PROMINENT

Processes for MEMS by Inkjet Enhanced Technologies

Partners: Okmetic (Contact Markku Tilli) , FI; Murata Electronics (Heikki Kuisma), FI; Tampere University of Technology (Matti Mäntysalo), FI; Spinverse (Pirjo Pasanen), FI; Silex (Thorbjörn Ebefors), SE; KTH Royal Institute of Technology (Andreas Fischer), SE; Mycronic (Gustaf Mårtensson), SE; InnoPhysics (Alquin Stevens), NL; poLight (Jon Herman Ulvensøen), NO; Nanium (André Cardoso), PT

General description

Printed electronics achieved recently considerable progress due to new printing technologies and to the introduction of nanoparticle inks, paving the way towards integrating its capabilities within the silicon-based nanoelectronics. The objective of the ENIAC JU project PROMINENT is to demonstrate significant cost reduction in MEMS manufacturing by using printing technologies to reduce materials, chemicals and energy consumption, waste water production, processing cycle time and capital investments.

Goals / Objectives

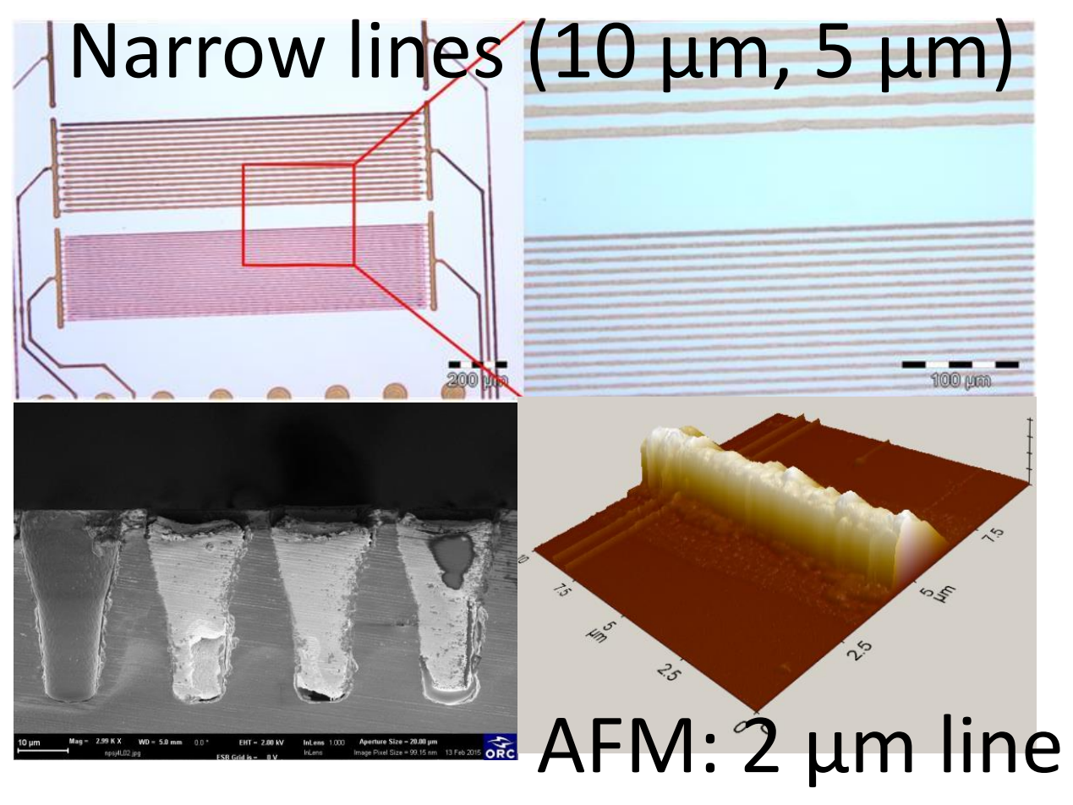
In particular, executing selected steps in the MEMS manufacturing using maskless, digitally controlled, localized additive processes instead of the incumbent subtractive processes will result in a greatly simplified process sequence. This will result in

