MICROPRINCE-Open access pilot line for Micro-Transfer-Printing of functional components on wafer level

*Dr. Sebastian Wicht[1], Sebastian.Wicht@xfab.com; Dr. Uwe Krieger[1], Uwe.Krieger@xfab.com; Daniela Guenther[1], Daniela.Guenther@xfab.com; Niclas Heise[1], Niclas.Heise@xfab.com; Matthias Krojer[2], Matthias.Krojer@xfab.com; Dr. Gabriel Kittler[2], Gabriel.Kittler@xfab.com; Falk Naumann[3], falk.naumann@imws.fraunhofer.de; Frank Altmann[3], frank.altmann@imws.fraunhofer.de; David Gomez[4], dgomez@x-celeprint.com; Alin Fecioru[5], afecioru@x-celeprint.com

[1] X-FAB MEMS Foundry GmbH, Haarbergstr. 67, 99097 Erfurt, Germany

[2] X-FAB Semiconductor Foundries GmbH, Haarbergstr. 67, 99097 Erfurt, Germany

[3] Fraunhofer IMWS, Walter-Huelse-Str.1, 06120 Halle, Germany

[4] X-Celeprint US, Research Triangle Park NC, USA

[5] X-Celeprint Ireland, Dyke Parade Cork, Ireland

Oral presentation

Introduction

Micro-transfer-printing (µTP) represents a versatile micro-assembly technology which has been developed in laboratory and (for photo-voltaic application) in an industrial environment over the last ten years. Within the European funded ECSEL project “MICROPRINCE” the worldwide first open access pilot line for µTP will be installed in the clean room facilities of the X-FAB MEMS Foundry GmbH. Moreover, the project possesses the objective to demonstrate the capabilities of this pilot line for heterogeneous integration of different application scenarios. Therefore, functional components for several target applications will be transferred and assembled on wafer level and the benefits of the µTP technology will be explained.

Pilot line for micro-transfer-printing

The µTP process relies on a wafer level integration technology that utilizes an elastomer stamp to transfer devices or arrays of devices from their native substrate wafer to a non-native target material [1]. A crucial constraint for this process is that the stamp, commonly consisting of polydimethylsiloxane (PDMS), provides reversible or switchable adhesion properties to the source material [2]. Thereby, high adhesion during the “pick-up” as well as low adhesion forces during the “placing” processes as illustrated in Figure 1a) can be achieved.

The primary objective of the ECSEL project “MICROPRINCE” is to facilitate this technology in an industrial environment by the installation of an open access pilot line. As can be seen in Figure 1b) the µTP process requires several pre- and post-process steps to enable the functionality of micro-assembled devices. Starting with the source wafer it is mandatory to form reliable anchor and tether structures that carry the printable chiplets after the release (under-etching of the device) until the print process. Concerning this source wafer process step, results of recent developments on utilizing and characterizing silicon nitride tethers will be presented.

On the other hand the target material has to be coated with an intermediate layer that will provide a good adhesion of the chiplet after the printing process. Moreover, this adhesion layer has to be patterned once the printing is done and, for some application, the printed coupon has to be electrically contacted via a redistribution layer (RLD) and finally passivated.

In addition to the installation of the required equipment and the development of the related processes, the MICROPRINCE project aims on the demonstration of the capability of this

micro-assembly technology by fabricating four different target devices. These devices include heterogeneously integrated optical sensors carrying filters, current sensors based on GaAs hall plates, driver ICs equipped with LEDs for car illumination and finally photonic devices printed onto passive waveguide materials for biomedical applications.

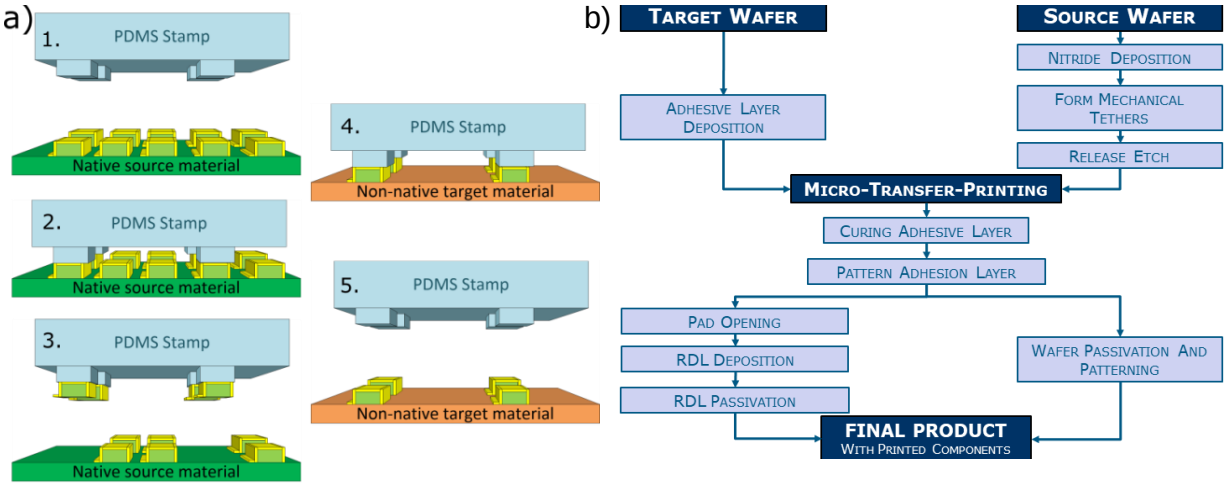

Figure 1a): schematic illustration of the transfer-printing process including the device pick-up from a dense source wafer as well as the "diluted" placement on a non-native target material. Figure 1b) visualizes a schematic overview of all the pre- and post-printing steps which are mandatory for the micro-assembly technology.

Conclusion

By this publication the ECSEL project “MICROPRINCE” will be introduced. The project aims on the installation of a pilot line for heterogeneous integration of functional components via the micro-transfer-printing (µTP) process. This technology is based on the micro-assembly of devices on non-native target materials by the transfer with elastomer stamps.
In addition to that, the capabilities of the technology will be demonstrated by four different target applications including the printing of filters, LEDs, Hall plates and active photonic devices.

References

[1] C. A. Bower, M. A. Meitl, S. Bonafede and D. Gomez, ”Heterogeneous Integration of Microscale Compound Semiconductor Devices By Micro-Transfer-Printing”, IEEE 65th ECTC Proceedings (2015).

[2] M. A. Meitl, Z.-T. Zhu, V. Kumar, K.J. Lee, X. Feng, Y.Y. Huang, I. Adesida, R.G. Nuzzo, and J.A. Rogers, “Transfer Printing by Kinetic Control of Adhesion to an Elastomeric Stamp,” Nature Materials 5, 33-38 (2006).

The MICROPRINCE project has received funding from the ECSEL Joint Undertaking under grant agreement No 737465. This Joint Undertaking receives support from the European Union’s Horizon 2020 research and innovation programme and Germany, Belgium, Ireland.