Development and Exploitation of Processes For Thin Flexible Glass

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Bonding and De-bonding for Handling Thin Flexible Glass

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5.3.14

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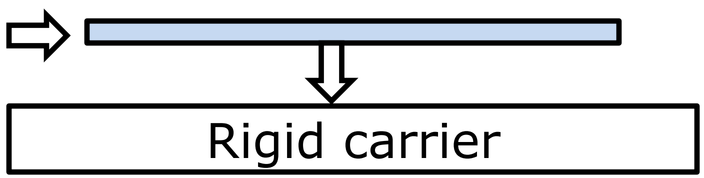
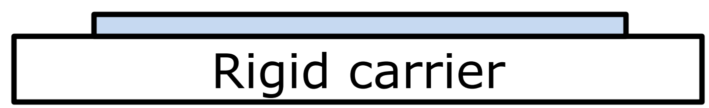
Aim: Facilitate initial uptake of TFG by developing handling techniques to use with conventional tools. Glass can be easy to break so bonding to a carrier will allow easy handling.

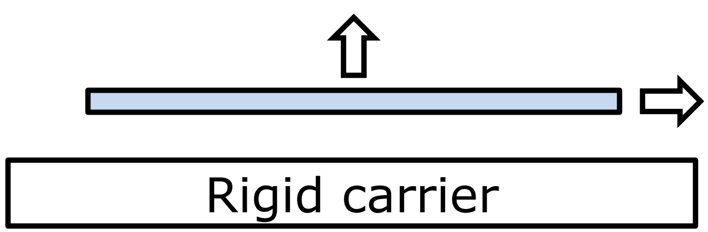


(1) Unroll TFG and bond onto carrier

Conventional tool set

(2) Process TFG (laser/inkjet etc.)





(3) Cut out pieces and De-bond TFG

Method 1: Bond + Thermal de-bond

Adhesive: Material “A” – UV curable epoxy adhesive that becomes brittle and releases at elevated temperature.

Method 2: Bond + Mechanical de-bond

Adhesive: Material “B” – UV curable epoxy adhesive that adheres more strongly to carrier than TFG

Method 1: Thermal de-bond

Various pieces of TFG were bonded to glass carrier by applying a small drop of epoxy to the carrier. The TFG was then placed on top an pressure was applied by hand to help the epoxy spread.

Capillary forces were sufficient to yield uniform bonding even without much pressure. Epoxy slowly spreads between TFG and carrier.

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Curing

Curing was performed using a Mercury lamp with fibre delivery for ~30s total exposure at ~3W with a 5mm spot.

Cure dose undefined as sample translation rate was not accurately controlled, but epoxy was found to be hard after curing.

De-bonding

After curing samples were placed on a pre-heated hot plate to de-bond.

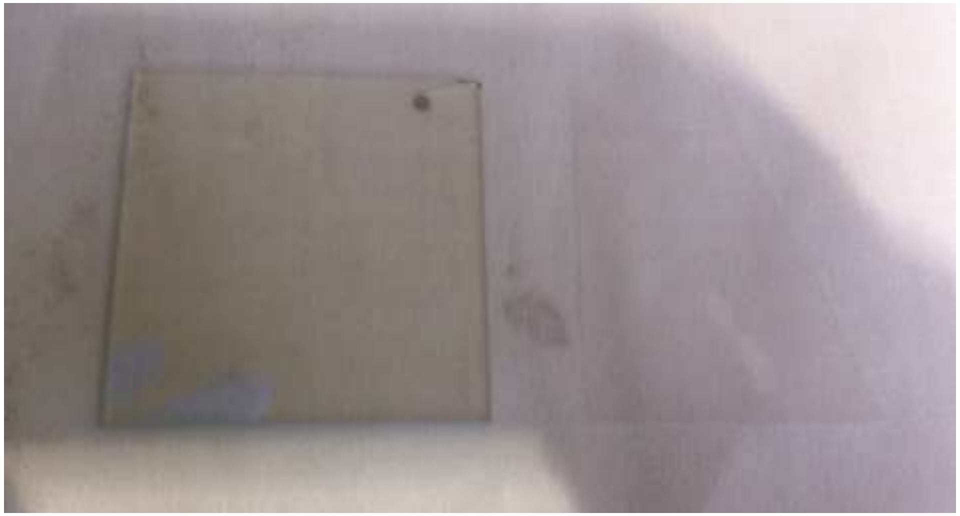
Dipping samples into boiling water was tried, but this did not seem to have any effect.

