How To Peel Ultra Thin Dies From Wafer Tape

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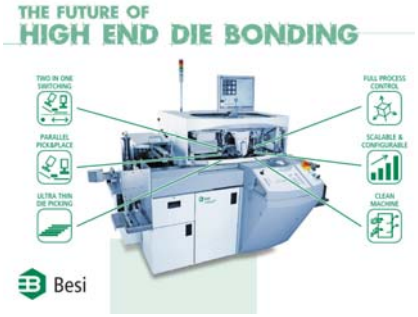
Introduction:

- 4 key properties
- Multidisc Die Ejector
- FEA Model

1. Wafer foil bulk peel force
2. Wafer foil edge peel force
3. Bending stress: ejector types, FEA simualtions, comparison
4. Die strength: overview, examples



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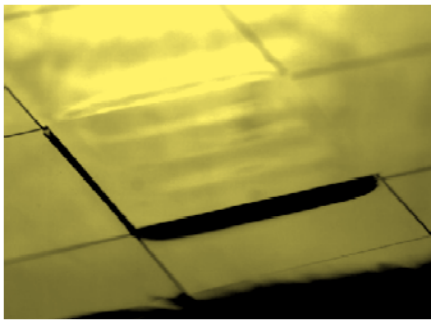
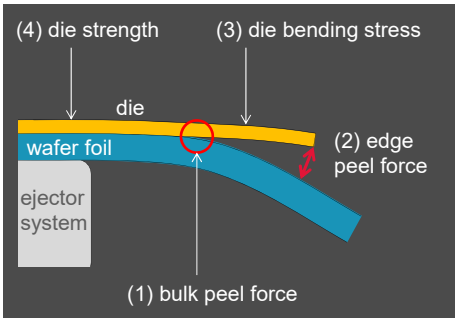
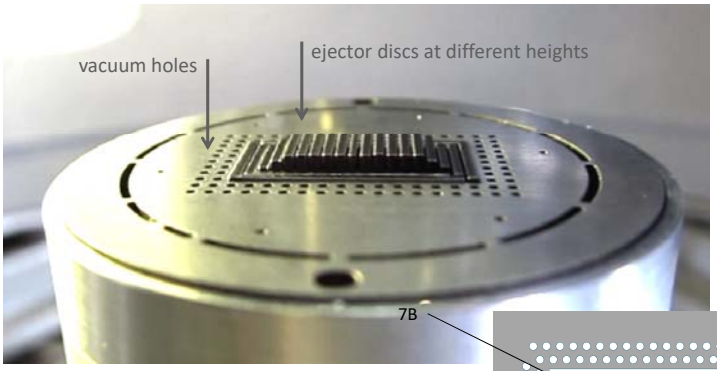
Four Key Properties

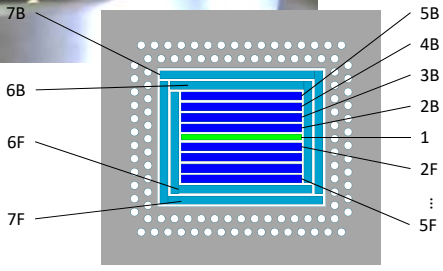
- handling thin dies with carrier foils is still state of the art
- typical die bonder data sheet specification:
  «min. die thickness 20 μm»
- this specification is too simple!



