

Bend it like...

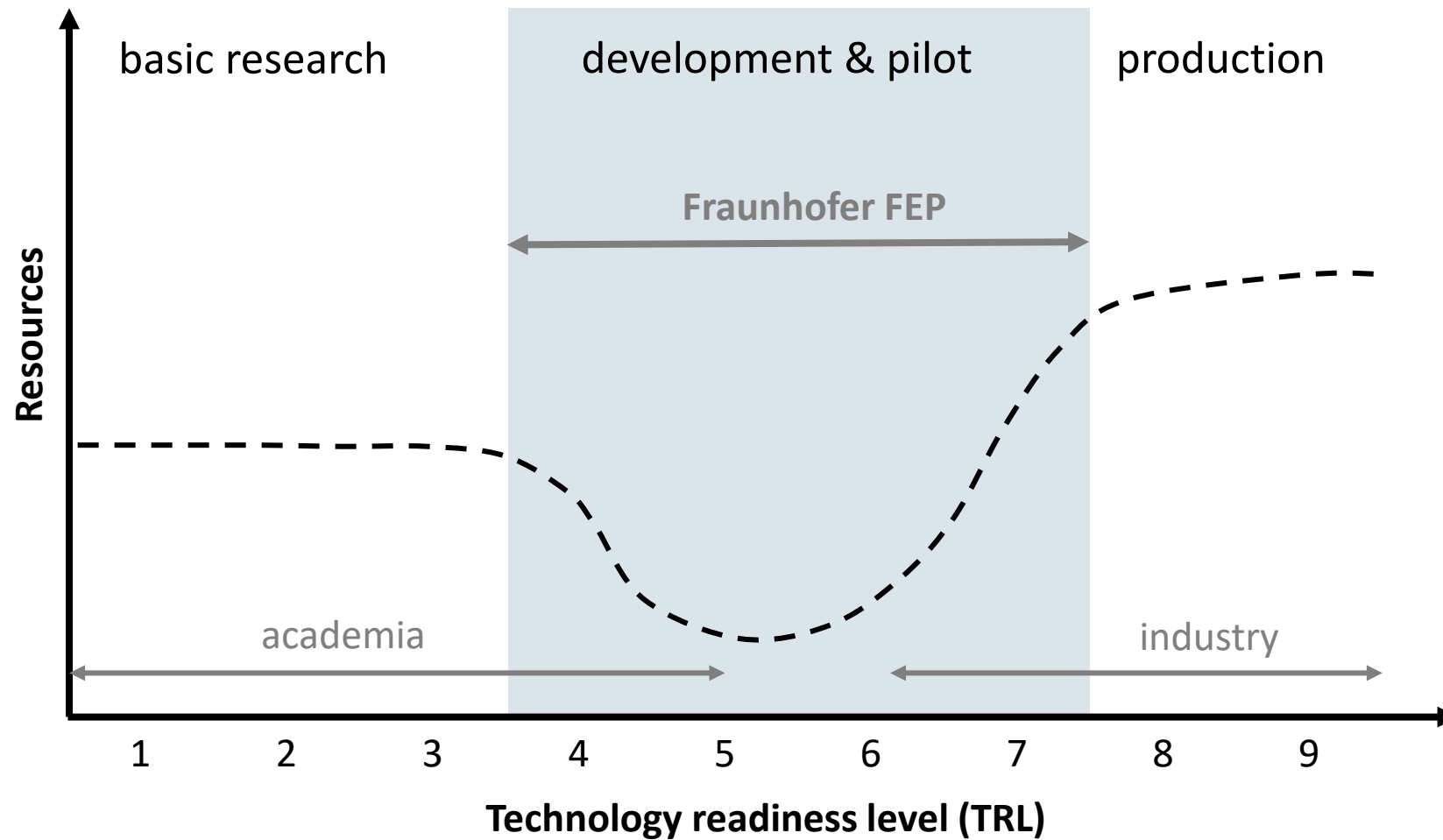
A contribution to investigations of the fatigue behavior of flexible glass

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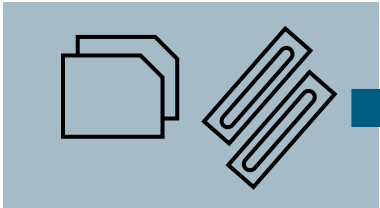
...but it is partly stuck in the technological valley of death



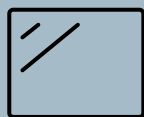
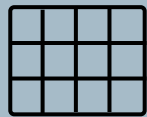
In imitation of REHVA Journal 03/2015 p.58

