TERAmeasure Non-contact millimeter and Terahertz frequency measurement paradigm for instrumentation and sensing applications unlocking metrology-grade results

D2.1:
First batch of samples for interconnect head

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Dissemination level		
PU	**Public**	**X**
PP	**Restricted to other programme participants (including the Commission Services)**	
RE	**Restricted to a group specified by the consortium (including the Commission Services)**	
CO	**Confidential, only for members of the consortium (including the Commission Services)**	

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Document updates

Version	Date	Author	Organisation	Changes
1.0	26/04/2022	G. Carpintero	UC3M	First draft. Sent to partners
1.1	29/04/2022	S. Lauck	HHI	Review
2.0	20/04/2022	G. Carpintero	UC3M	Consolidation of review comments

Abbreviations

VNA	Vector Network Analyser	**mmW**	Millimetre wave frequency (30 GHz–300 GHz)
THz	Terahertz wave frequency (300 GHz–3 THz)	**PIC**	Photonic integrated circuit
Tx	Transmitter	**Rx**	Receiver

Statement of independence

The work described in this document is genuinely a result of efforts pertaining to the TERAmeasure project. Any external source is properly referenced

Confirmation by Authors:

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Executive Summary

This deliverable, by means of photographic documentation, reports on the successful fabrication of the first iteration of sample devices of micromachined silicon rod waveguides from KTH and chip with photomixers for transmitter and receiver functionalities from HHI for SUB-SYSTEM 1.

These are the key elements for the novel interconnection head of the photonic-based vector network analyser (VNA) signal source.

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1. Introduction

The interconnection head is the element enabling the radically new measurement paradigm in the millimetre (MMW, 30 GHz–300 GHz) and Terahertz (THz, 300 GHz–3 THz) frequency bands, overcoming the current obstacles to better measurements by eliminating the frequency banded nature of rectangular waveguides.

This deliverable reports the achievement of the end of the first fabrication round of the two key components for the assembly of TERAmeasure interconnection head. These two components were identified as key breakthroughs in the project:

1) Transceiver Chip (UC3M, HHI-THz), to unlock continuous-wave frequency generation and phase sensitive detection, including 1550 nm photomixing emitter (Tx) and receiver (Rx) with wideband antennas creating a point source to optimize the coupling of the generated signals to the dielectric waveguide over a wide frequency range.

2) Dielectric waveguide (UC3M, KTH), to unlock the ultrawideband non-contact interconnection between the interconnection head and the Device-Under-Test. This is a critical element which needs to provide low insertion losses, over an extremely wide frequency range. These are challenging aspects, as it is difficult to achieve impedance match over such a spectral range.

It has demonstrated extremely convenient that UC3M was involved in the design of both components to maintain the compatibility between the two, in order to assemble the interconnection head, ensuring the desired performance.

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2. Transceiver Chip

2.1 Fabricated photomixers for the first iteration of the interconnection head

The concept design required to separate the transmitter and receiver elements in separate chips.

During the design phase of first batch of devices, there were many improvements in the structures. To decrease the risk, we focused in photoconductor devices, which can act as transmitters and receivers.

After the fabrication of the mask-sets comprising the designs that resulted from Task 1.2, the fabrication of the first iteration of TERAmeasure photomixers has been carried out successfully.

A picture of the fabricated photomixer wafer is shown in Figure 1a), as well as separated and cleaved as shown in **Figure 1**.