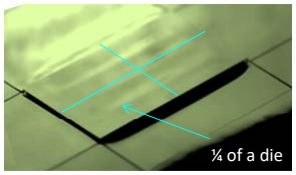


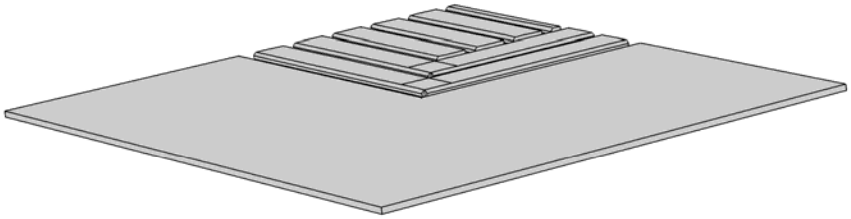
Multidisc Die Ejector





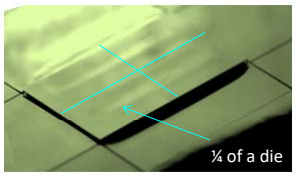
Multidisc Die Ejector: Disc Move

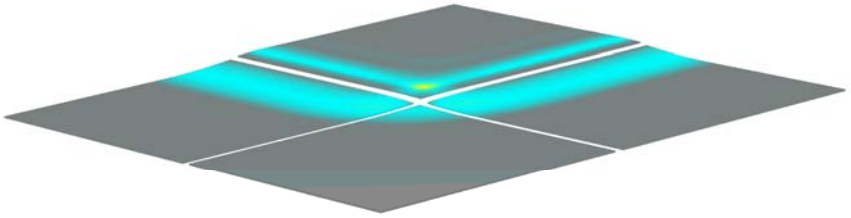




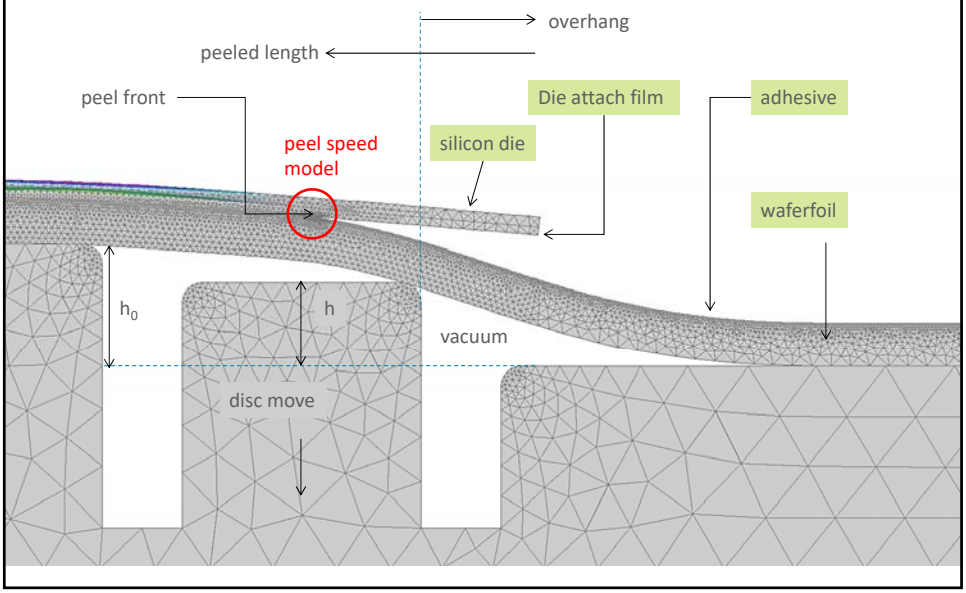
Multidisc Die Ejector: Die Peeling Simulation

pre-defined geometries, pseudo-dynamic
8um peel/step (47steps)
disc height 300um
color code: bending stress
z-axis 4X





FEA Model: Geometry

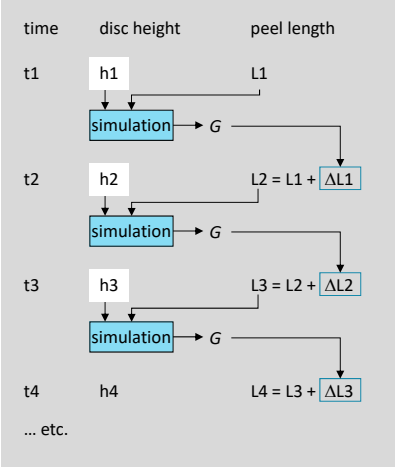


FEA Model: Dynamics

1. run simulation for static geometry
2. convert stress at peel front to peel energy G (D = adhesive thickness, E = adhesive modulus)