Flexible glass requires dedicated handling

raw materials



functionalization



products

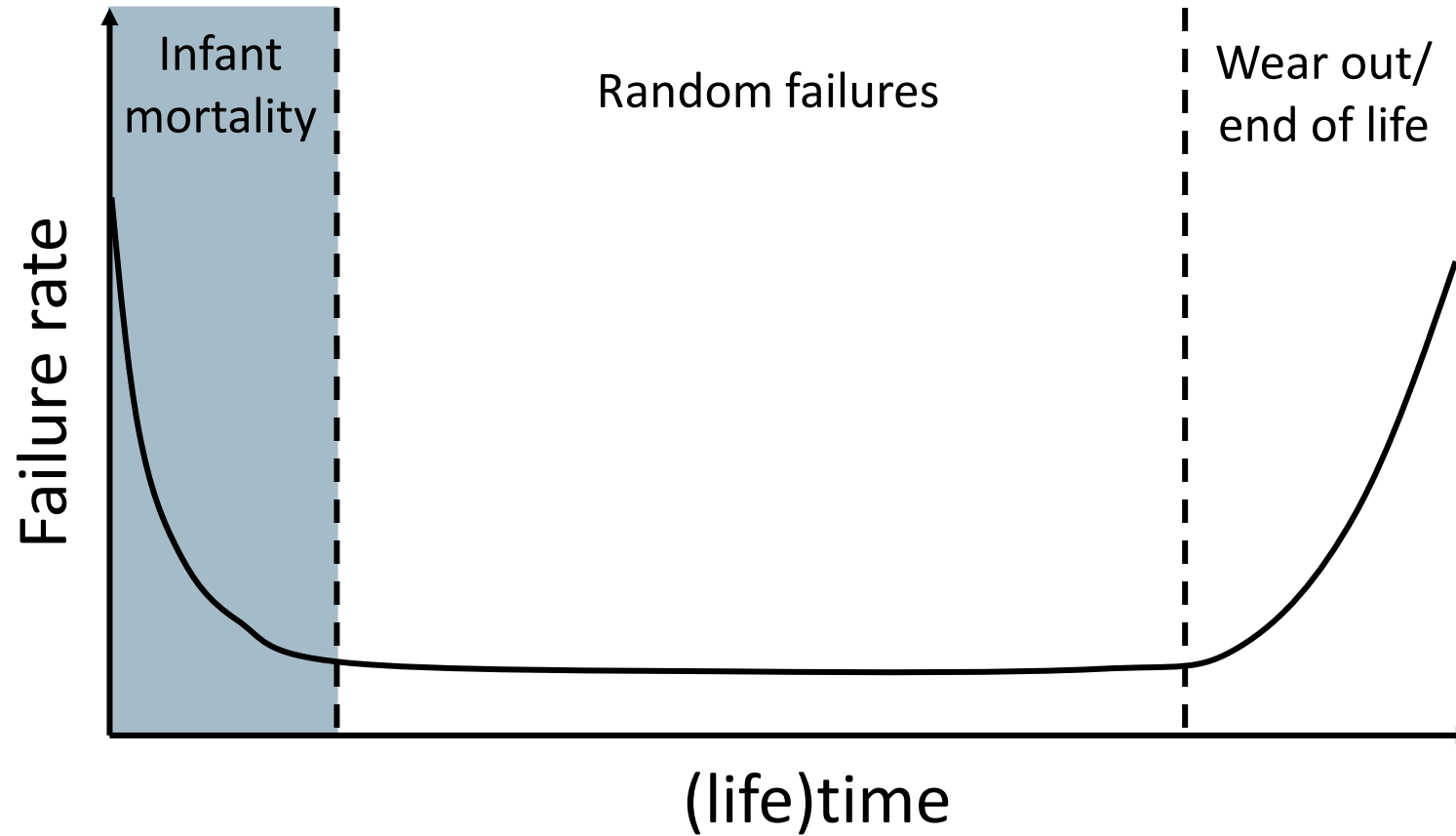


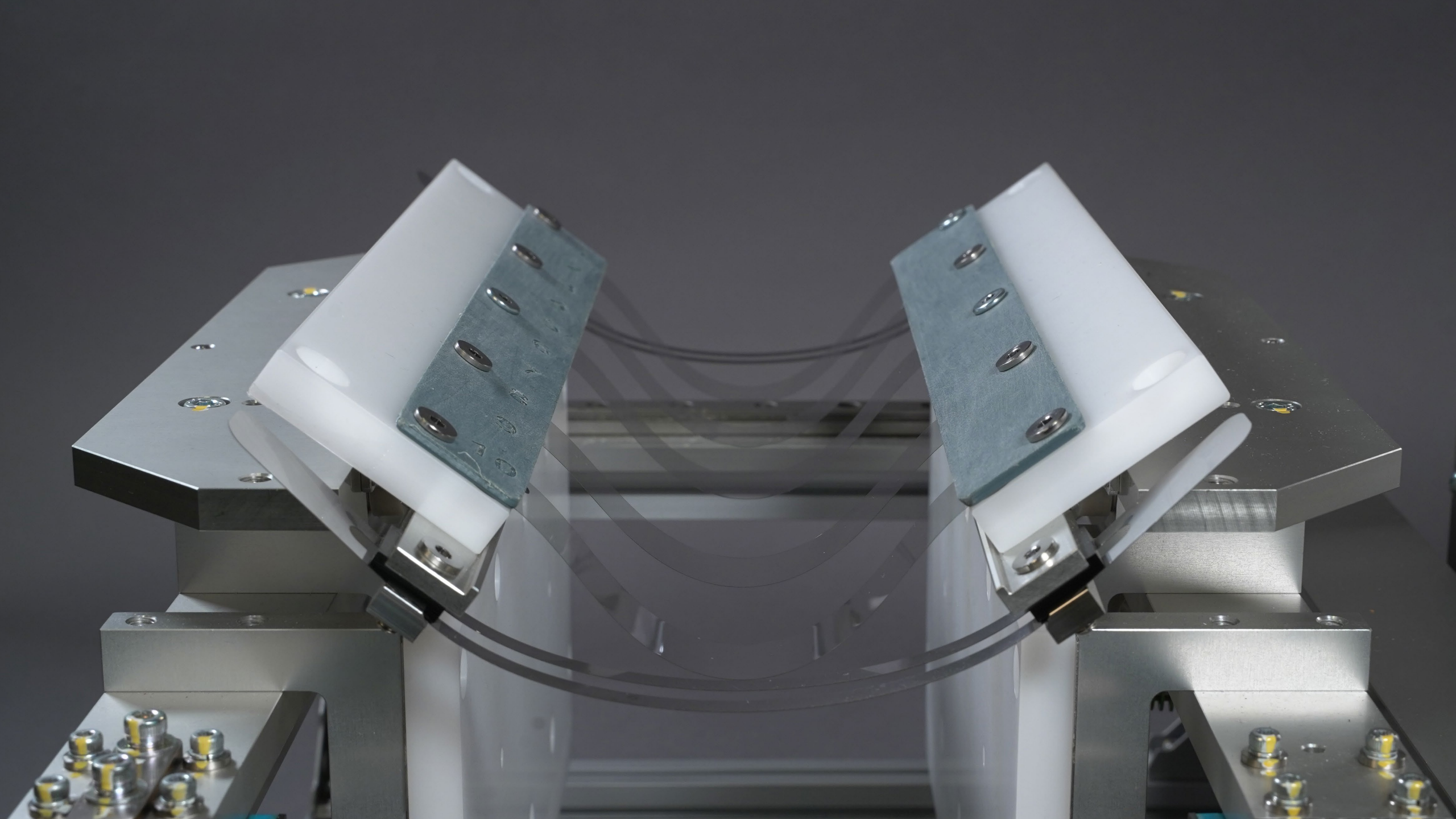
Cutting Cleaning

Handling

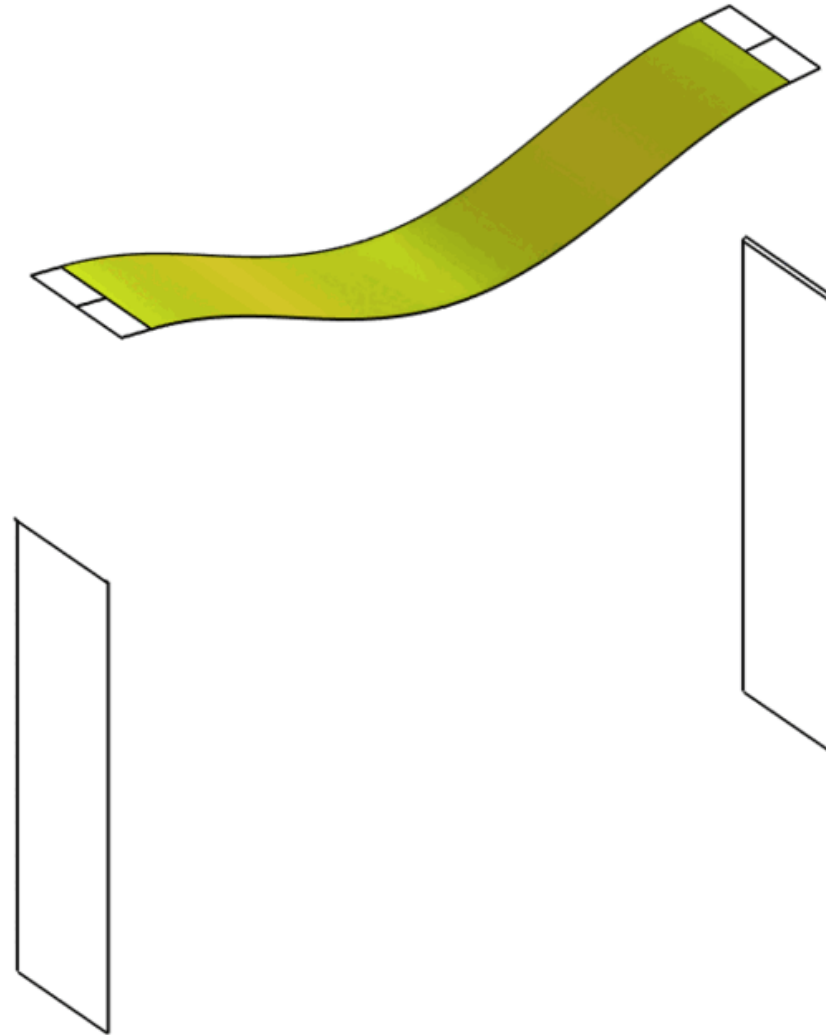
