

Laser welded edge seals for glass/glass modules

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Motivation: Towards polymer-free glass/glass modules

Problems

- Many module **degradation** issues result from polymer breakdown
- Module **throughput** is heavily influenced by lamination times
- Module **recycling** by separation of materials is hampered by polymers

Drivers

- Nearly polymer-free modules have been shown (N.I.C.E. modules from Apollon Solar, JPV 12 1 p38 2022)
- Non-polymer edge-seals are the last step to form an all polymer-free module

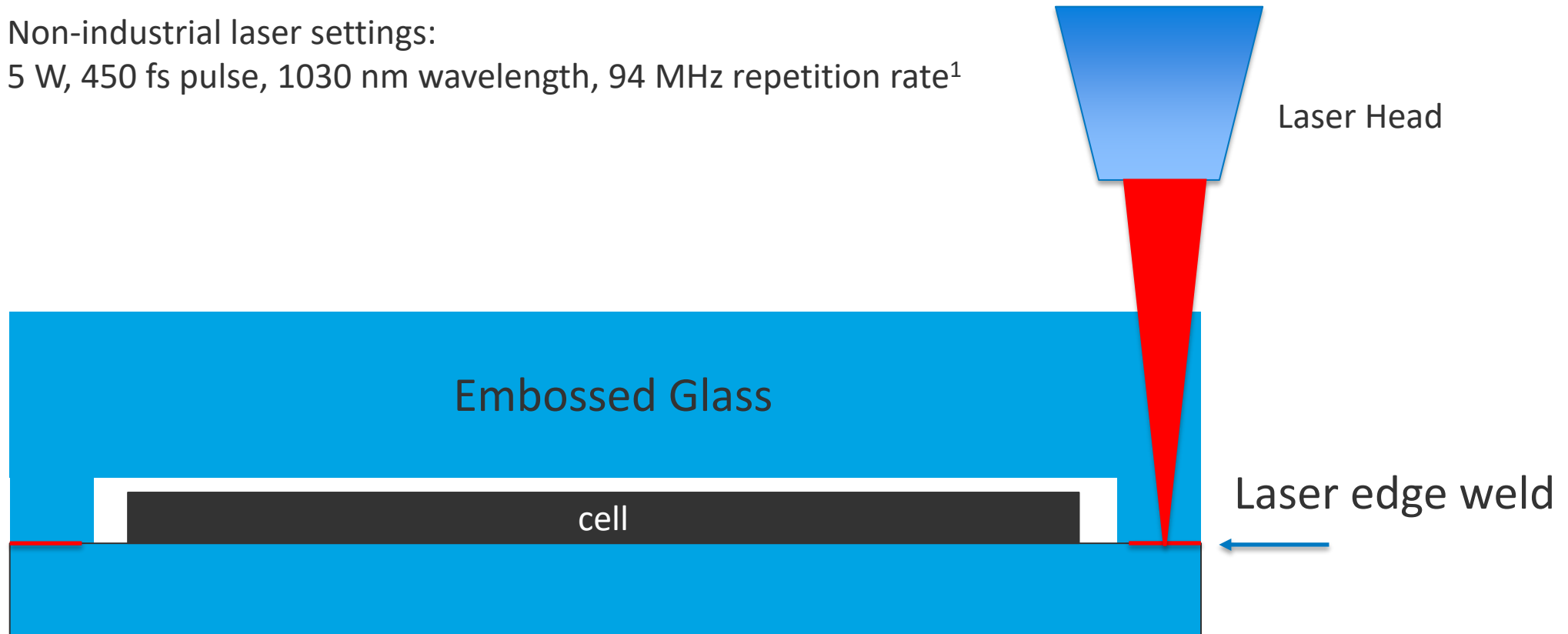
Solution

Why laser welding?