- lower initial investment costs for a MEMS line, making it easier for manufacturers to introduce new products
- new features in the MEMS devices, new application areas
- increased flexibility in production, allowing for smaller batches, mass customization and fast changes in the production process
- easier prototyping and shorter time-to-market period in new MEMS devices
- greatly reduced production costs and environmental impact

Results

High-density printing

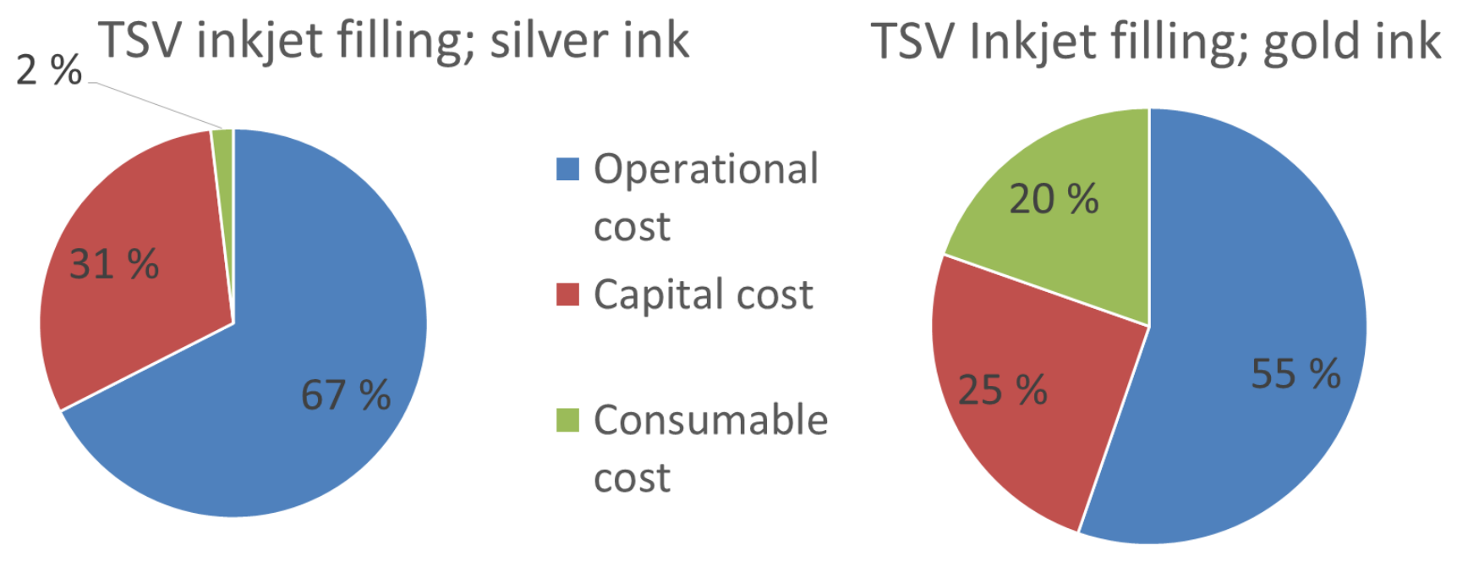
- EHD printing is used to fabricate high-density RDL and TSVs using Ag and Au inks
- Excellent sheet resistance was achieved
- In this work: TSV-diameter of 23 µm.
- Full-filling due to fast evaporation of small droplets without heating