Coating Inspection

Infant mortality is highly relevant in the flexible glass process chain

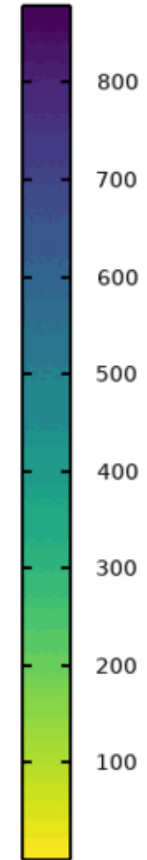




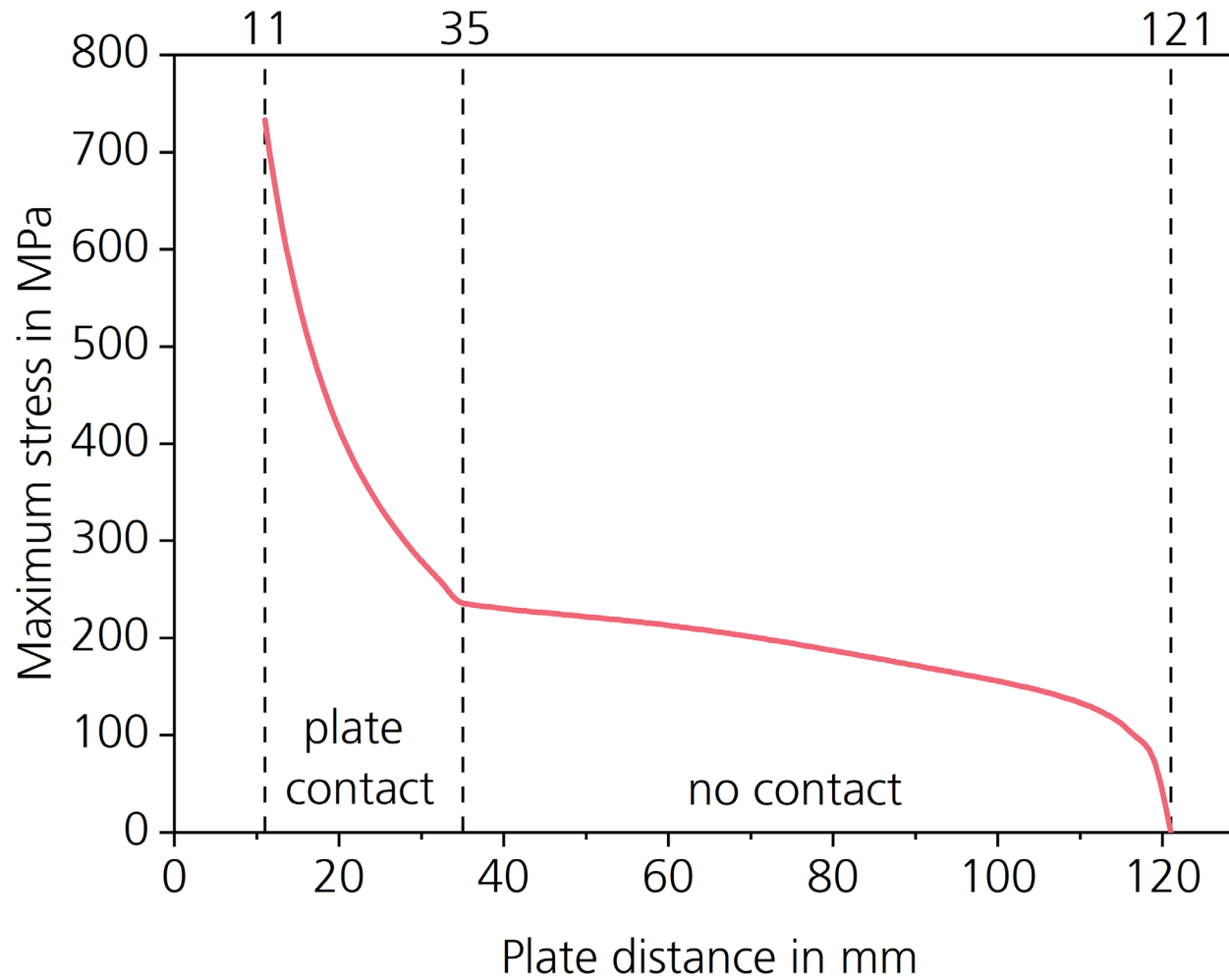
U-Shape folding test using an endurance testing machine