- fs pulse laser welding allows glass/glass welding that is far superior to ns pulse welding or frit welding of glass
- fs, fiber lasers are **low cost** and used in many industrial settings
- **Fast** laser head raster speeds increase throughput, decrease production floor area
- **Local laser heating** keeps semiconductor at ambient temperatures (ideal for perovskites)
- **Hermetic seal** provides ideal gas/vapor barrier (ideal for perovskites)

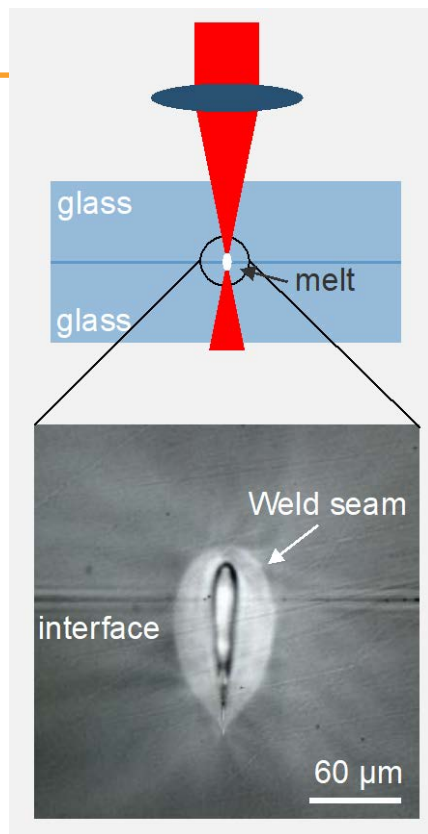
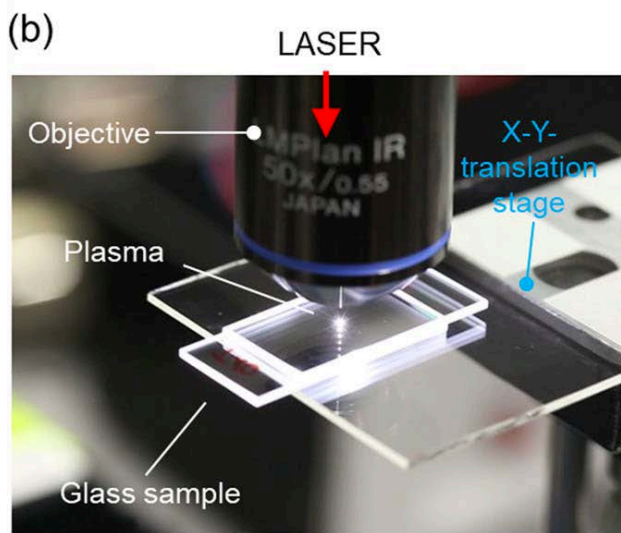
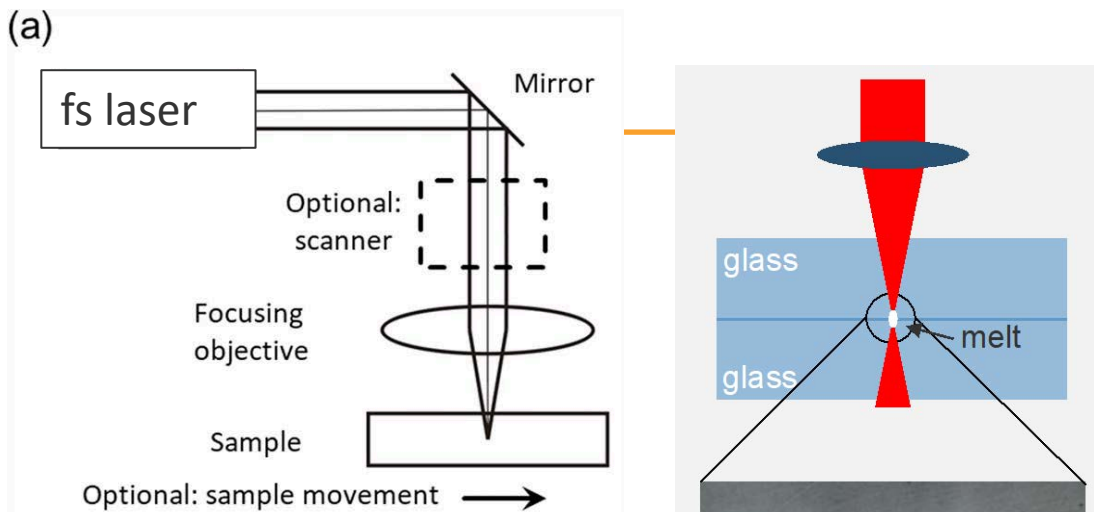
Module Edge Seals by Laser Welding