Narrow lines (10 µm, 5 µm)
AFM: 2 µm line

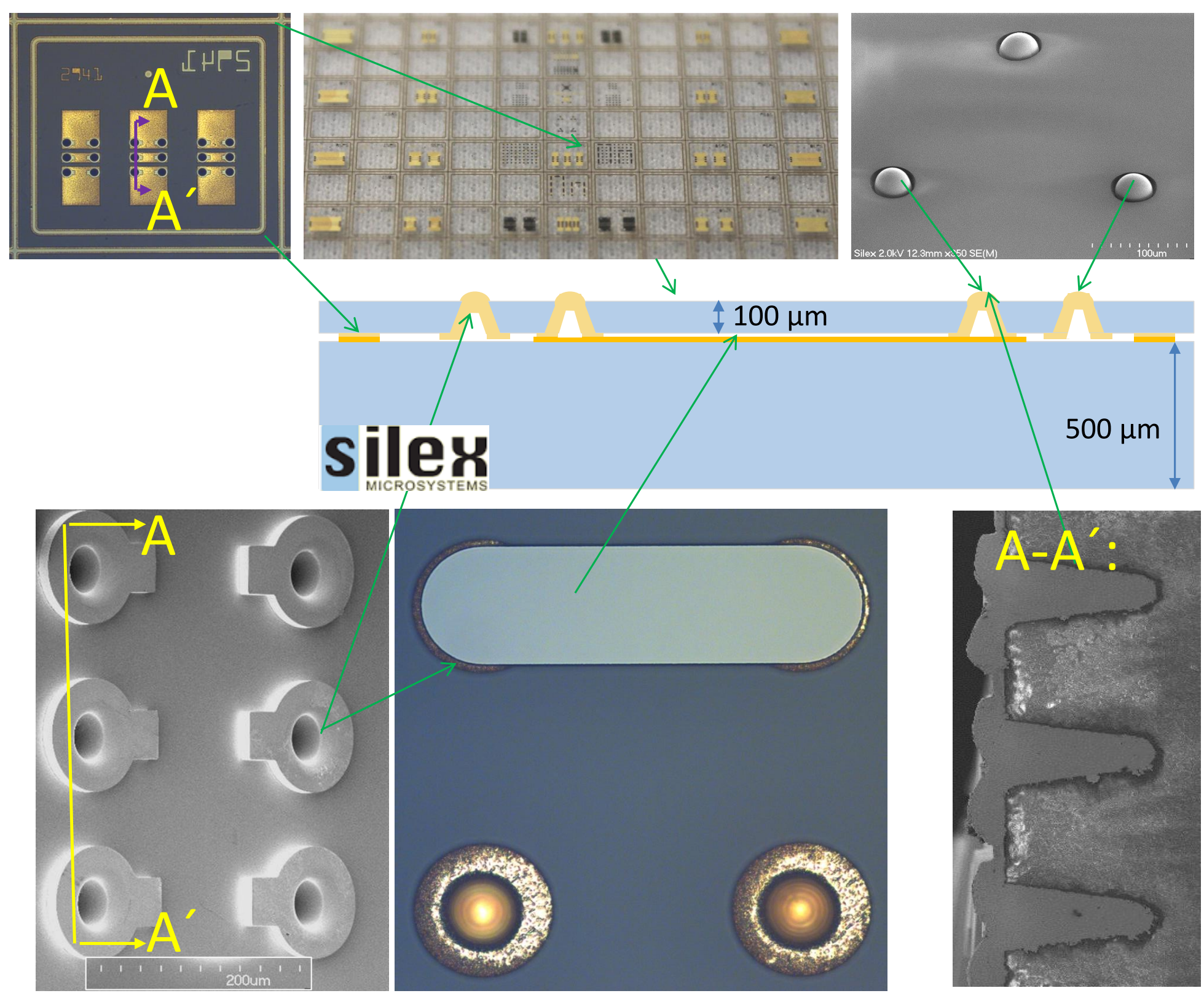
Cost modelling of TSV filling using inkjet technology

Cost modelling tool

- Model allows parametric study of printing time and cost
- Cost is allocated to processes based on processing time and consumables used, capital investment.
- Example: gold ink vs. silver ink for fully filled vias: the price per wafer is over 20 % higher using gold ink, and cost structure is significantly different