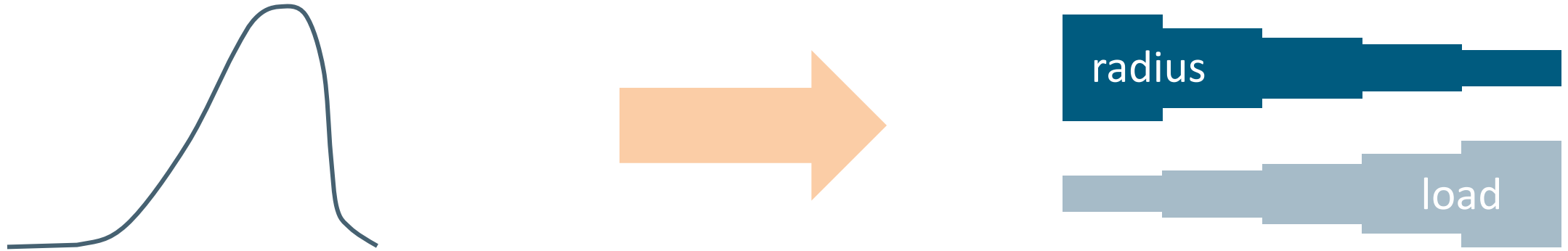
Stress in MPa



The maximum stress curve is non-linear and consists of two ranges



Stepwise testing can probably reveal the fatigue window of flexible glass

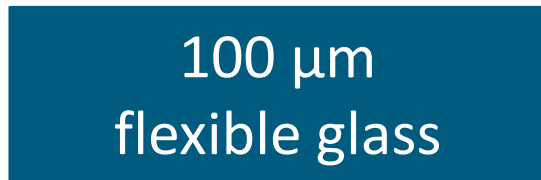


- Glass strength is randomly distributed, following the Weibull distribution
- Fatigue occurs in a very small window right before total failure

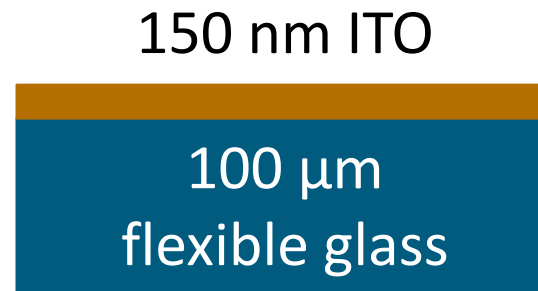
- Stepwise load increase
- 500 cycles per load step
- 30 specimens per sample

Three different sample groups have been tested

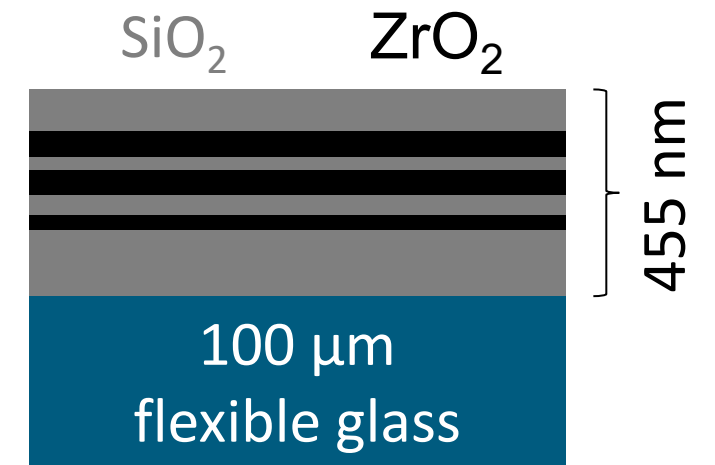
Blank substrates



Transparent electrode



Antireflective layer stack



4 variations per group

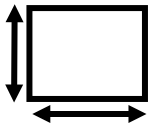
Vacuum inline coating machine with 10 process stations