$$G = \frac{<\sigma_z^2> D}{2E}$$

3. convert peel energy to peel speed



Four Key Properties

Introduction:
- 4 key properties
- Multidisc Die Ejector
- FEA Model

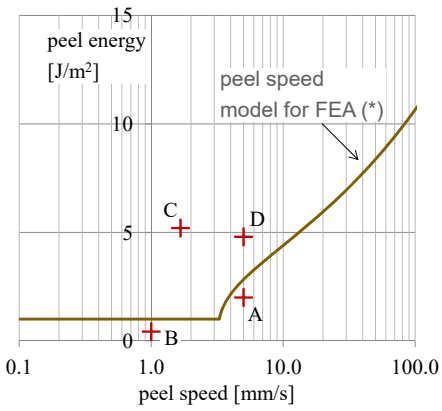
1. Wafer foil bulk
2. Wafer edge peel force
3. Bending stress: ejector types, FEA simualtions, comparison
4. Die strength: overview, examples

1. Wafer foil «bulk» peel force | data sheets

Label	Foil	Type	Peel speed [mm/s]	Peel energy [J/m²]
A	Lintec LE4728	UV	5.0	2.0
B	Hitachi HR Series	UV	1.0	0.43
C	Ablestik ATB-100US1	UV	1.7	5.2
D	Nitto EM-310J-P	UV	5.0	4.8
-	Nitto SWT-20P+	non-UV	5.0	70.0

$$peel\ energy = \frac{F}{b}(1-\cos\varphi)$$

peel force *peel angle*

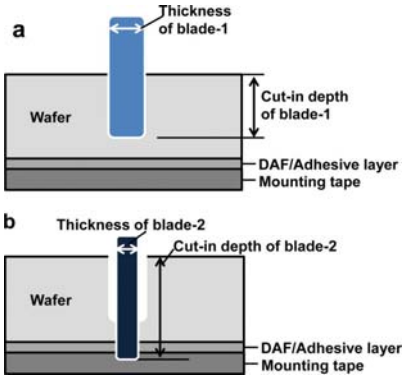


* approximates trend in data from Saiki et al, Tokoyo Institute of Technology

2. Wafer foil «edge» peel force

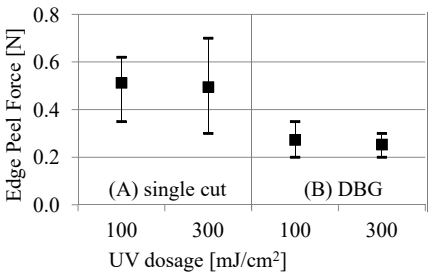
- adhesion at die edge (point load)
- typical range 0.1 … 1.5 N
- must be < 0.3 N for thin dies
- value depends on dicing method
- can be reduced by step cut, DBG, ..

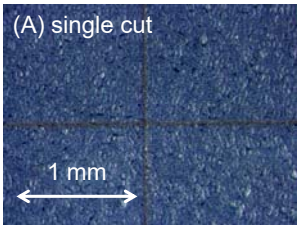
example: step cut

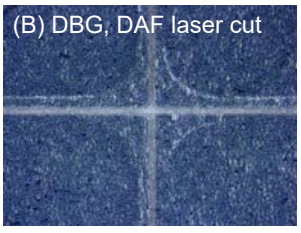


2. Wafer foil «edge» peel force

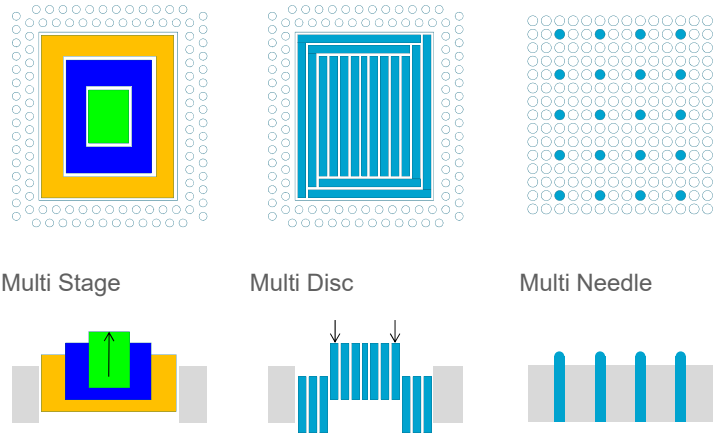
- single cut shows 2x higher edge peelforce due to local heating by blade
- Hitachi HR-9070-GT1