Non-industrial laser settings:
5 W, 450 fs pulse, 1030 nm wavelength, 94 MHz repetition rate¹

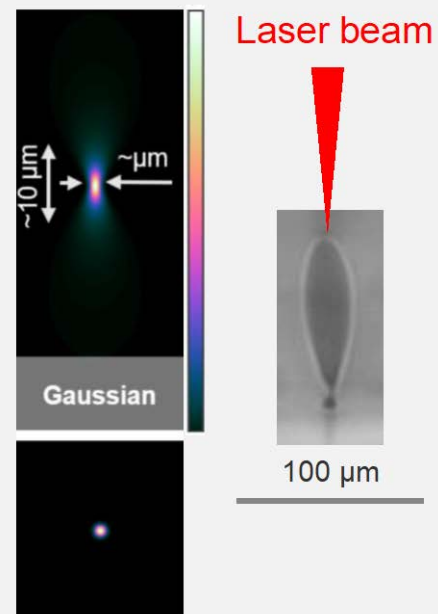


Zimmermann et al., Applied Optics and Precision Engineering 52 p 1149 2013

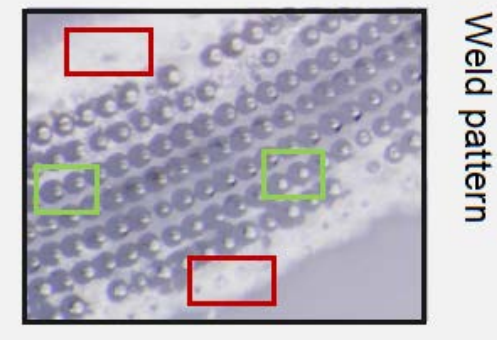
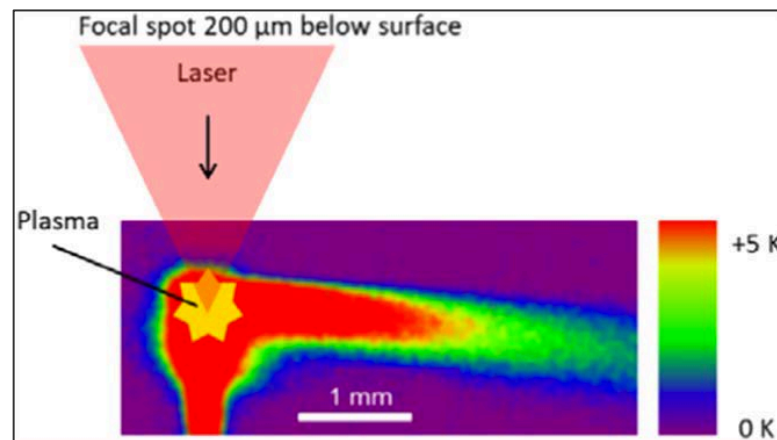
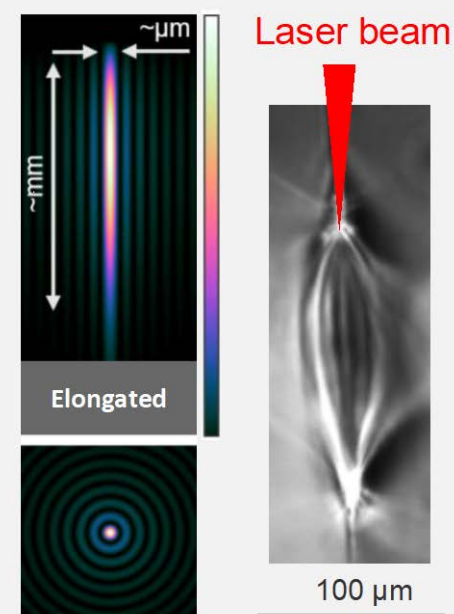
Glass/Glass Laser Welding



