Through-Glass-Via Enabling Low Loss High-Linearity RF Components

Silex MICROSYSTEMS

KTH VETENSKAP OCH KONST

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Summary

Successful fabrication of metalized through glass vias (TGVs) using glass wafers for low-loss high-linearity 3D wafer-level packages (WLP). Characterization of the TGVs shows significantly better performance than today´s commercial TGV MEMS technology, with DC resistance of 28mOhm/TGV and the non-linearity of *two sets of TGVs with a 1.1 mm long transmission line* gave ***excellent non-linearity performance of 78 dBm.***

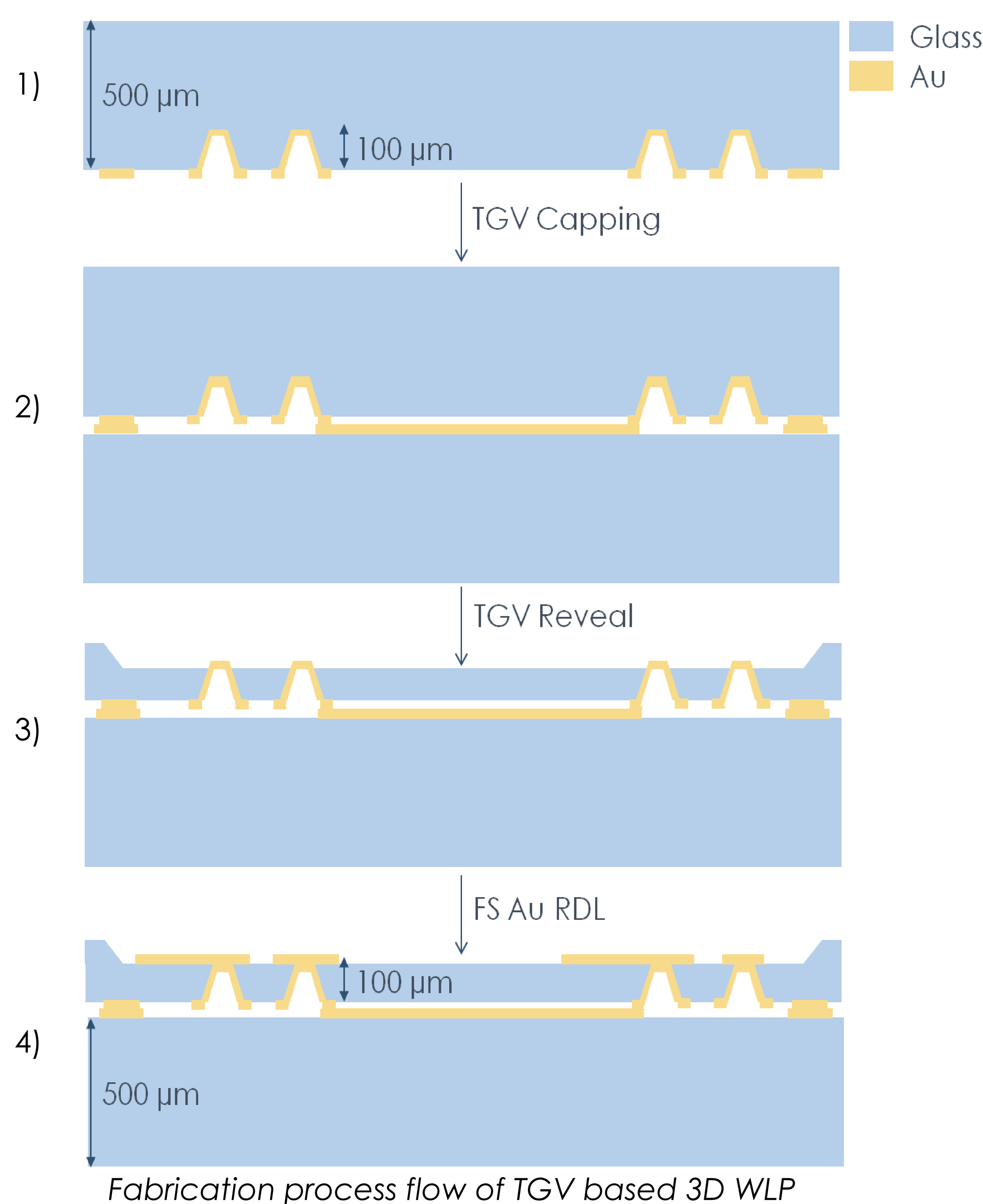
Why Through Glass Vias (TGVs)?