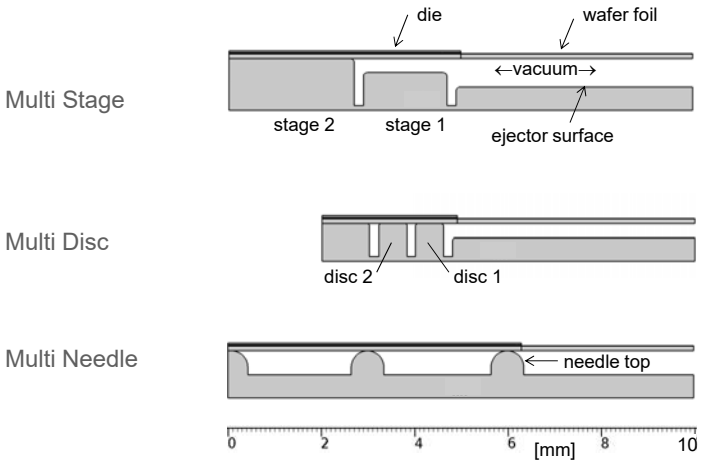


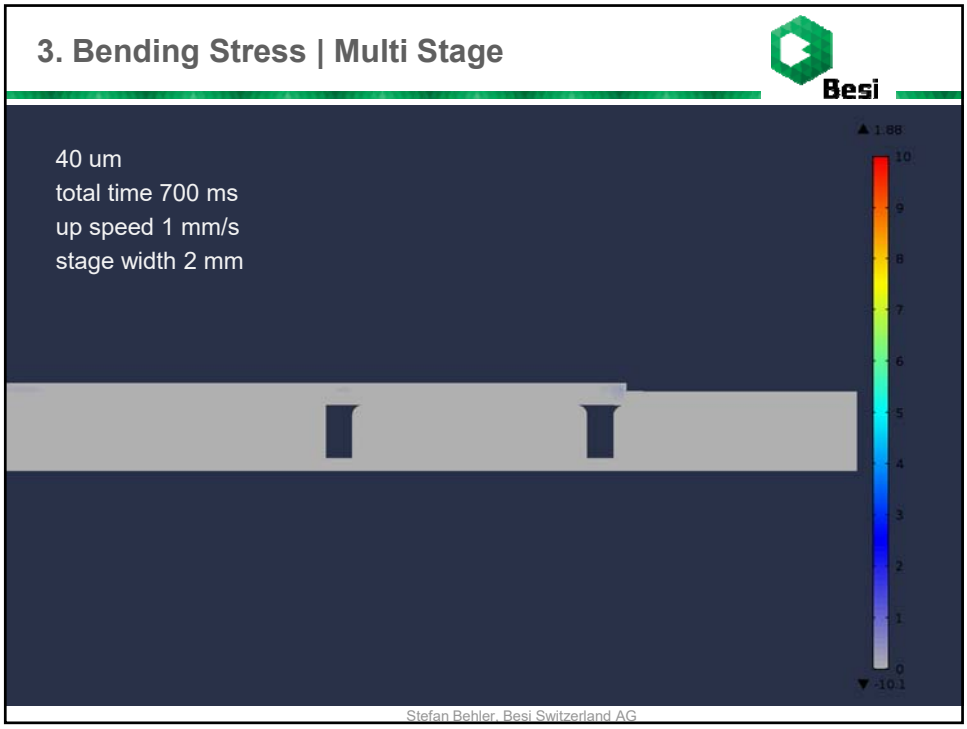


3. Bending Stress | Ejector types



3. Bending Stress | 2D FEA models




3. Bending Stress | Multi Stage
Besi
40 um
total time 700 ms
up speed 1 mm/s
stage width 2 mm
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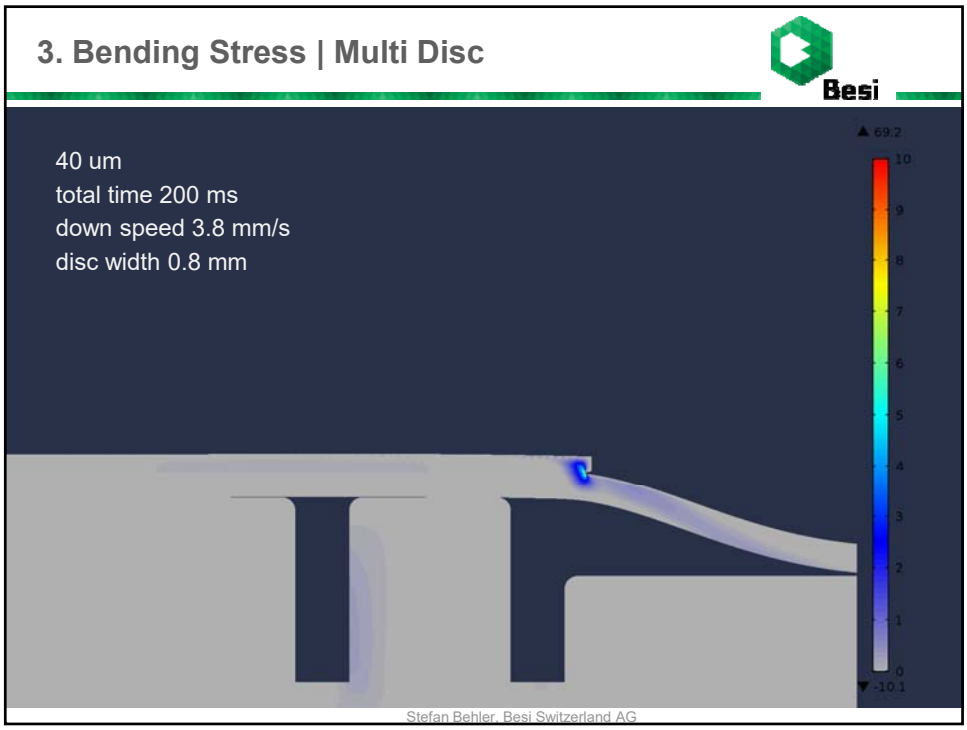