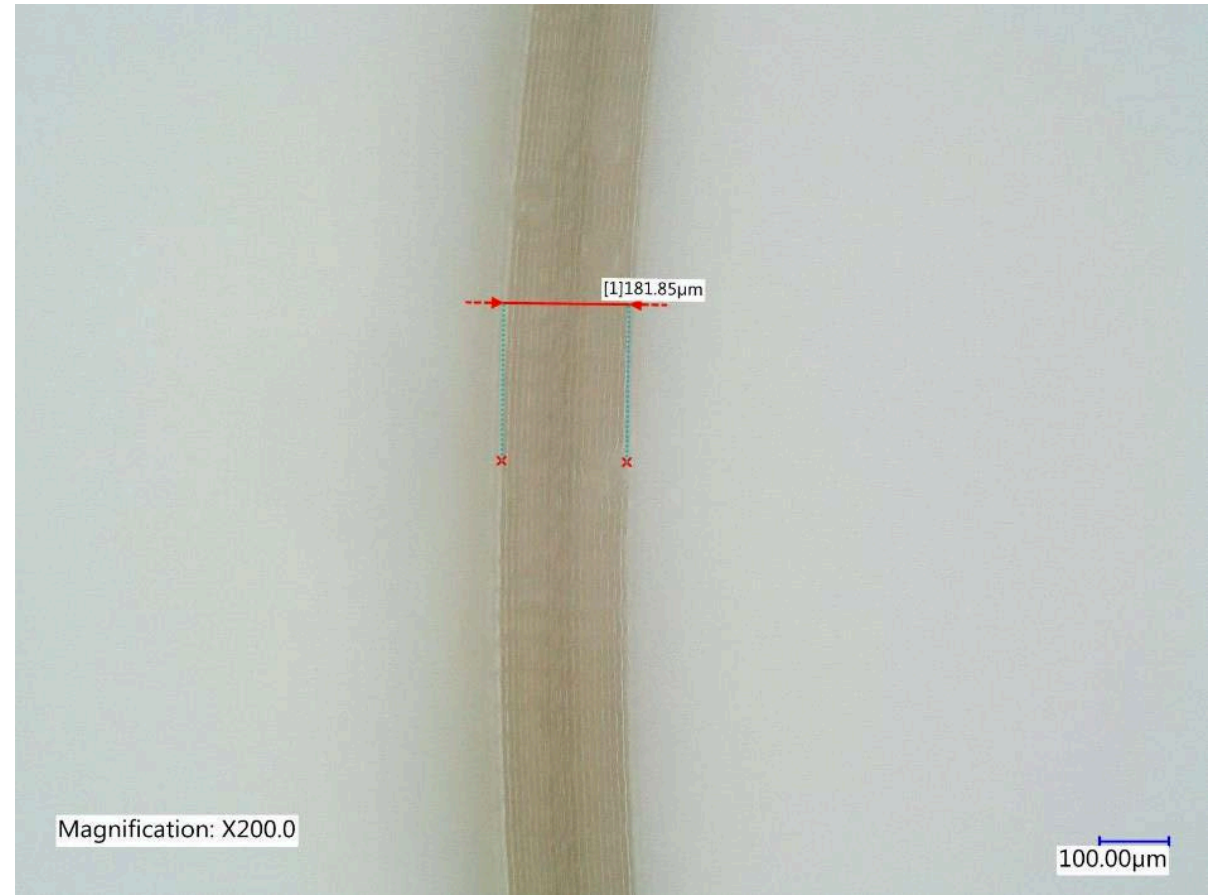
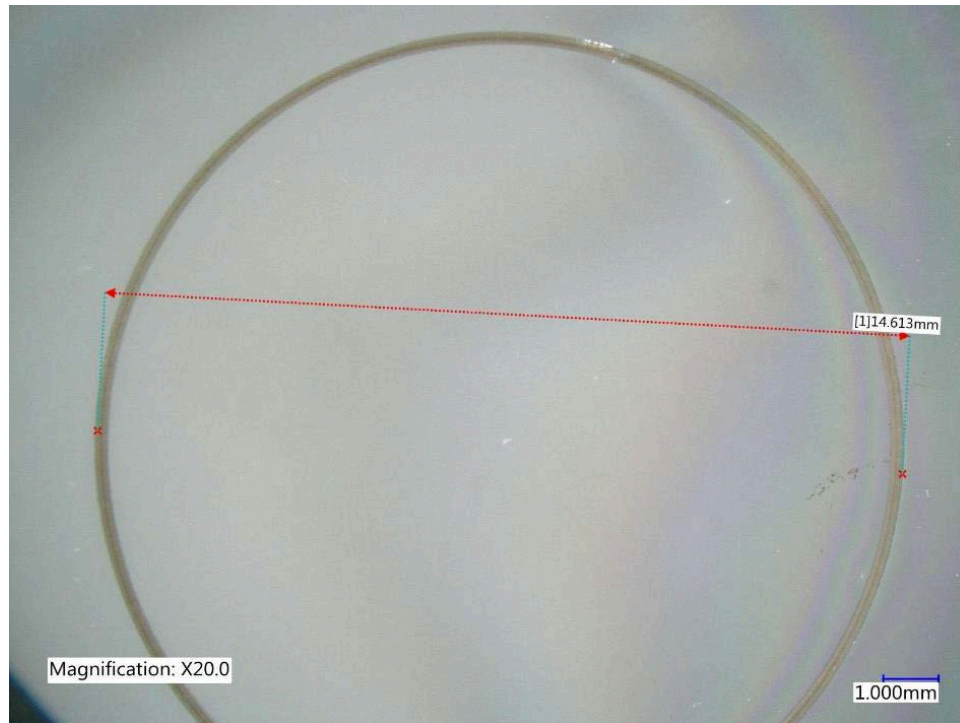
State of the art



