PROBERS WITH PHYSICAL STIMULUS – NEW ERA FOR MEMS FINAL TESTING

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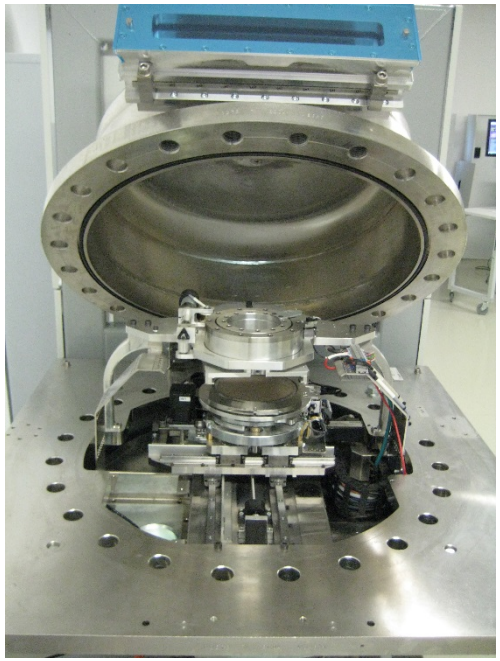
PROBER WITH PHYSICAL STIMULUS - WHAT IT IS

- Handles the DUTs on film frames, whether in diced or un-diced form (or bare wafers).
- Applies the real physical stimulus while probing
- Capable also for **final** testing (not only MEMS elements)
- The only feasible solution for WLCSP testing?
- Also capable of testing conventional package types

KRONOS – PROBER FOR MOTION SENSORS, UP TO 9 DOF

AIOLOS – PROBER FOR ENVIRONMENTAL SENSORS



MEMS TESTING CHALLENGES

- ECONOMICAL CHALLENGES:
  - The nominal COT (Cost of Test) with current test systems has not increased, but the percentual COT has, due to price dilution of sensors ($25 -> $2,5 -> $0,25 ->???)
  - Market demands for more economical ways to test
    - COT/cost price > 30% is intolerable
- TECHNICAL CHALLENGES DUE TO PACKAGE DEVELOPMENT:
  - Miniaturization of sensors, new package technologies
    - WLCSP (chipping, alignment)
    - Complicated handling (reliability issues)

WHY PROBER WITH STIMULUS?

Prober with physical stimulus (= Wafer Level Test Handler) is an excellent response to the market demand of lower cost of test (COT) and to the challenges of sensor miniaturization.

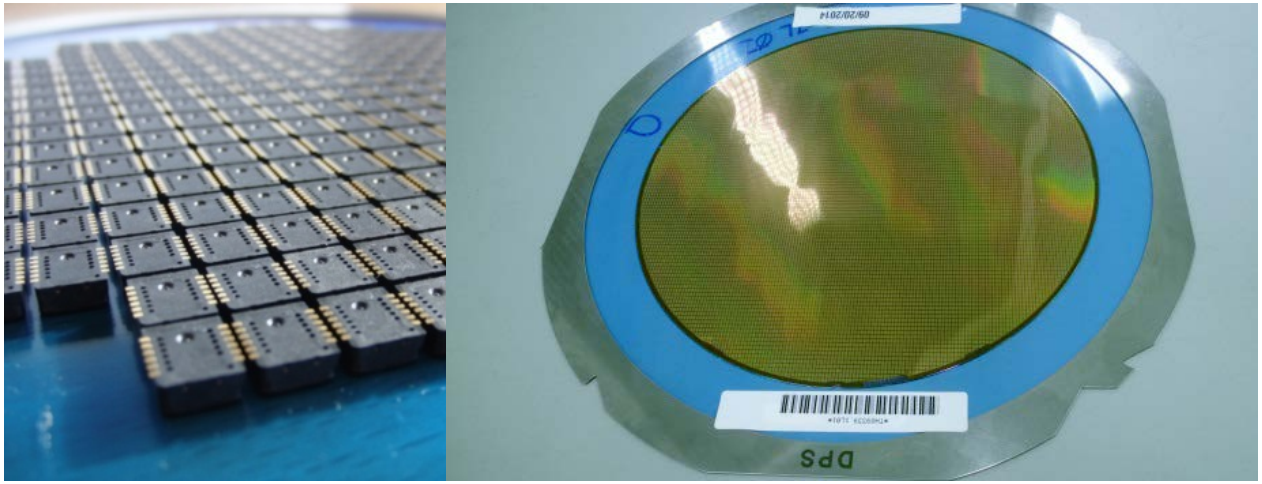
Use of stimulus prober gains:

1. **High capacity**
2. **Short test process**
3. **Jam free operation and smooth handling**
4. **Versatility**
5. **Reliable operation with small sensors**

All this leads to the lowest COT

1. HIGH CAPACITY

- Everybody is talking about MORE PARALLELISM. The bigger the number of sensors under test simultaneously, the bigger is the capacity. Simple?
- Any other ways to increase the capacity without risking reliability and without increasing CAPEX? New way to test?
- Yes, Multiple touchdown method.



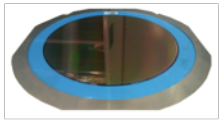
TWO WAYS TO TEST MEMS

1. **Single touchdown method – common practice**
   - Only possible way to test MEMS with traditional gravity/p&p handlers
   - Load group of DUTs to stimulus unit → execute all tests → unload → load new group of DUTs

2. **Multiple touchdown method – a new way to test**
   - Suitable for probers with physical stimulus
   - Load wafer ring (film frame) to prober → set stimulus → probe all DUTs → set stimulus → probe again→ …→ unload wafer.