3. Bending Stress | Multi Disc
Besi
40 um
total time 200 ms
down speed 3.8 mm/s
disc width 0.8 mm
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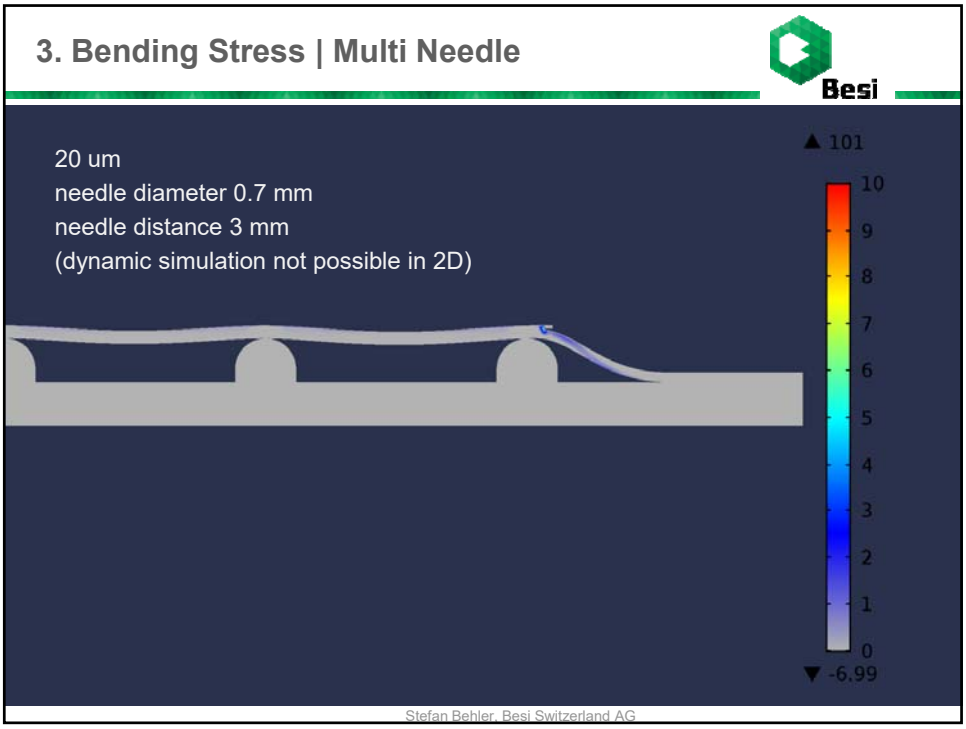
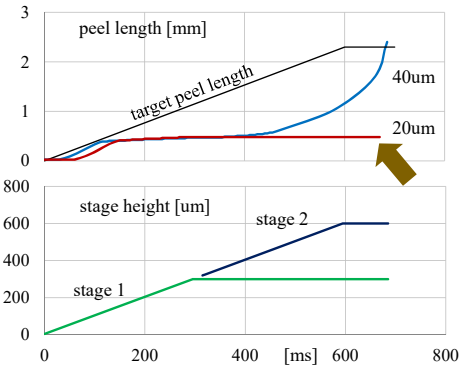
3. Bending Stress | Multi Needle