Set temperature of hot plate was varied between 100 ^{o}C and 205 ^{o}C .

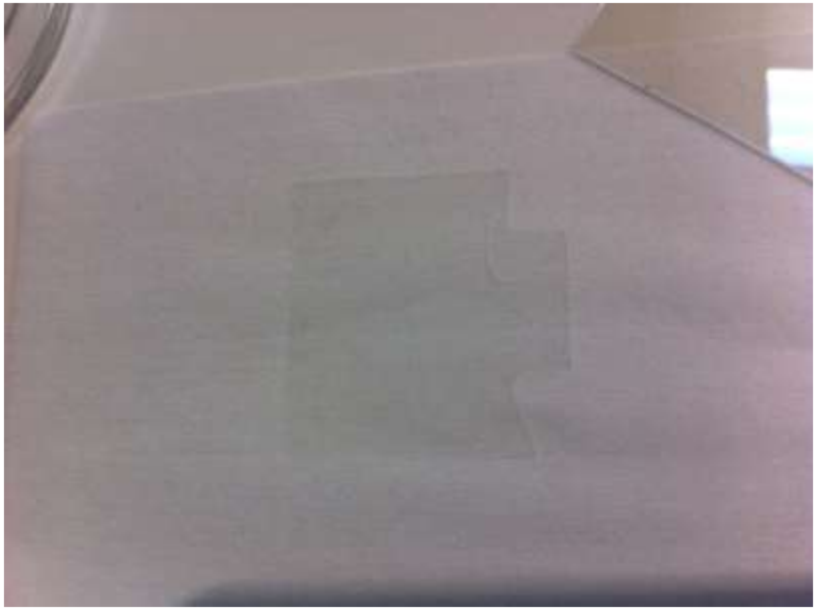
A visual change in the epoxy was observed for temperatures above 150 ^{o}C.

Note: Surface temperature of hot plate was not measured independently so may need calibration.

Test with normal glass (not TFG)



After heating the epoxy completely debonded from <u>both</u> the TFG and the glass, leaving no obvious residues.

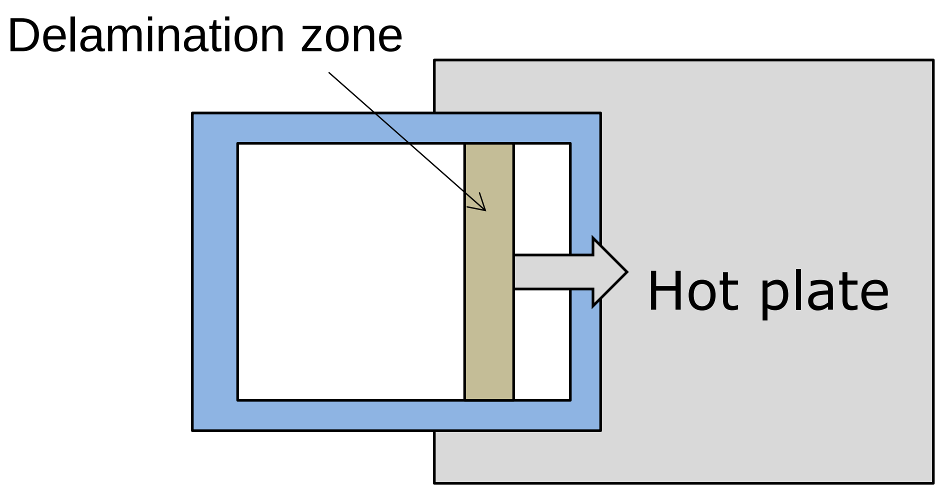


However, the stress caused during release caused cracking in many of the samples.