Improved Process



Initial Results on Solite Module Glass



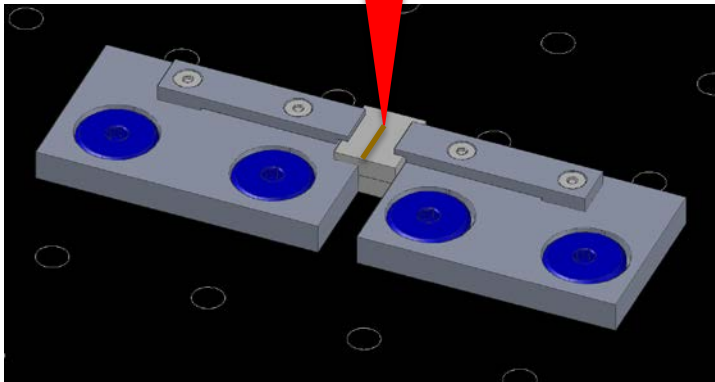
Experimental Plan: Testing

Purchase 1 cm x 1 cm Solite glass samples:

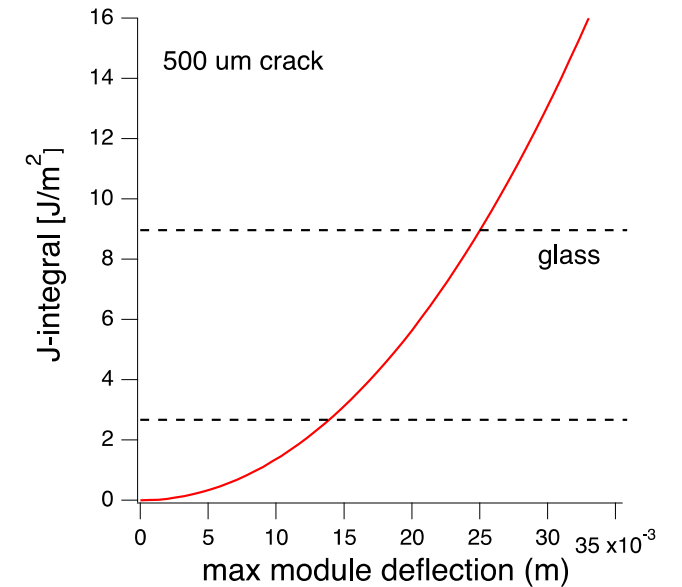
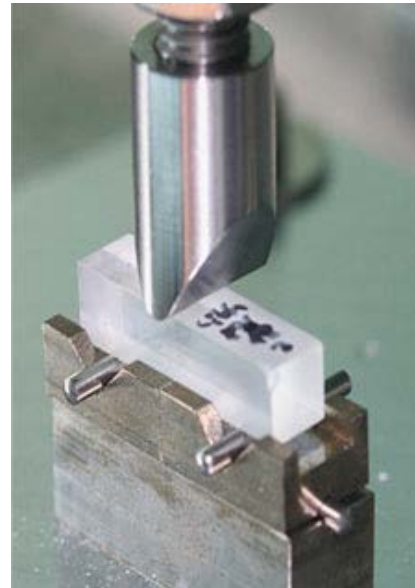
1. No treatment
2. Chemically hardened surface
3. Tempered surface