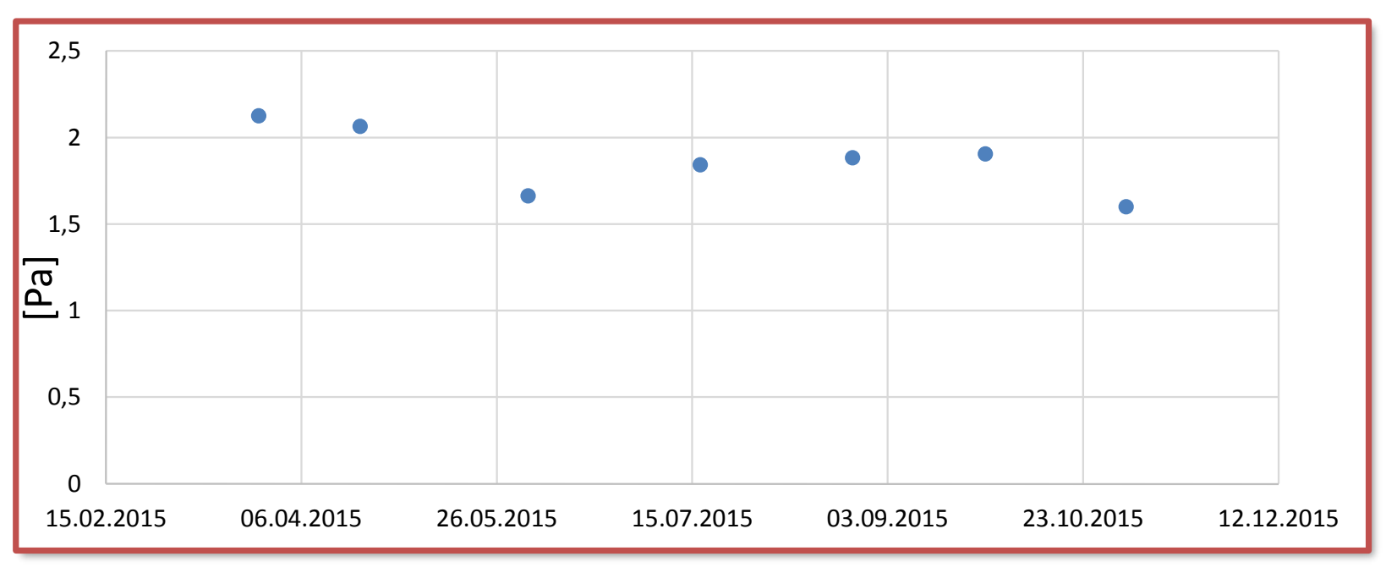


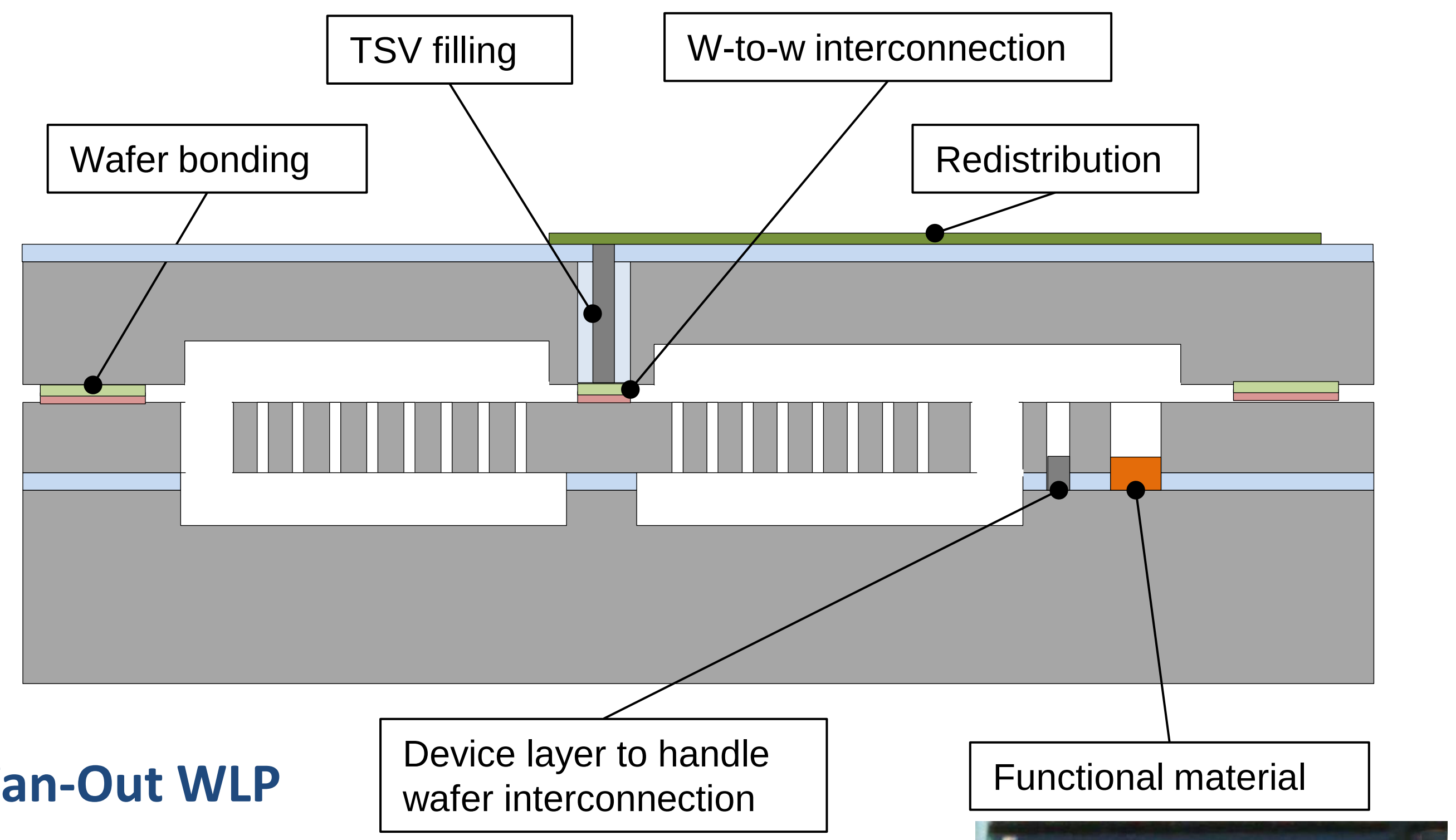
- Biggest cost savings compared to traditional processes can be achieved with laser drilled vias
- Printing time is extremely dependent on the parameters.