DC and PMS

PVD and PECVD

Planar and rotatable
targets



max. 600 x 1200 mm²

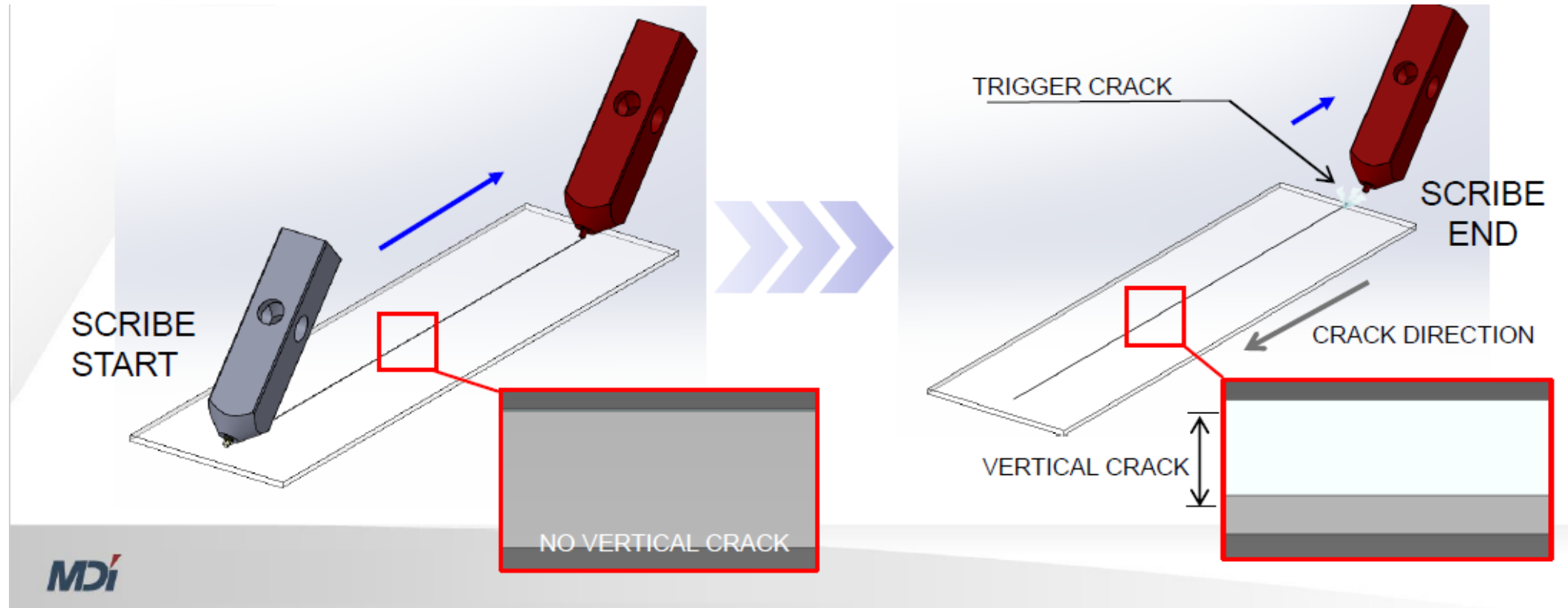


Pre- and postannealing

Inline flash lamp annealing

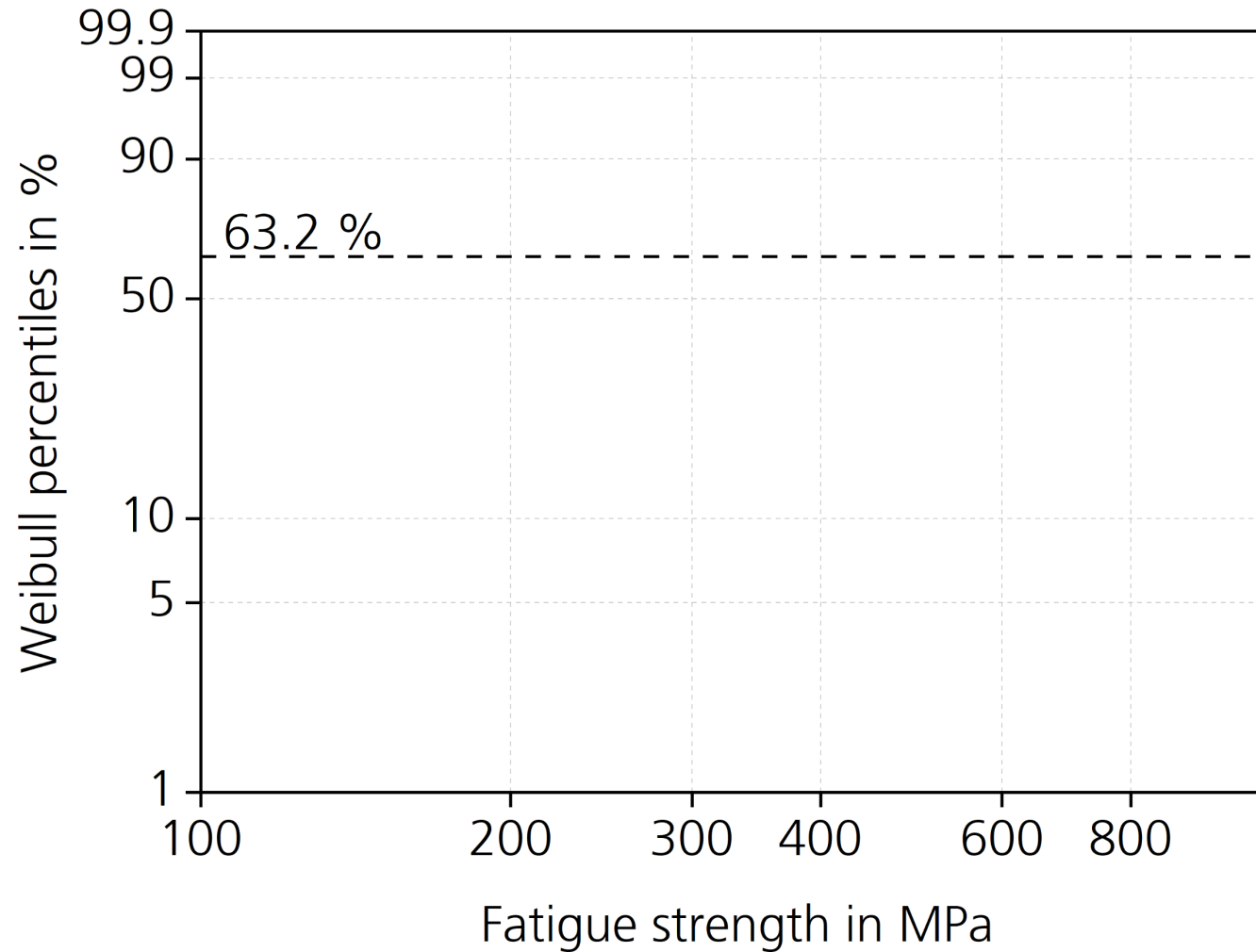


The samples were cut on the coated side with a diamant tip



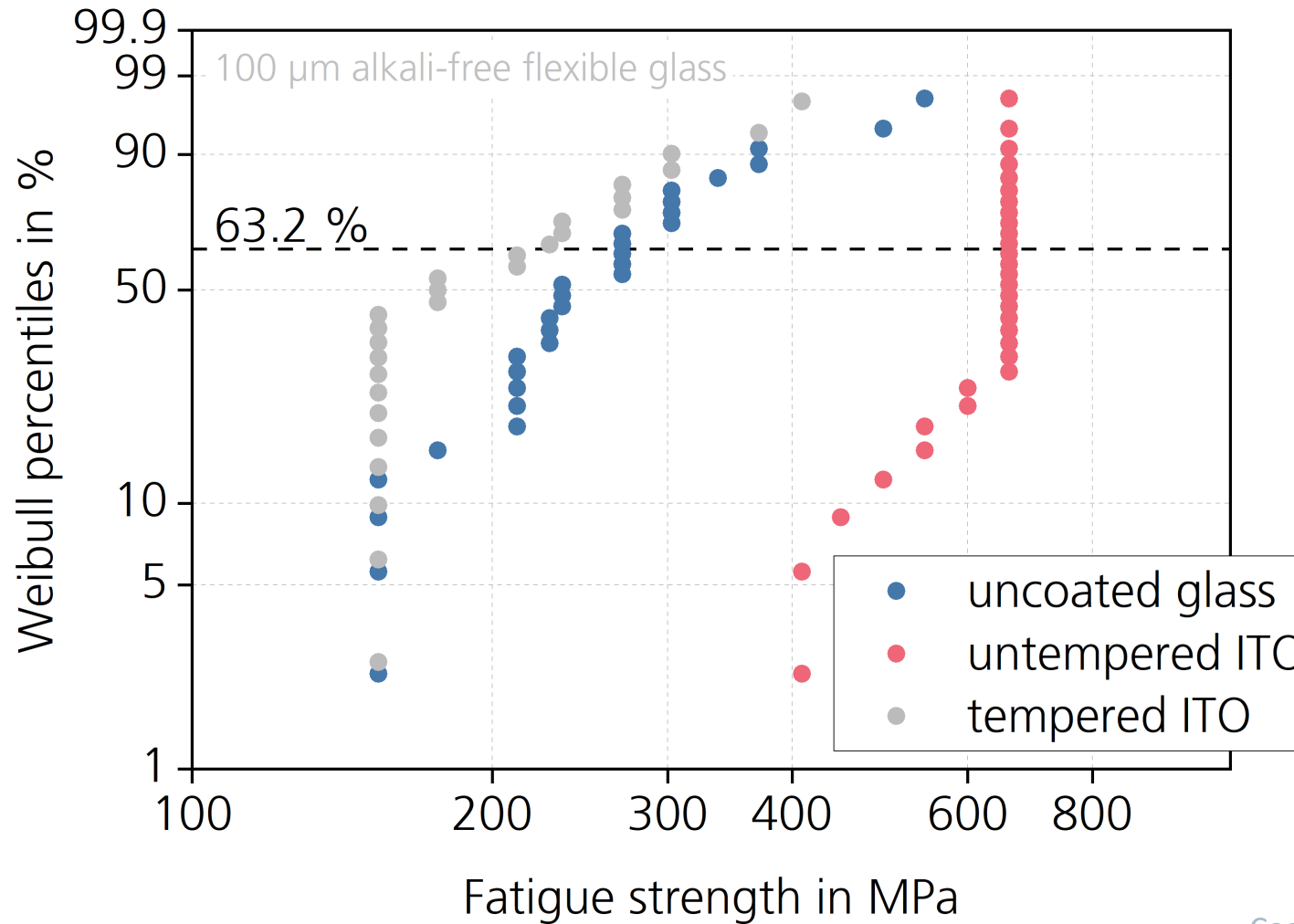
A coating seems to increase the fatigue strength...