3D printed holder used during laser welding



Samples will be broken to measure J-integral (J/m^2)

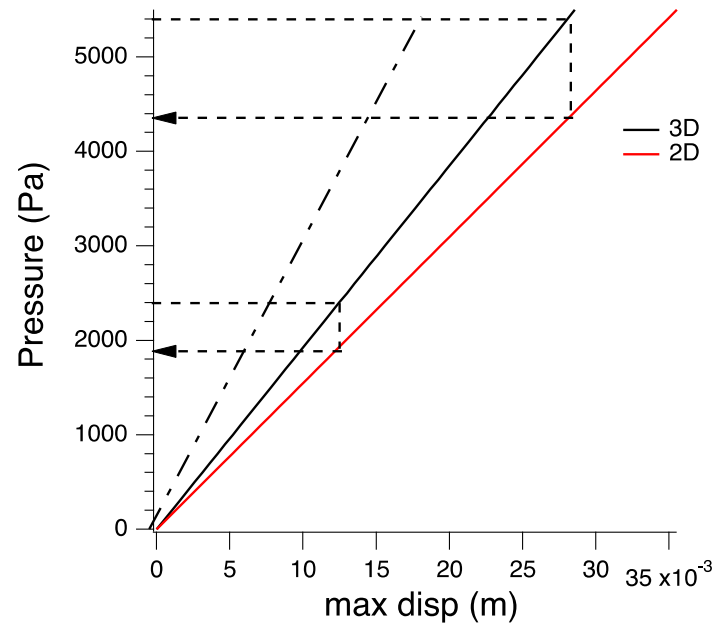
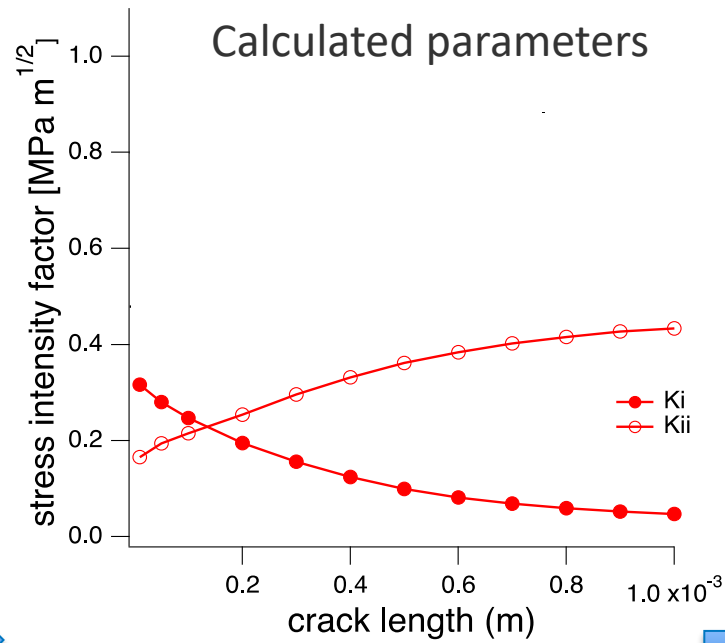
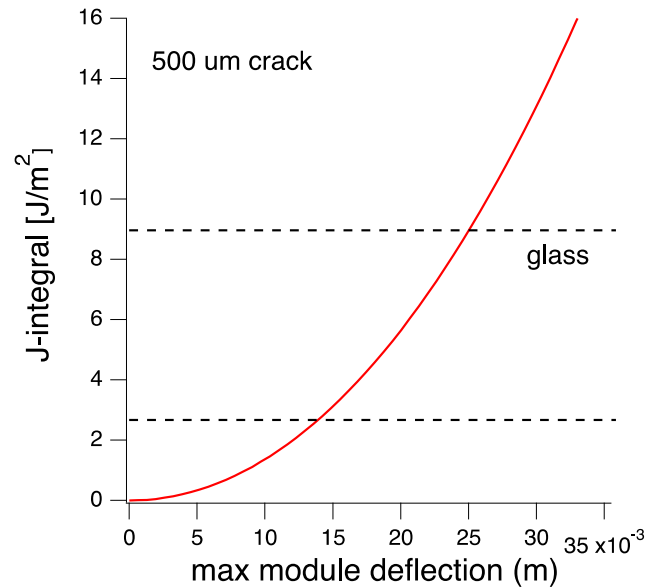