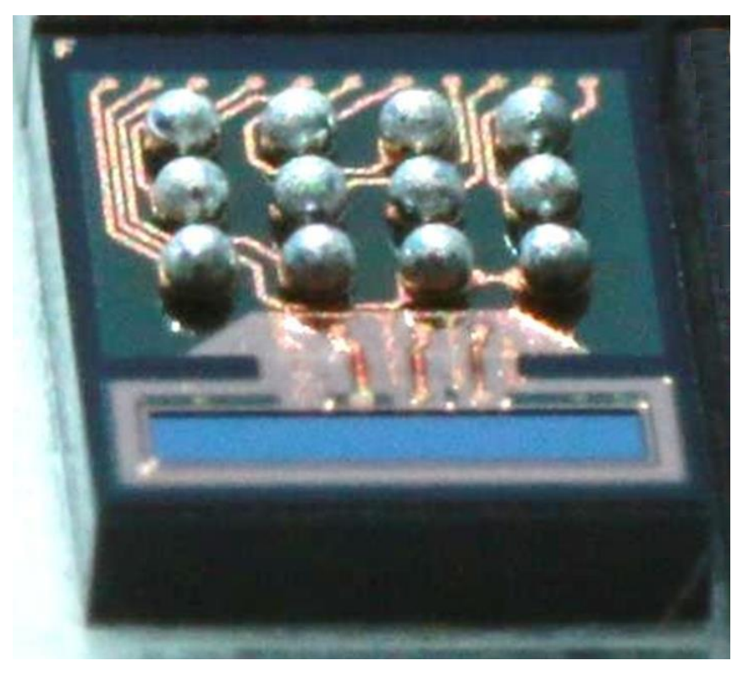
Through Glass Vias

- TGVs with Au-Au W2W interconnection through Wafer Level Bonding with low RF losses -0.006dB @GHz.
- Long term vacuum / pressure stability testing from Prominent deposited functional material