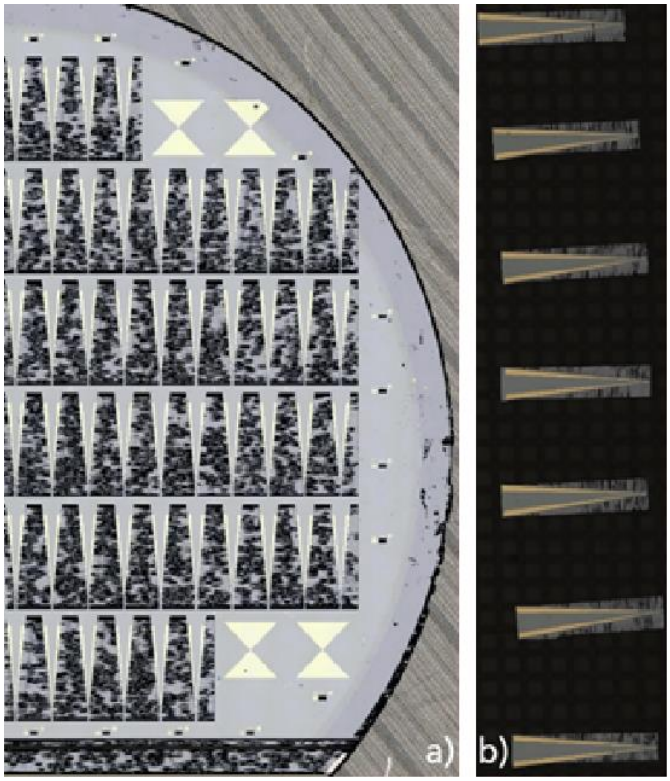

Figure 1. Picture of the fabricated photomixer wafer a), cleaved chips b), singulated devices.

Figure 2 shows the measurement setup for characterizing the photoresponse of the PCAs. The photoconductive area between the metal contacts is illuminated by a lensed polarization-maintaining optical fiber. By sweeping the optical power and the bias voltage and measuring the resulting photocurrent, we verified the functionality of the fabricated devices.

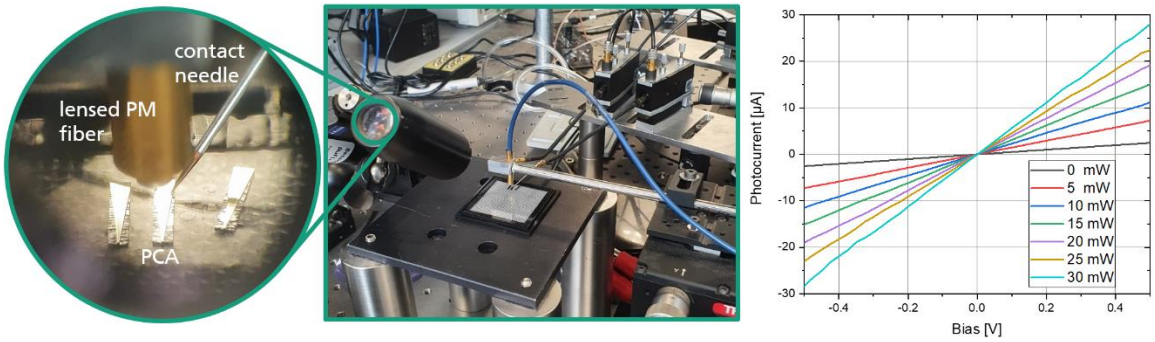

Figure 2. Setup and results of the photocurrent measurement of the fabricated PCAs.

3. Dielectric Waveguide

Fabricated silicon rod waveguides and other elements for the first iteration of the interconnection head

Different silicon designs were developed, including dielectric rod waveguides. These designs aimed to assemble a structure for launching the signals generated by the photoconductors into the dielectric rod waveguides.

The fabrication of the mask-sets comprising the designs that resulted from Task 1.3, the fabrication of the first iteration of silicon rod waveguides were carried out successfully.

Figure 3 shows a picture of the parts fabricated by KTH, shipped to UC3M for assembly.

(a)

(b)

Figure 3. Picture of the silicon rod waveguides fabricated by KTH: (a) casing received at UC3M, and (b) content with the fabricated parts.

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4. Conclusions and next steps

The pictures of the components shown enable us to proceed with the hybrid assembly tests combining the InP chips with the silicon parts for the 1st generation of interconnection heads.

The assembly results will be reported in Deiverable 2.3 (due in month 16).