$$F(\sigma) = 1 - e^{-\left(\frac{\sigma}{\sigma_{crit}}\right)^m}$$

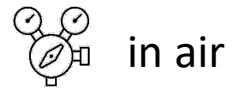
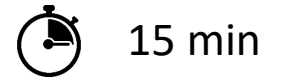
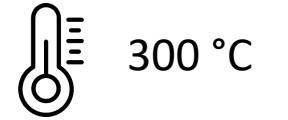


d/cut side under tensile stress

... but tempering seems to lower the fatigue strength again

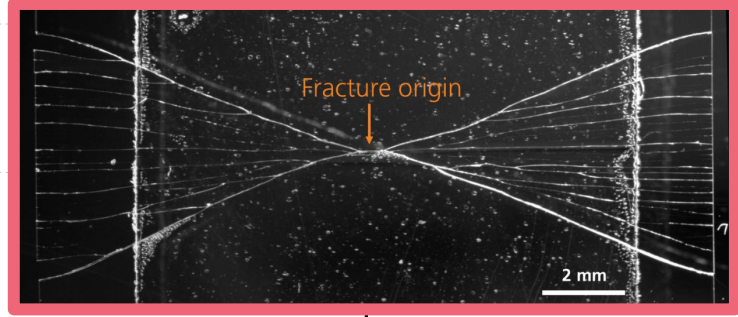
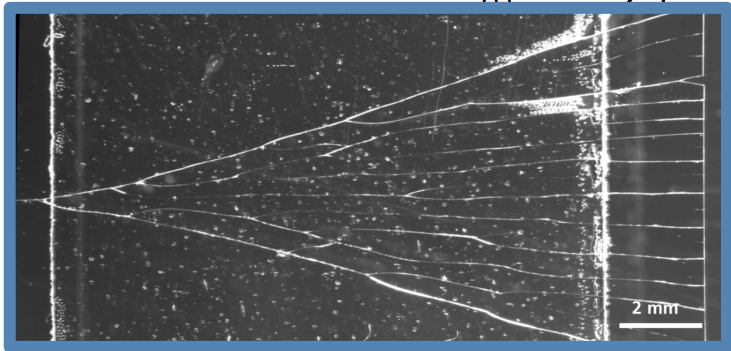
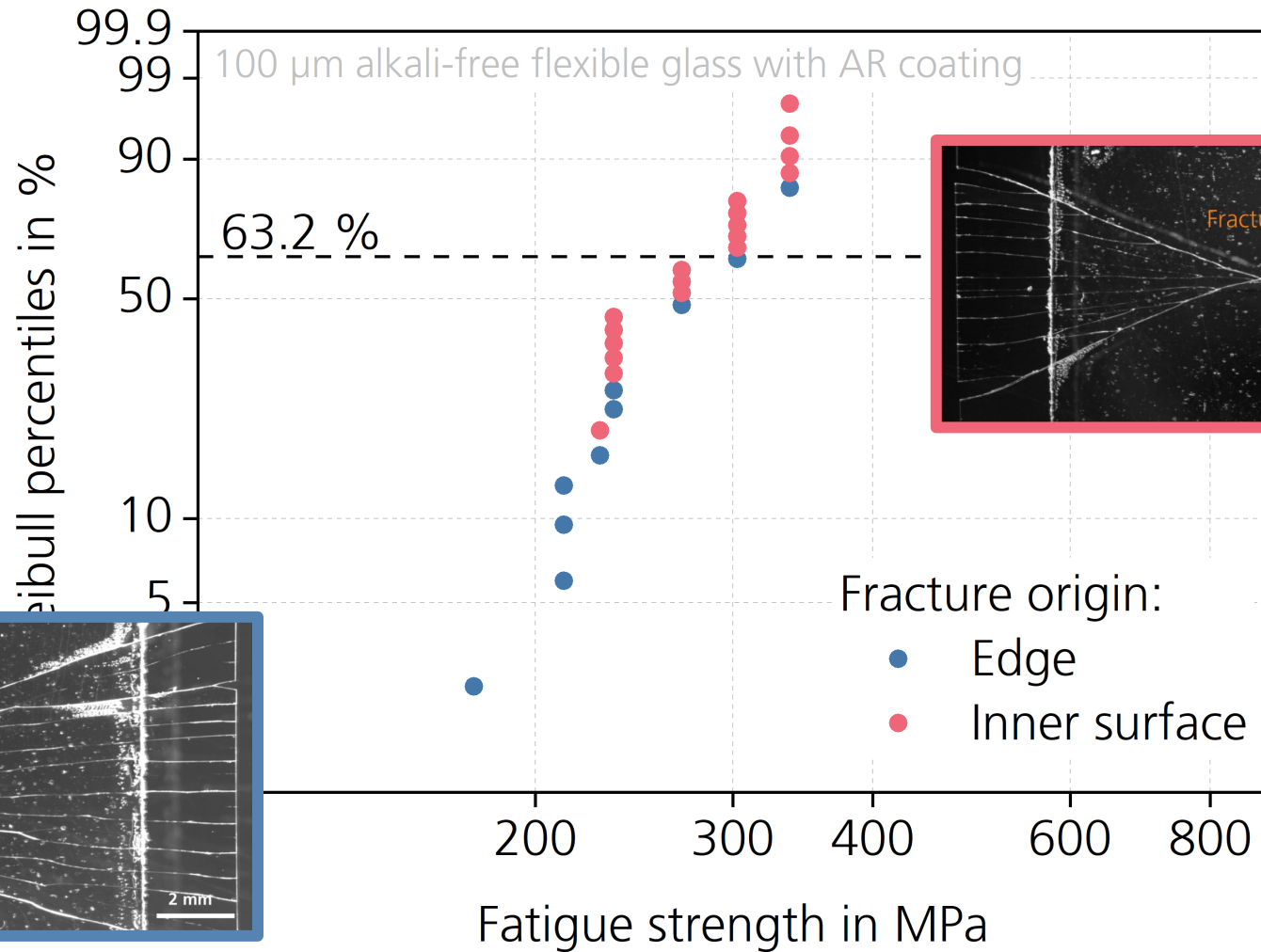