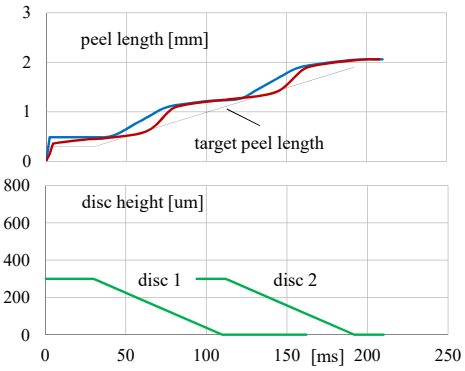


3. Bending Stress | Peel propagation

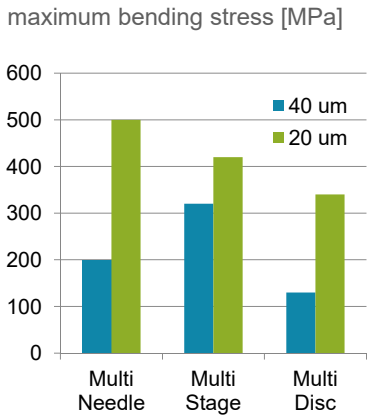
Multi Stage
20 um die can not be peeled



Multi Disc



3. Bending stress | Comparison



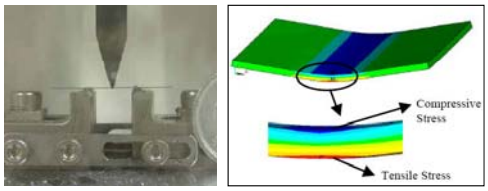
- thinner die → more bending stress
- tensile stress on surface (compressive stress only for multi needle)
- smallest bending stress by multi disc
- with assumption/settings in this model, 20um dies cannot be picked with multi stage