MEMS technology market is now aiming at miniaturization of high performance applications, in particular radio-frequency (RF MEMS). By using 3D WLP with TGVs, shorter low loss electrical connections and smaller foot print can be achieved. Compared to commercial available silicon based vias (TSVs), glass substrates provides superior electrical insulation and low capacitive coupling, which is critical parameters for RF signal handling.

How to fabricate TGVs?

The fabrication of the TGVs were executed on 150 mm Eagle glass substrates, which are alkaline earth boro-aluminosilicate and contain no heavy metals.

1) The via holes were fabricated and the redistribution layer (RDL) and W-2-W bond pad as well as the metallization of the vias were realized by conformal Au-plating, 7 µm thick, and *2)*bonded to a glass cap wafer. *3)* A thinning and reveal process was executed in order to *4)*contact the TGVs from the front side with 7 µm thick Au-RDL.

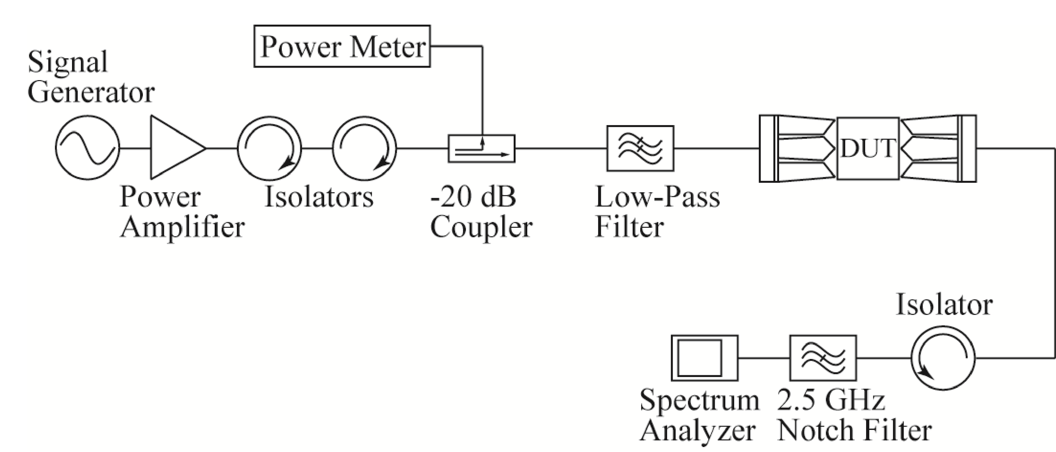


Fabrication process flow of TGV based 3D WLP

Successful full wafer fabrication process of the TGVs was established and by DC measurements via resistance of 28 mOhm/via concluded, including RDL and bond interfaces.

RF – Characterization Set-up

The linearity of the TGVs was characterized by measuring the output power of the 2nd and the 3rd harmonics in relation to the input power at the center frequency of 2.5 GHz for a coplanar waveguide transmission line with and without TGVs. This was done with a very broadband measurement setup (up to the 3rd harmonics).



