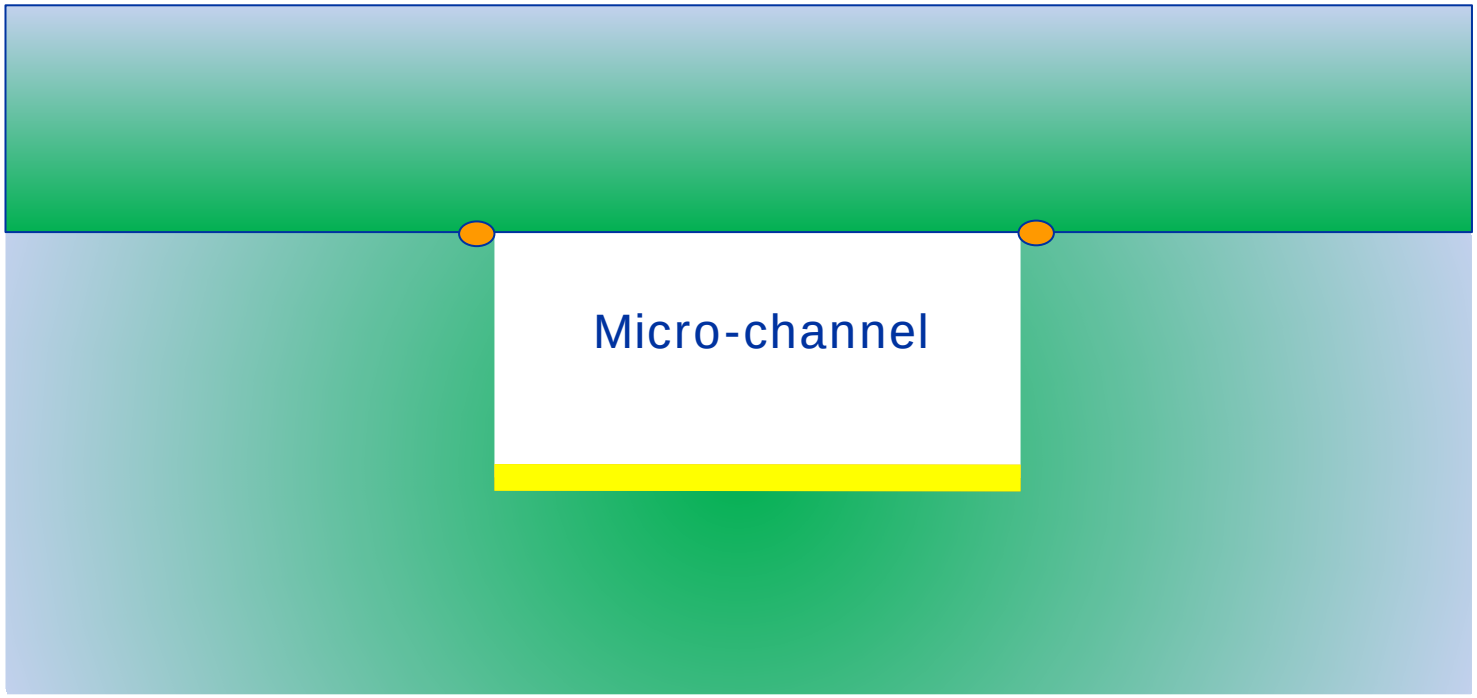


Curtain laser

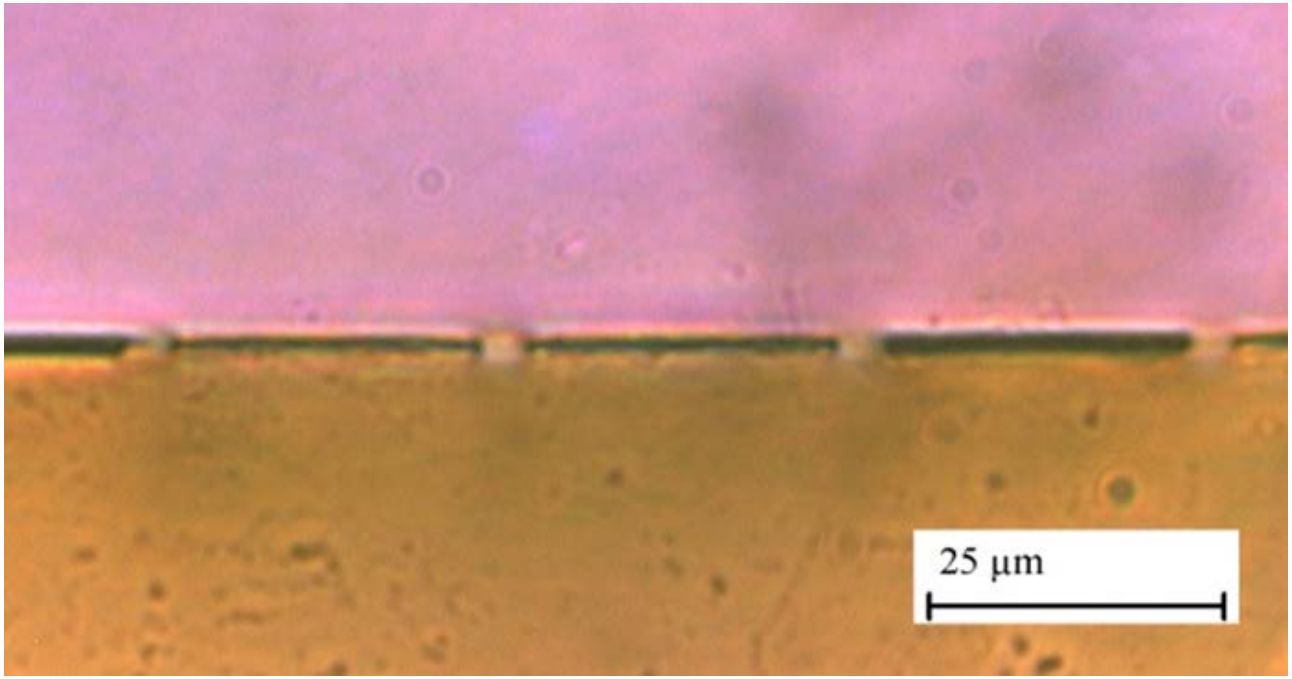


Scanning laser system

Procedure developed using EB lithography

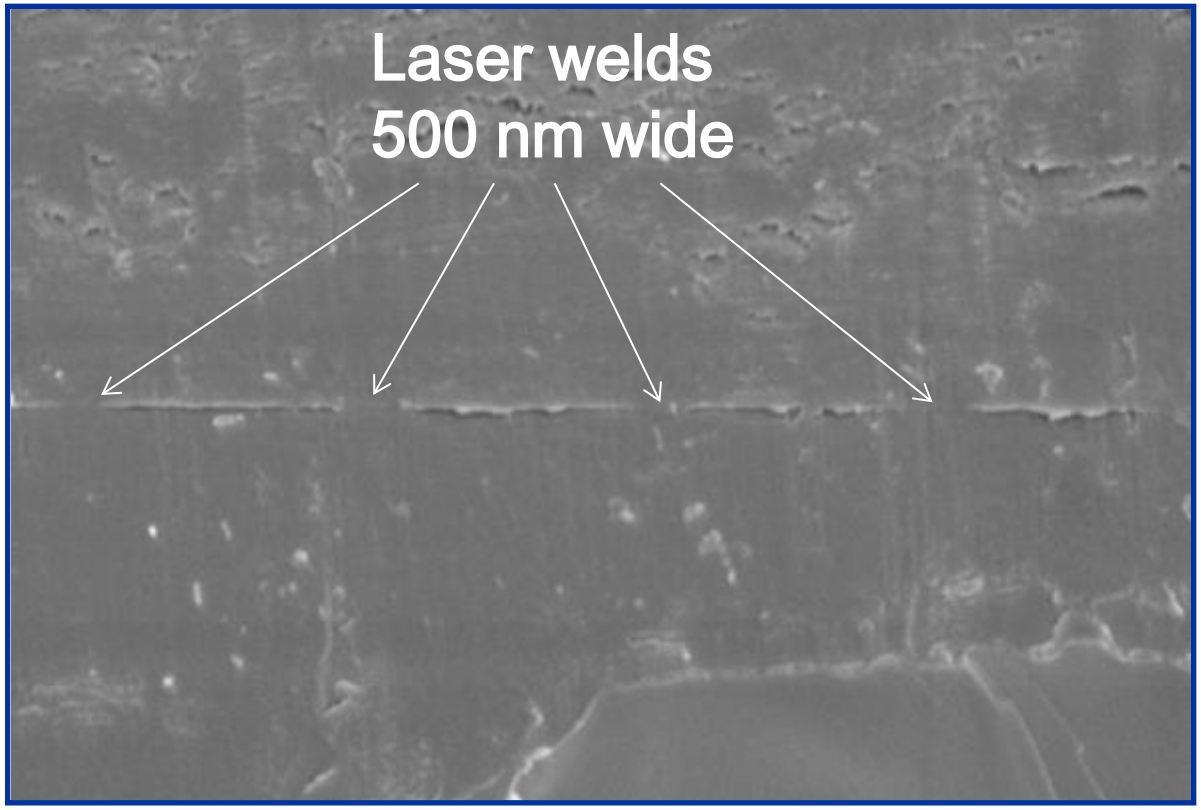


Appearance after welding



5um wide welds in PMMA

World's smallest weld in plastics
Dimension defined by absorber patterning



6 μm

Ian Jones

Principal Project Leader,
Laser Section

DD: +44 777 613 2618
E: ian.jones@twi.co.uk

TWI Ltd
Granta Park
Great Abington
Cambridge
CB21 6AL
UK
T: +44 (0)1223 899 000
F: +44 (0)1223 892 588
W: www.twi-global.com

Materials Joining and Engineering Technologies