4. Die strength

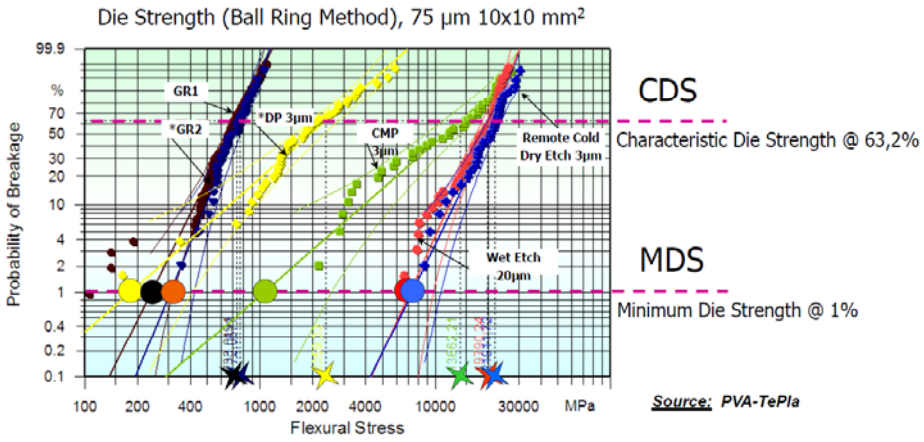
- material property, (almost) independent of thickness
- measured by bending test

three main regions of different strength:
- surface (active structure)
- backside (grinding, polishing...)
- edges (dicing)

die strength [MPa] measured by 3-point bending



4. Die strength | example



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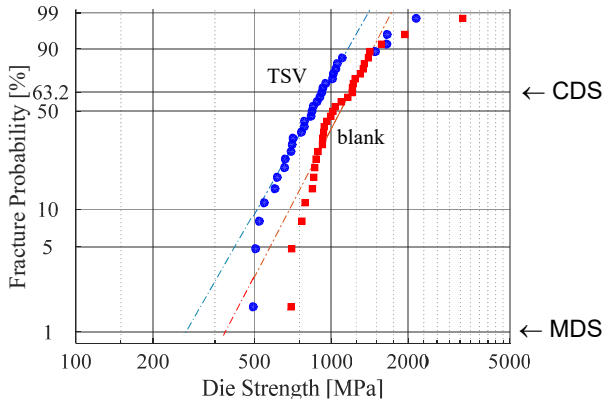
4. Die strength | example: blank vs. TSV

- wafer preparation & strength measurement by IMEC
- IMEC's standard 5x50 µm via-middle TSV
- die size 10x10x0.05 mm | stealth dicing



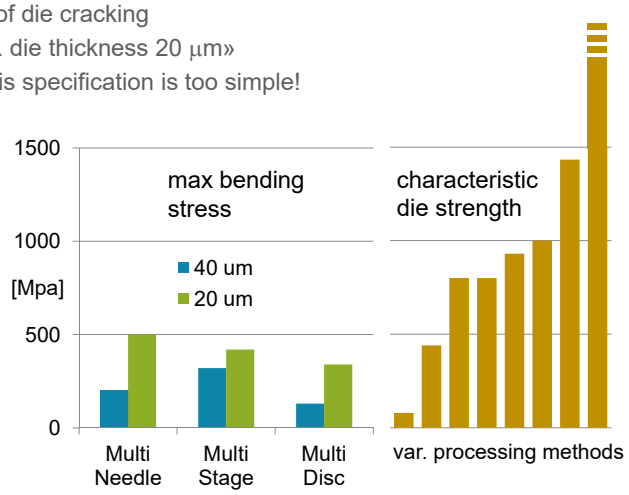
4. Die strength | overview

wafer processing	CDS [MPa]	
conventional backgrind, #320	80	backgrinding grit size effect
conventional backgrind, #2000	800	
DBG, CMP	1'000 – 15'000	
DBG, CMP, thickness 100 um	440	size effect
DBG, CMP, thickness 30 um	1'433	
DBG, blank 20 um	1000	structure effect
DBG, metal tracks and bondpads	800	
Stealth dicing, with TSV's	930	

- large variation, 2 orders of magnitude!

4. Die strength vs. bending stress

- typical ranges are very close
- risk of die cracking
- «min. die thickness 20 µm»
  → this specification is too simple!



Summary

- Introduction of the key properties
- Wafer foil bulk & edge peel force
- Bending stress: ejector types, FEA model, comparison
- Die strength: overview

Acknowledgements

- Thanks to Shotaro Kato and co-workers (Hitachi Chemical) for providing test wafers
- Thanks to W. Teng, A. Podpod (IMEC, Belgium) for providing strength data for TSV dies