Cracking issues

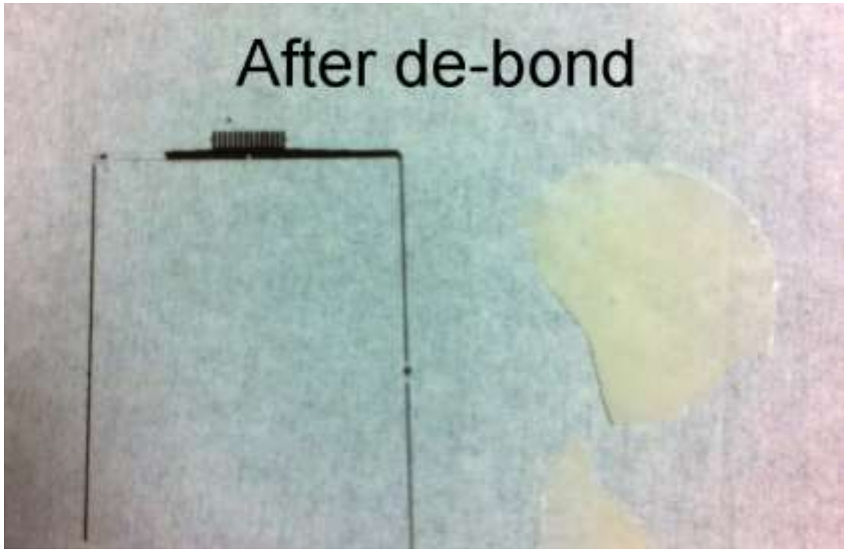
Crack appear to initiate and propagate from the edge of the scribed TFG samples. It is likely that defects at the edges are responsible. Edge quality may be superior in large pristine sheets of TFG.

In an attempt to decrease cracks, slowly moving samples onto the hot plate from one side was found to help.



Bonding and De-bonding Touch panel sensor on TFG

To demonstrate process a inkjet printed and laser cured copper touch sensor metal pattern on 50 μm thick glass was successfully attached to a carrier and then de-bonded.



Initial conclusions – Thermal release

- Bonding and de-bonding was successfully achieved, but success rate was poor with 100 μm glass due to edge cracking issues. With 50 μm glass cracking was less of a problem.

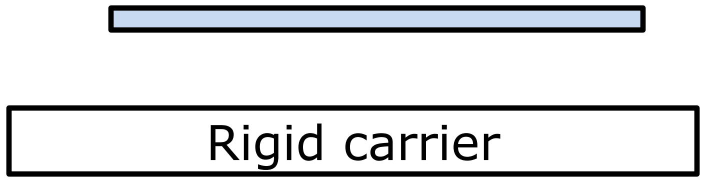
- A complete systematic test with larger pieces of TFG direct from roll would be required in order to optimise process.

- Crack generation mechanisms and methods to minimise/relieve stress after the sudden de-bond event need to be examined.

Method 2: Mechanical de-bond

Corona

(1) Prior to bonding either the TFG or the carrier were surface treated to aid adhesion.

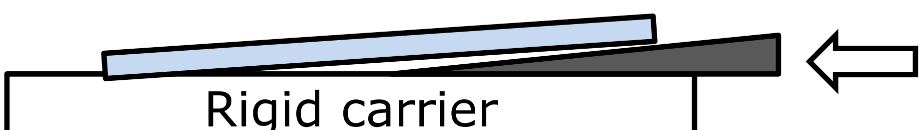


Either a corona treatment or an atmospheric plasma gun were used to treat the surfaces.