Tempering:

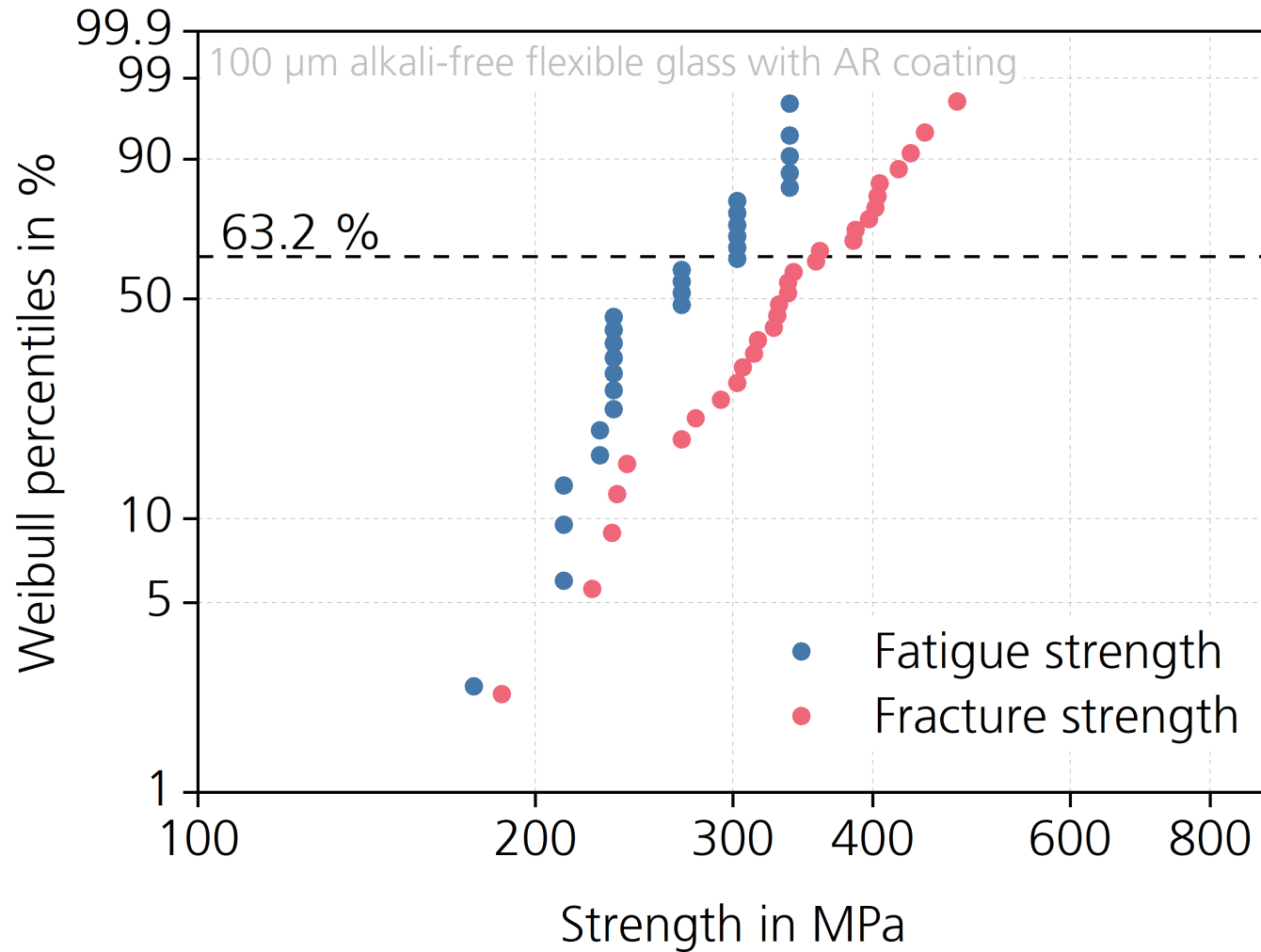


Coated/cut side under tensile stress

Fractures due to edge defects seem to dominate at low failure probabilities

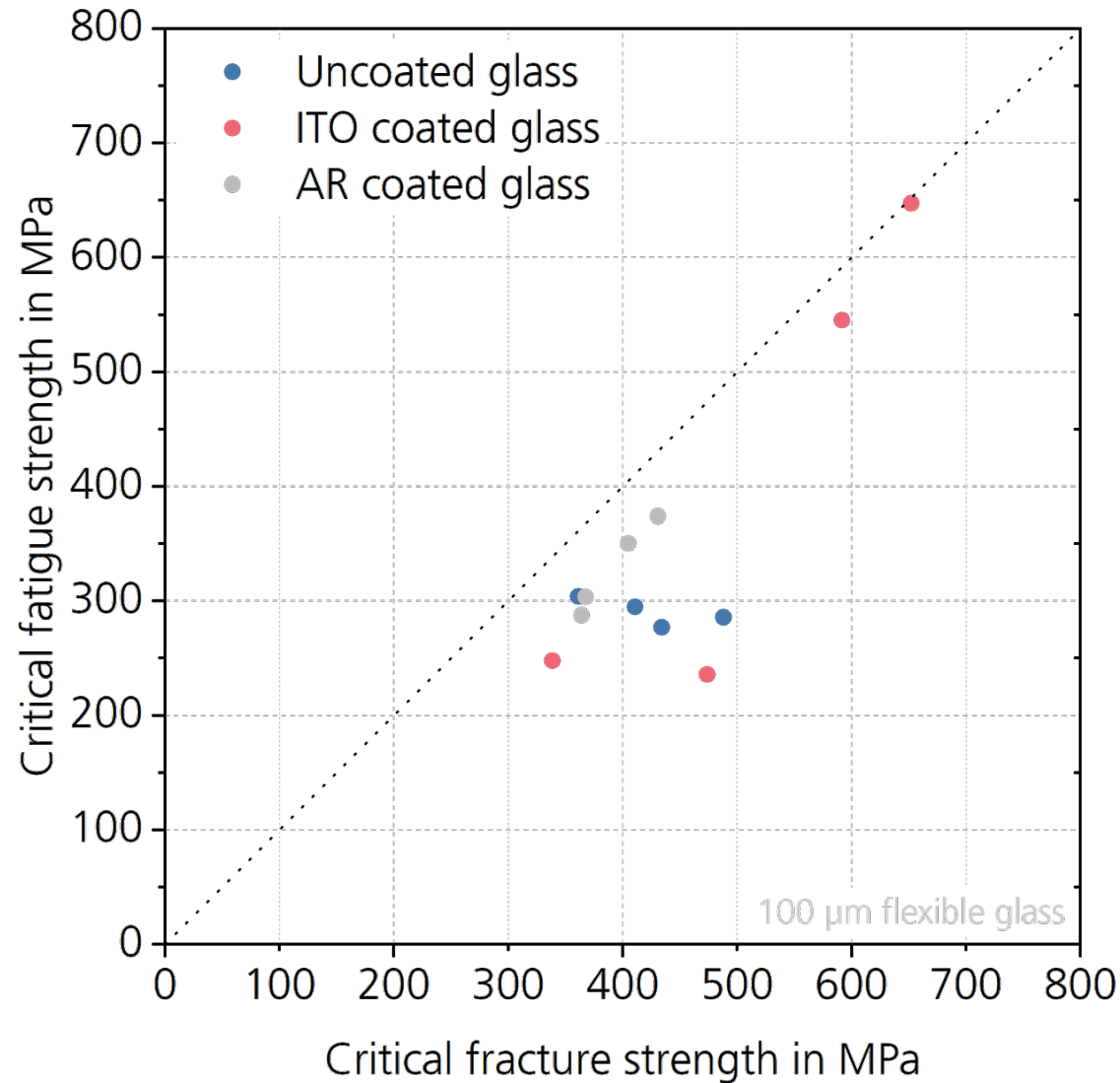


The fatigue strength seems to differ from the „normal“ fracture strength



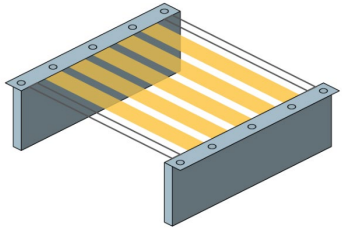
Coated/cut side under tensile stress

The critical fatigue strength seems to be lower than the critical fracture strength