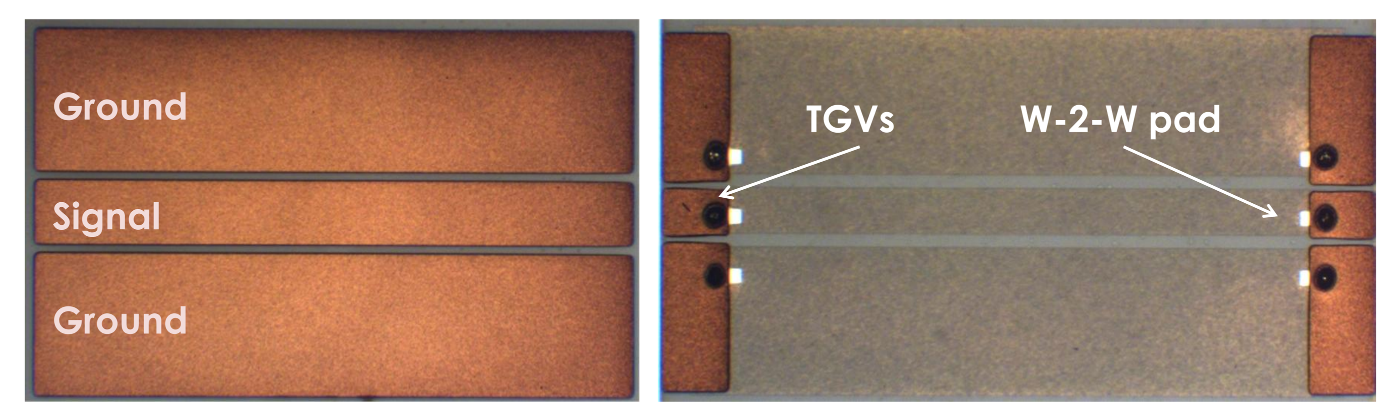
Harmonics measurement setup

The measurements were performed at several input power levels ranging from 11.5 to 36.5 dBm. The 2nd harmonic level for both the thru line and the line with TGVs is roughly the same while the 3rd harmonic level for the line with TGVs is about 2 dB lower as compared with the thru line without TGVs.

RF – Characterization Results

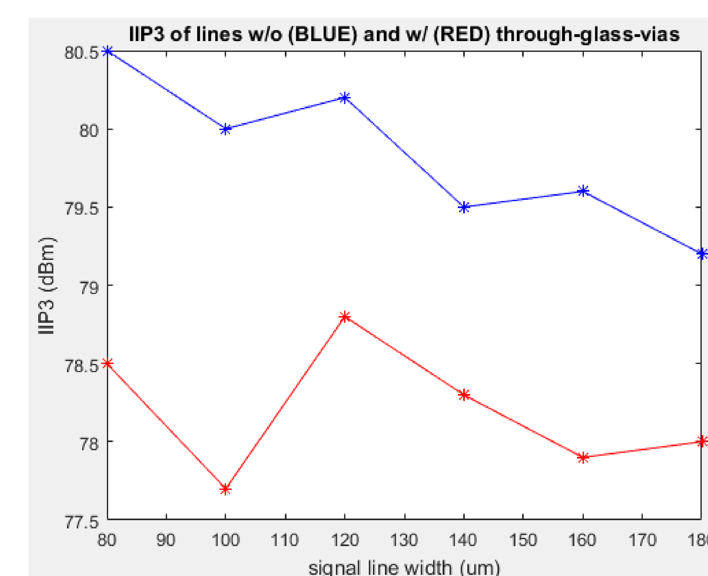
RF characterization was performed on full 6” wafer, where 1.1 mm long transmission lines with signal width from 80-180 µm was measured.

The non-linearity (IIP3) for the straight 50-Ohm transmission lines (a), with signal line widths from 80 to 180 µm, are between 80.5 and 79.2 dBm.