Plasma

(2) Samples were then bonded with adhesive "B" and UV cured as before

(3) A moving metal blade was then used to "peel" the TFG from the carrier.

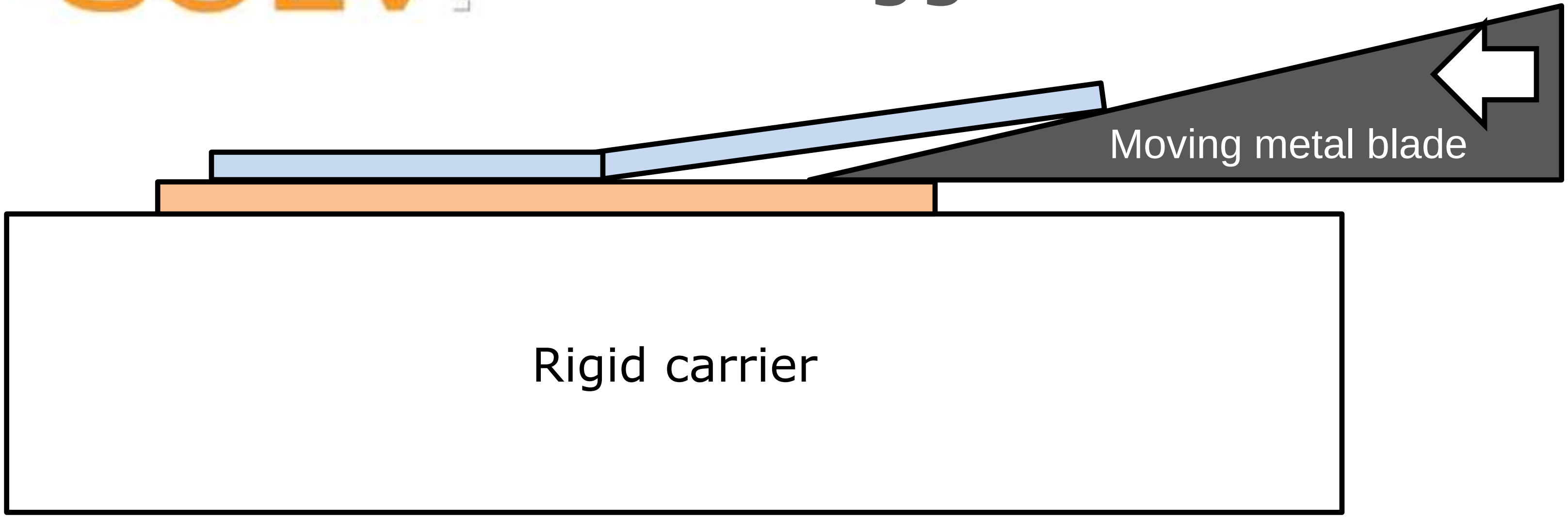


Moving metal blade

Results

- The mechanical peel was successful.
- The adhesive bonds most strongly to the surfaces that have been treated (corona performs better than the plasma). This ensures that the epoxy can be left on the carrier.
- The success rate was highest for the corona treated carriers.
- Optimising the wedge angle is important.

Suggestions



TFG is flexible enough to accommodate some flexing prior to peel.

The angle on the blade needs to be optimised/maintained such that the peel point is always ahead of the blade. Otherwise the blade digs into the epoxy.

A flat angle on the blade doesn't work (hits the epoxy) - nor does a steep angle (as glass cracks.)

Conclusions

- Two methods demonstrated for bonding and de-bonding TFG from a carrier.
- The thermal de-bonding was possible but problematic, as the release was not instantaneous everywhere, so stresses can induce cracking. Careful management of temperature profiles would be needed.
- Mechanical de-bonding assisted by surface pre-treatment was successful but needs optimisation. Further study of the reliability of peeling with larger pieces would be required.