Coated/cut side under tensile stress

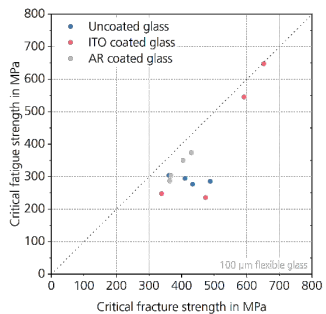
Take home messages



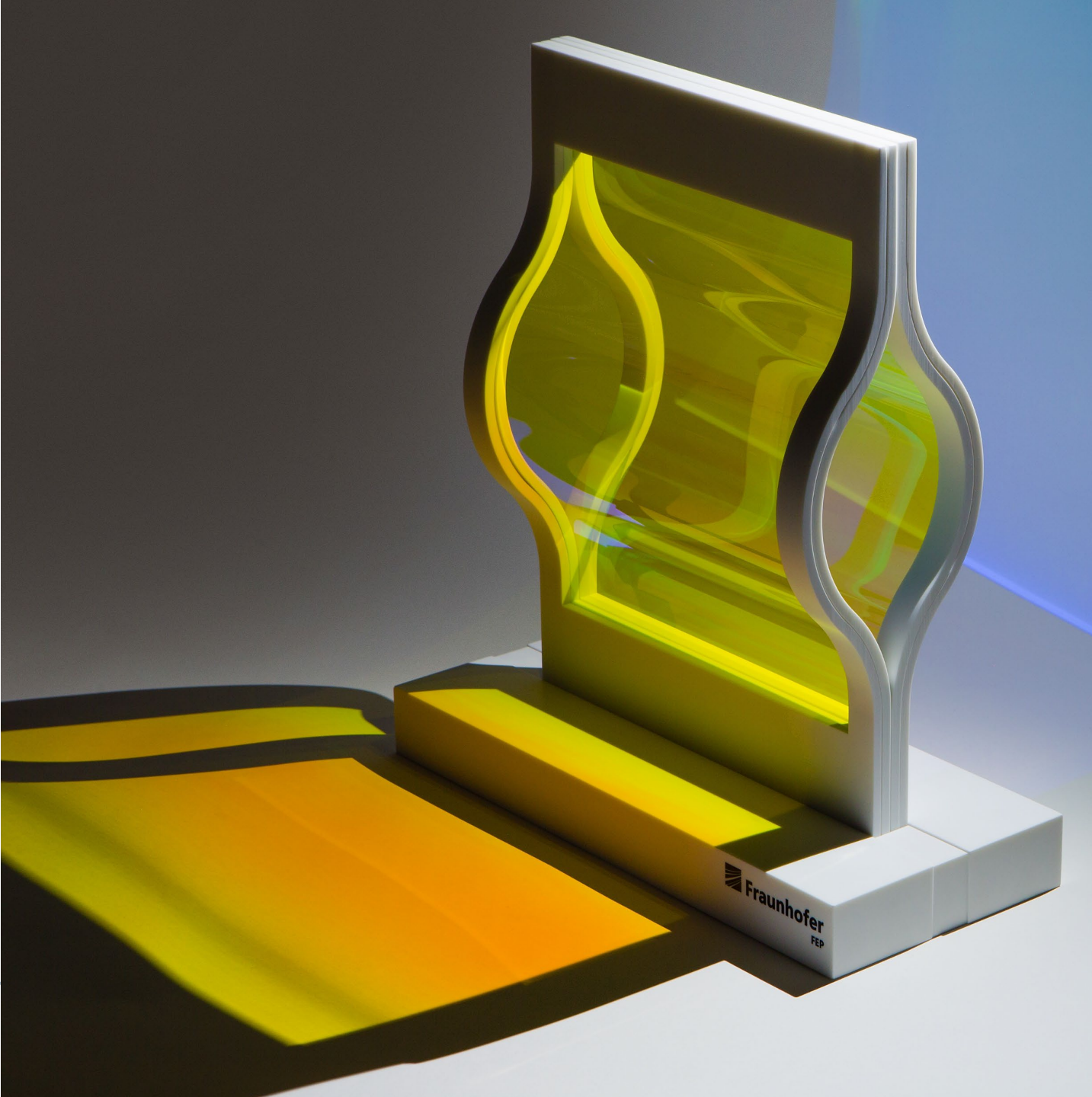
U-Shape Folding is an easy to conduct rapid testing method.



Coatings can both strengthen and weaken the glass depending on the functionalization procedure.



First results suggest that the fatigue strength of flexible glass is lower than its fracture strength.



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