Fan-Out WLP



- Fan-Out WLB is an optimum platform for heterogeneous integration of MEMS and ICs in small form factor.

Tlens

- The first Tlens® is fully integrated in a camera module and demonstrated in high end phone.
- Shown in Mobil World Congress 2015 and other meetings.

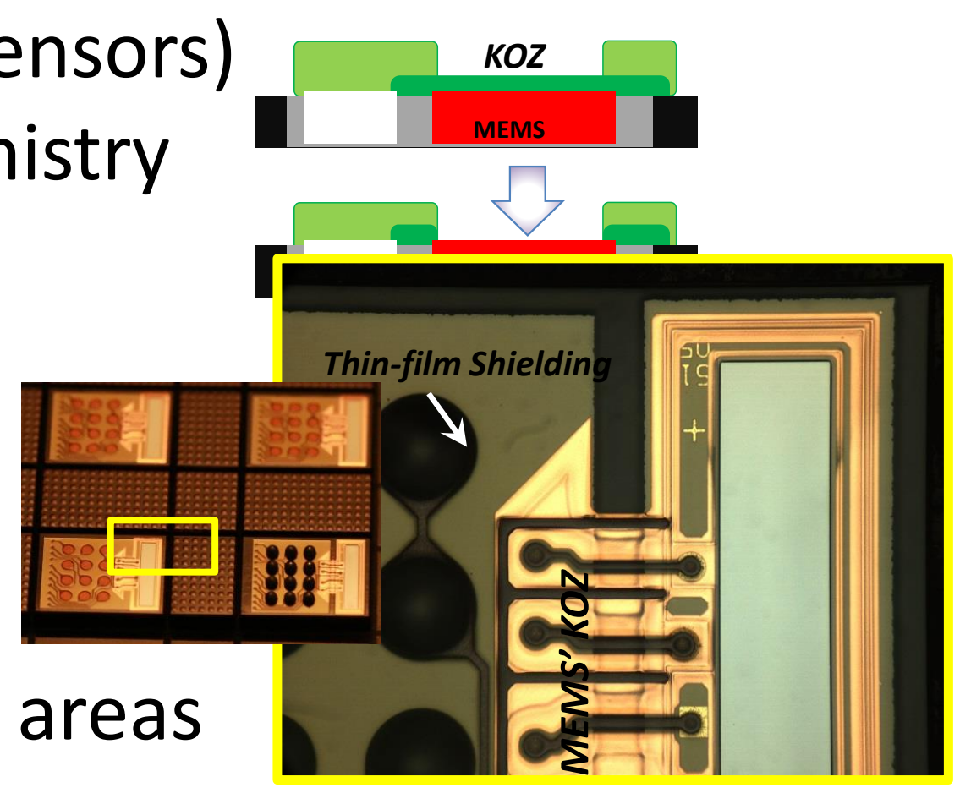
MEMS in Fan-Out Wafer Level Packaging

Keep-Out-Zones

  - Open areas on RDL (e.g., MEMS, sensors)
  - Protection of areas from RDL chemistry
- How?
  - Thick DL2 mask over thin DL1
  - Plasma ashing discrimination

Thin-Film Shielding

  - Electrostatic shielding on sensitive areas
- How?
  - Low cost solution using RDL seed layer



Additional information

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Project leader: Markku Tilli
Company: Okmetic Oyj
Email: markku.tilli@okmetic.com
Tel.: + 358 40 500 8210

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