COMSOL Model

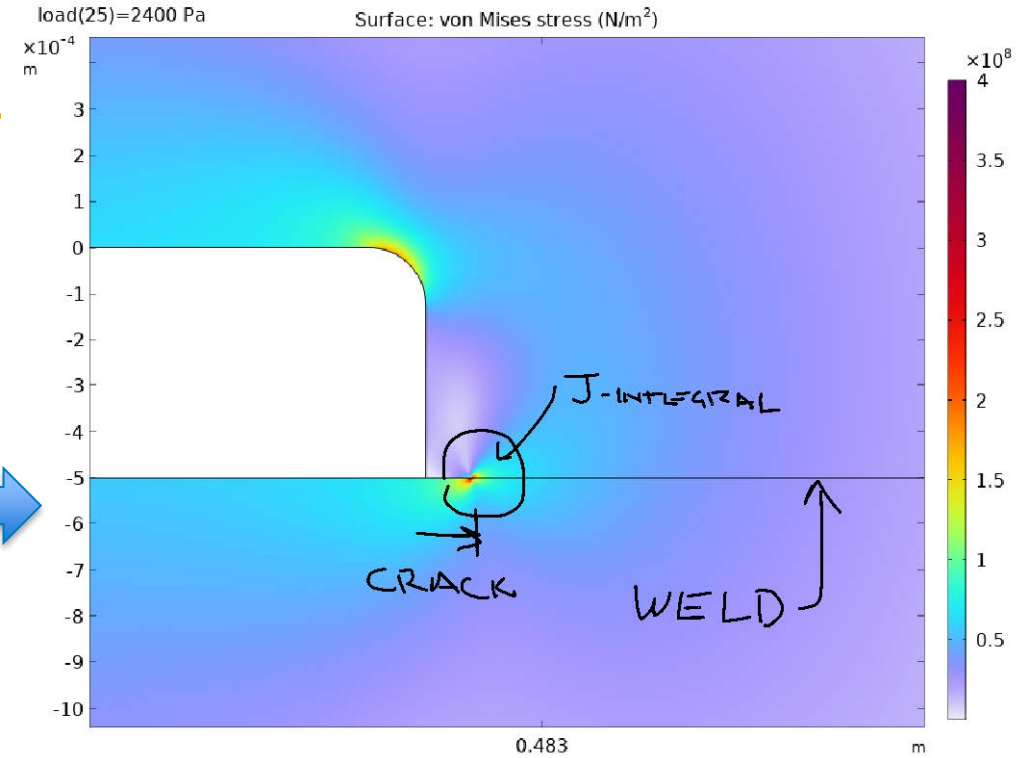
Appl Phys A (2011) 103: 257–261

Experimental plan: Modeling

Experimental input



2D COMSOL model of module weld



Glass laser welding? **Go/No_Go**

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Thank you

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