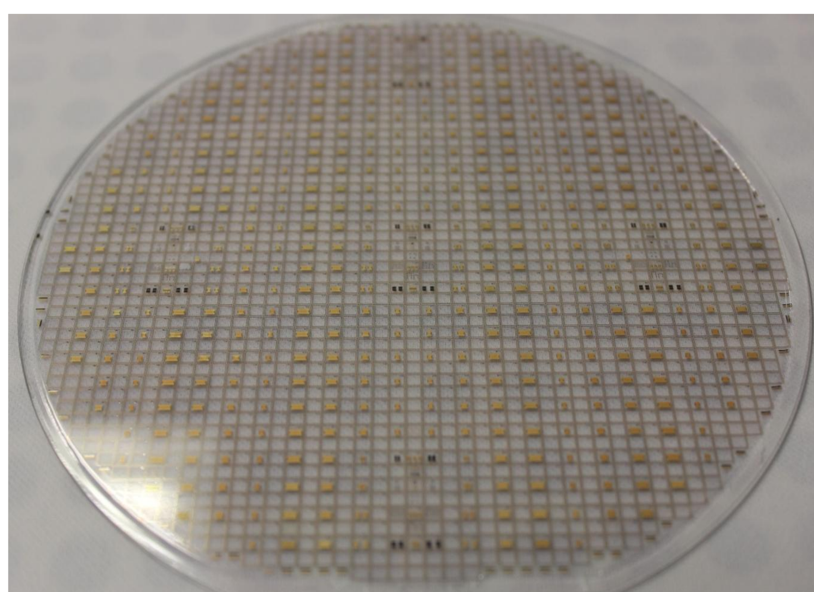


a) 50-Ohm transmission lines *b) Transmissions line with two sets of TGVs*

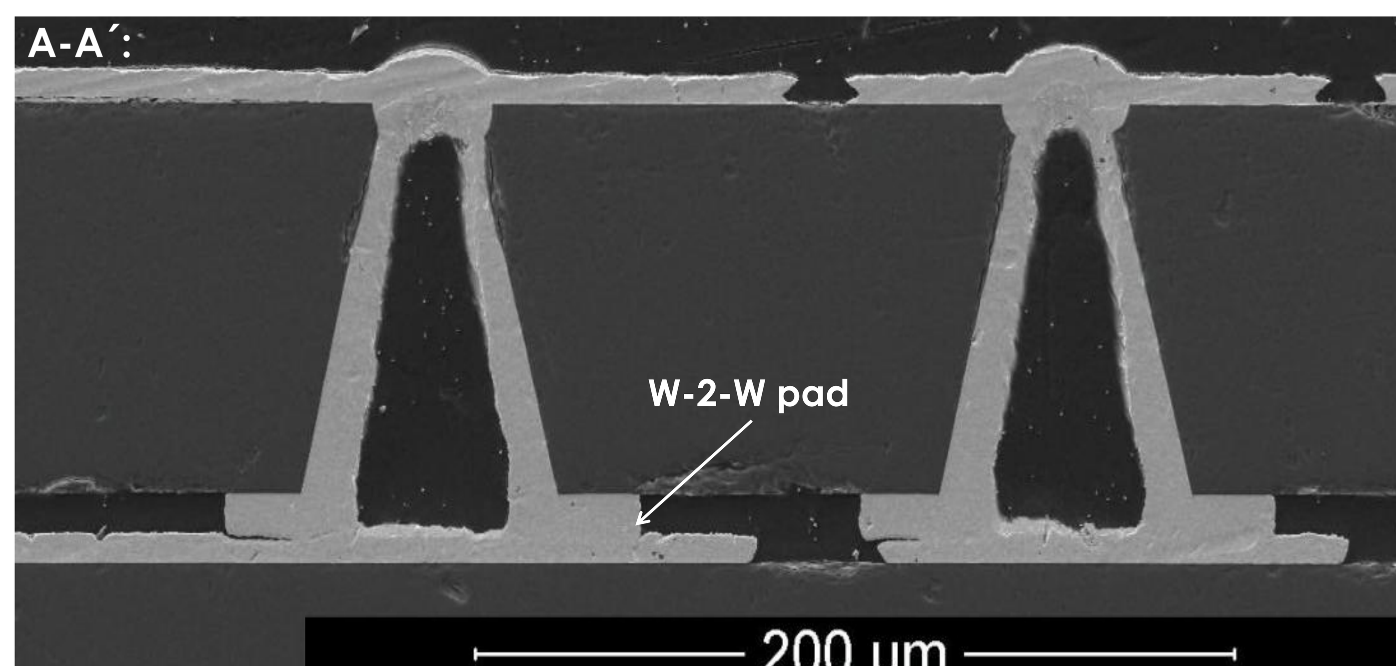
IIP3 measurement results for these transmission lines with two sets of TGVs (b) are 78.5 to 78.0 dBm.