UPH EXAMPLE
3-axes accelerometer, 16000 DUTs, 32 parallel, 4 stimulus points, zero test time

Multiple touchdown method - Prober with physical stimulus



16k

LOAD TO PROBER

Load/unload
To handler +
alignment
180 s

GO TO ANGLE

2,5 s

GO TO INDEX

EXECUTE TEST

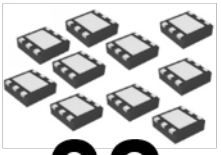
500 x 0,5 s

4 x [2,5 s + (500 x 0,5 s)]

UPH
48 400

Loading +
rotation time +
index time
= 1190 s

Single touchdown method - P&P handler



32

LOAD TO HANDLER

UNLOAD HANDLER

7 s

GO TO ANGLE

EXECUTE TEST

4 x 0,5 s

500 x [7 s + (4x 0,5 s)]

UPH
12 800

Loading +
rotation time
= 4500 s

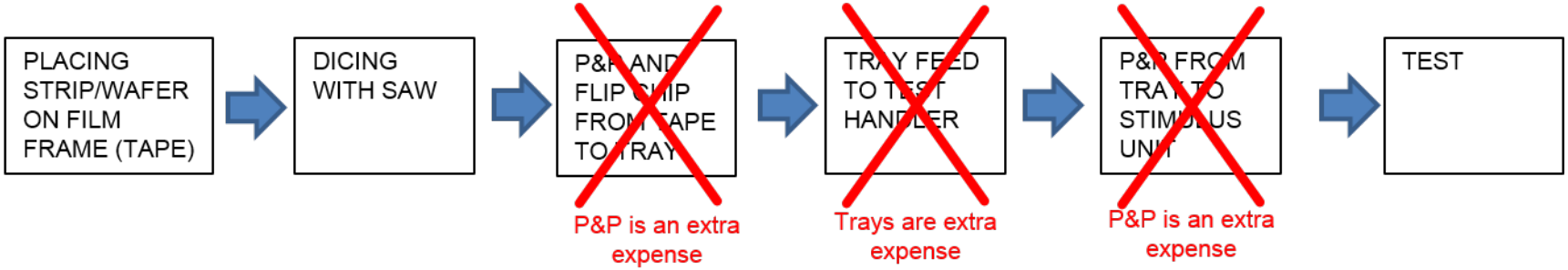
WHY MULTIPLE TOUCHDOWN METHOD GIVES SO MUCH HIGHER UPH?

1. **The time is used for testing, not for loading and unloading.**
   - On film frame >10 000 DUTs are loaded to system at the time
   - With pick&place for same amount hundreds of loadings are needed. Loading/unloading time is waste time
2. **Stepping is fast compared to stimulus change**
   - Accelerometer is the easiest. The difference in UPH will even grow with other type of stimuli

Sensor type	Prober index time	Stimulus change	Note (stimulus change)
accelerometer	0,5	0,5 s	Change of angle
gyroscope	0,5	2 s	Acceleration + deceleration
pressure sensor	0,5	3 s	Change of pressure + pressure stabilization time

2. SHORT PROCESS

Typical current process:



Process with Stimulus Prober:

2. SHORT PROCESS

- Saves CAPEX
- Every process have a yield → Less processes, better yield
- Saves clean room floor space
- Reduces operational cost
- Reduces maintenance cost
- Minimizes the amount of material in process

3. JAM FREE OPERATION AND SMOOTH HANDLING

- When operating with Prober with physical stimulus and film frames the risk of getting jams is close to zero.
- The DUTs are not affected to any shocks when handled on film frames
- The contact force of the prober is adjustable and can be optimized for each case. Also the contacting movement can be smooth.
- The DUTs are in well organized form on the tape. There is no need for extra mechanical alignment, which could cause strain to MEMS structure.

4. VERSATILITY

- Change from product to product means only the change of probe card and recipe.
- Prober with physical stimulus is also applicable for conventional package types (LGA, BGA, QFN etc.). Strips, diced strips, singulated components placed on film frame.
- Capable of doing both front-end and back-end (final) testing

5. RELIABLE OPERATION WITH SMALL SENSORS

- This has lot to do with the short process. Handling of small sensor (like 1x1 mm) is always complicated. Less operations → better reliability
- Sensors on the film frame are well aligned. The only alignment needed is the alignment of the whole film frame, which is simple.
- Handling and contacting is smooth and well controlled, no shocks.

KRONOS COST OF TEST
COT example for 3-axes accelerometer

Price for total solution	900 000	EUR	Full test Cell (handler, tester, probe card)
Cost for labour (annually)	20 000	EUR	Operator cost 5 shifts (24/7)
Operator cost per hour	5	EUR	8000 hours/year
Cost for use	20000	EUR	Consumables, energy
Test capacity	140 000	UPH	With zero test time
Real test capacity	13 000	UPH	UPH: with 5 turn test/calicration and 32 accelerometers parallel
Cost of test (COT)	0,04	Cents	No CAPEX included
	0,21	Cents	CAPEX using 5 years depriciation
	0,13	Cents	CAPEX using 10 years depriciation

CONCLUSIONS

- Prober with physical stimulus:
  - Capable also for final testing
  - With WLCSP the only testing? (skip front-end testing)
  - Capable also for testing conventional package types
  - Meets the challenges of sensor miniaturization
  - Yields high capacity
  - Shortens the process
  - Gains the lowest COT
  - KRONOS for 9DOF motion sensors
  - AIOLOS for environment sensors