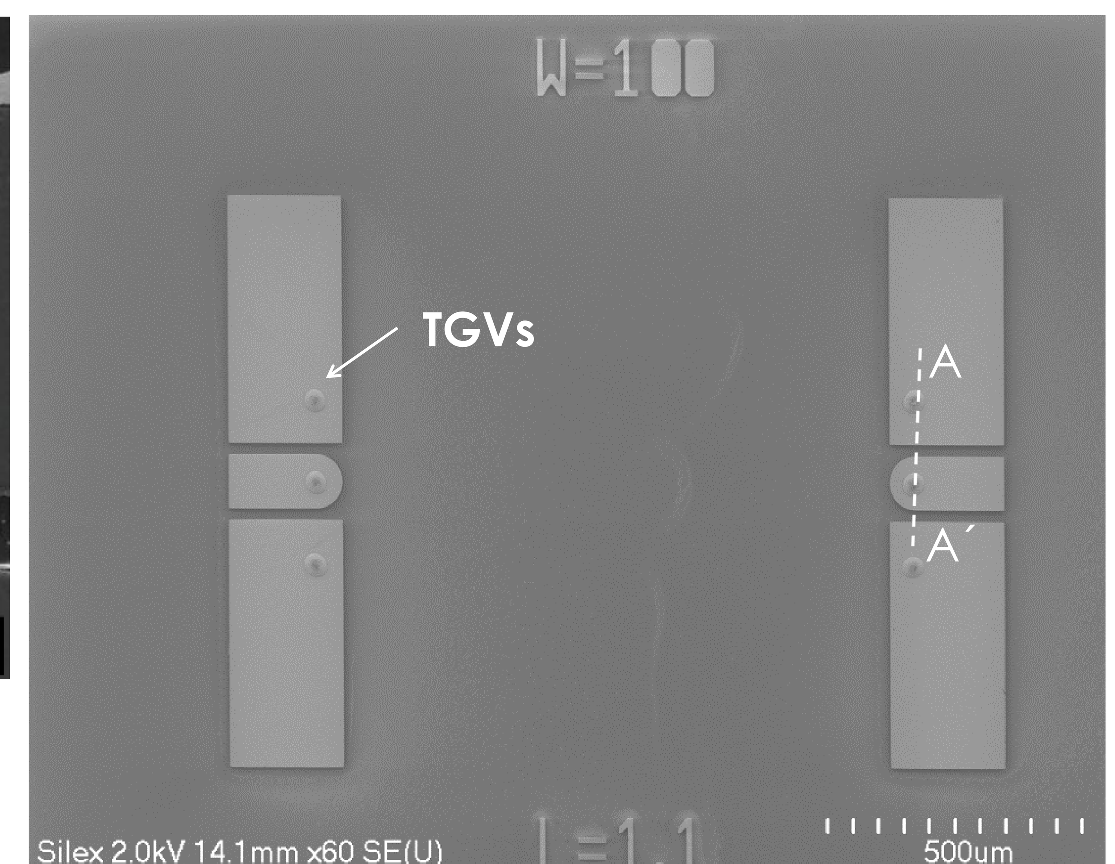
IIP3 results over signal line width for all devices in for through lines without vias (top line) and through lines with two sets of vias each (bottom line).



Full 150 mm 3D WLP bonded glass wafer pair with using Au-Au thermo compression bond TGV



Cross-section of the TGVs showing the conformal Au-plating and the wafer to wafer (W-2-W) bond interface.



Top view SEM image of G-S-G TGV RF test structure.

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